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ALPHABETICAL LIST OF SUBJECTS.

RESEARCHES

ON

THE STATE OF THE HEART,

AND THE

USE OF WINE IN TYPHUS FEVER.

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Before I enter on the investigations which form the basis of this paper, I may premise, that I consider typhous fever as an essential disease, not symptomatic of any known local lesion. To British readers this may appear unnecessary, as it is only the expression of opinions entertained by our most learned and experienced physicians. But as on the continent a different doctrine is held by some eminent pathologists, and as I have found it necessary to state to many continental physicians who have honoured the Meath Hospital with their presence, that we were opposed to the doctrine of localisation, I trust that the expression of these opinions will not be considered unnecessary or egotistical by my readers at home.

There can be no doubt that the typhus of Great Britain and Ireland is a disease of the whole system, not symptomatic of any particular local lesion; showing on the one hand a tendency to a favourable termination, after a period which varies indefinitely; and on the other, being capable of destroying life *with* various lesions, or *without* any appreciable change in the solids. It is a disease on which anatomy sheds but a negative light, not telling us what it is, but rather what it is not.

With respect to the organic lesions, I consider them as much secondary to the general disease, as the pustule in small-pox is to the disease of variola. Their not unfrequent absence in the worst cases of the disease proves that they are not the cause of typhus, while in cases where they do occur, we observe a signal want of proportion between their amount and the severity of the symptoms. They are in the fullest sense inconstant in their seat and extent,

[1] Dublin Journal of Medical Science, March, 1839.

incompetent to the explanation of symptoms, and unnecessary to the characteristic phenomena of the disease.

In making these observations I do not mean to throw the slightest doubt on the accuracy of those observations, which, accumulating for many years, have shown the singular frequency of intestinal ulceration in the fever at Paris and other situations on the continent. That there exists a much greater disposition to these forms of disease in those situations must be admitted, a frequency almost sufficient to justify the doctrine of the justly celebrated Broussais, that typhus was but a gastro-enteric irritation. But as my excellent friend, Dr. Staberoh, has well remarked, we must study disease in various countries before we come to any conclusions as to its nature. Had Broussais examined the typhus of Great Britain and Ireland, he would never have formed his theory of fever.[1]

If we compare the inexperienced man with him who has had a long continued practice in fever, we may often observe that the former employs a too vigorous antiphlogistic treatment in the commencement of the disease, and delays the exhibition of stimulants until the powers of life are sunk too low, while the latter is much more cautious in husbanding the strengh of his patient, and shows much less fear of resorting to wine and other stimulants. It is in determining on the use of wine in fever that the junior or inexperienced man feels the greatest difficulty; it is in its exhibition that he betrays the greatest uncertainty and fear. This is to be explained by referring to the general character of the doctrines which have prevailed within the last quarter of a century, and which are only now beginning to yield to a more rational pathology. The doctrine of an exclusive, or almost exclusive, solidism, which

[1] Dr. Lombard, of Geneva, has lately endeavoured to show that the typhus fever of Ireland is a peculiar affection, differing from that of the continent in the absence of ulcerations. (See Dublin Medical Journal, vol. x. pp. 17, 101.) But the fact is, that intestinal ulcerations have been repeatedly observed in the typhus of Ireland, their amount and frequency varying with the epidemic influence. Of this we have abundant evidence in Doctor Cheyne's Reports. (See Dublin Hospital Reports, vols. i. and ii.) And in the epidemic of 1826 and 1827 we observed the follicular ulcerations (dothinenteritis of the French) in the greater number of cases. In many instances perforation took place, and the whole group of vital and cadaveric phenomena, corresponded almost exactly to the dothinenteric typhus of the French authors. The prominent symptoms were thirst, nausea, epigastric tenderness, vomiting, diarrhœa, and tympanitis, and in almost every dissection we found the ulcerated patches of the small intestine. Since then no severe or decided epidemic of fever has occurred, but cases of typhus are to be met with, with or without this peculiar lesion. The researches of Dr. Bright and the others in London, and of Dr. Staberoh in Glasgow, show, that ulcerations of the intestine occur not unfrequently in the typhous fever in these situations. We cannot then found any general distinction of British or continental fevers on this circumstance, the difference is in the degree of liability. This may be explained by local circumstances, and original dispositions inherent in particular races.

referred all diseases to visible changes of organs, which taught that inflammation was the first and principal morbid phenomenon, and that fevers were always the result, or accompanied with, some local inflammation, was, however disguised under various denominations, the doctrine taught to the majority of our students. Their ideas were thus exclusively anatomical; inflammation formed the basis of their limited pathology, and thus instructed, they entered on the wide field of practice, most of them having never even attended a fever hospital; utterly ignorant of the nature of essential fevers, they applied, in the diseases of debility, the treatment of acute local inflammation, and delayed stimulation until nature could not be stimulated.

Let it not be supposed that in this picture I seek to make a favourable contrast between the education which I myself received and that given to others. Far from it; I confess that it was not until several years after I commenced practice that I became fully aware of the erroneousness of what is termed the anatomical theory of disease; and I feel certain, humiliating though the confession may be, that the fear of stimulants in fever with which I was imbued, was the means of my losing many patients whose lives would have been saved, had I trusted less to the doctrine of inflammation, and more to the lessons of experience, given to us by men who observed and wrote before the times of Bichat or of Hunter.

The hospital physician will be frequently asked by students to state the principle on which he administers wine in fever, I conceive that the question may be thus answered. Typhous fever is a disease which has a tendency to a spontaneous and favourable termination, but one in the course of which the powers of life are attacked by a most malignant influence. By wine, food, and other stimulants, we support nature, until the struggle is past, so that, to use the words of an ancient author, which embody a more profound principle than appears at first sight, we "*cure the patient by preventing him from dying*;" that is to say, we prolong his existence until the natural and favourable termination of the disease arrives. We do not allow our patients to die of exhaustion, and bearing in mind the depressing influence they have to struggle with, we give stimulants at the proper time, and with a bold hand. We give our patients an artificial life, until the period arrives when nature and health resume their sway.

Yet, though we may admire the practice of an experienced physician in the use of wine in fever, it will often be found that he has a difficulty in expressing any exact reason for adopting the practice in a particular case. His practice is founded on a knowledge which is often incommunicable, an almost instinctive perception of the necessity for stimulation, characteristic of the great physician, and only to be obtained by a long and close familiarity with the disease. But is there any rule by which *the inexperienced man* can be guided; any one distinct phenomenon, the observation of which is easy, and leading to an intelligible and communicable rule of practice? If the following statement of facts shall assist the inexperienced man in the treatment of a single case of fever, I shall feel more than rewarded, for I am convinced that it is to the fear of wine, or to ignorance of the principles of its exhibition, that we are to attribute the loss of many lives in the typhous fever of this country. I shall first speak of the influence of wine on the circulation in fever, and examine the phenomena of the pulse, the force of the heart, and the character of its sounds.

We have long observed, that when under the influence of wine the pulse became less and less frequent, the termination of the case was generally favourable, and as might be expected, the contrary result led to a bad prognosis. This practical observation I do not put forward as original, but I wish to express my great confidence in its truth.

Let us suppose a case of typhus on the tenth day of fever, and presenting severe symptoms of prostration, the pulse varying from 115 to 120. Wine is exhibited, and on the first day the pulse rises to 125, and on the second to 130, and if on the third day there is no diminution, we may make a bad prognosis; and thus the following rule may be laid down, that when, in a case where the symptoms seem to indicate wine, the pulse either does not come down, or increases in frequency under its influence, we may expect a bad result.

These facts naturally lead to the examination of the state of the heart in typhus fever, and the cases in this report are so arranged as to exhibit together the condition of the heart, and the amount of wine employed. *In this investigation we have sought for an additional rule, drawn from the state of the heart itself, to guide the inexperienced man in the exhibition of wine*, and I am not without hopes, that in the careful study of the cardiac phenomena, an indication hitherto unobserved will be obtained.

In typhous fever two opposite conditions of the heart may be observed; in the one the impulse becomes extremely feeble, or altogether wanting, while the sounds are greatly diminished in intensity; while in the other, the heart's action and sounds continue vigorous throughout the whole course of the disease.

These opposite states are not necessarily revealed by the state of the pulse or the warmth of the surface. We may observe a hot skin, while the action of the heart is almost imperceptible, and on the other hand a patient may be pulseless, cold, and livid for days together, while the heart is acting with the greatest vigour.

The condition of the heart must be determined by the application of the hand and stethoscope to the infra-mammary and sternal regions. Of this principle the following case is an illustration:—

CASE I.

Petechial typhous fever with extreme prostration—Failure of the pulse, and coldness of the breath and surface, with vigorous action of the heart—Liberal use of stimulants—Employment of transfusion of blood—Death—Absence of organic lesion.

A middle aged woman was admitted into our wards in February 1837, at an early period of her fever. She had attended upon and washed the clothes of a person who had died of a peculiarly malignant fever, yet on admission, and for several days subsequently, she presented no symptom beyond those of an ordinary and rather mild case of maculated typhus. From the first, however, she had a strong presentiment of death, which nothing could shake; she gradually became more and more collapsed; the surface was of a violet hue; the countenance sunken; and the skin and breath cold. From the eighth day no pulse could be perceived at the wrist, although the heart's impulse was strong, and the sounds remarkably distinct. She continued in this condition for some days, during which time stimulants of every kind were freely resorted to; on the fifteenth day, the surface being icy cold, but the heart still acting with vigour, while no evidence of organic disease could be found in the abdomen or head, I advised transfusion, which was performed by my colleague, Mr. Smyly. About six ounces of recently drawn blood were injected into the median basilic vein; a slight reaction followed, and the breath, which had been cold for several days, became warm. The pulse, however, did not return, and she died three days after the operation.

On dissection no organic lesion of any kind could be discovered in any part of the body; the heart was firm, and its muscular structure natural; no obstruction existed in any artery, but the whole quantity of blood seemed much diminished; the consistence of the blood was somewhat pitchy, and its colour very dark. The wound in the arm was still gaping, and did not present the slightest appearance of adhesion or inflammation.

This was certainly a rare form of fever, but, nevertheless, it establishes the point, that without any mechanical obstruction, we may have in fever, absence of the pulse, while the heart continues to act with vigour, and the case is one out of several which go to establish the conclusion to which I think we must arrive, *that a vigorous action of the heart in typhus* points out *that stimulants will not have so beneficial effect as in the opposite case.* I shall present other illustrations of this principle in the course of the paper.

I now recur to the division of cases of typhus into those with and those without altered phenomena of the heart. In the first class we observe:—

1. Diminution and ultimate cessation of the impulse.
2. Diminution of the intensity of the sounds.

3. Cessation of one of the sounds.

These phenomena, hitherto undescribed, are among the most interesting of those connected with the heart which I have ever observed, and I shall be able to show that they have a most important application in practice, as bearing directly on the question as to the use of stimulants in typhous fever.

I shall now present a series of cases observed particularly with reference to the heart. They are so arranged as to show first, the general symptoms; next, the phenomena of the heart and pulse; and lastly, the amount of stimulants employed.

CASE II.

Severe catarrhal typhus—Failure of the circulation—Cessation of the first sound of the heart—Use of stimulants—Recovery.

John Keefe, ætat. 20, of rather muscular frame, was admitted on the 11th of April, the seventh day of fever, with severe nervous symptoms, and all the signs, both vital and physical, of an intense bronchial affection, predominating in the left lung. The skin was thickly covered with bright red petechiæ, which were confluent, forming large patches on the arms and thighs; respirations 28, laboured; pulse 120, small and very weak.

The heart's impulse was visible, and the contractions audible, but the second sound greatly predominated over the first. It was loud and distinct, while the first was very feeble, particularly at the left side of the heart.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
April 12.	Delirium; intense bronchial rales; insatiable thirst; diarrhœa.	Pulse 120, weaker than yesterday; impulse less perceptible; *first sound nearly inaudible;* carotid pulsations of good strength; extremities warm.	Cupping; blister to the sternum; anodyne enema, and poultices to the belly.
" 14.	Continual moaning; petechiæ more diffused, and dark coloured.	Pulse about 112; impulse barely perceptible; over the left cavities the first sound is scarcely distinguishable, while over the right it is more so; *second sound very clear.*	Wine 10 oz. arrow root, decoct. senegæ.
" 15.	Countenance improved; much delirium; bronchitis lessened; diarrhœa continues; the marks of the cupping glasses are black.	Pulse 112, contracted and compressible; no impulse of the heart under the mamma; the first sound totally inaudible, second less distinct than yesterday, on the left margin of the sternum nothing can be heard but the second sound, and this feebly.	Wine 16 oz. Blister to abdomen; anodyne enema; beef tea.
" 16.	Looks better; slept well; diarrhœa less.	Pulse 108, stronger and fuller; first sound audible over the whole præcordial region, second more distinct.	Repeat all.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
April 17.		Pulse 100; respirations 28; impulse again perceptible.	Wine 12 oz.
" 18.		Impulse still stronger, striking over a greater surface; both sounds distinctly audible at the inferior part of left side, and also to the right of the sternum; pulse 96; respirations 32.	Wine 12 oz.; jelly 2 glasses.
" 19.	Bronchitis much less; petechiæ fading; bowels regular.	Pulse 76, full, of good strength; heart's impulse more vigorous; sounds as yesterday.	Wine 6 oz.
" 20.		Pulse 88; phenomena of heart natural.	Wine 6 oz.
" 21.		Ditto, ditto.	Wine 4 oz.
" 23.	Convalescent. Patient discharged on 2d May, perfectly well.		

In this case, and that which follows, we observe the remarkable and important peculiarity of the supervention of bad symptoms of prostration and putrescence at an unusually early period of the disease. This circumstance should always excite great apprehension, and lead to the exhibition of stimulants, notwithstanding the existence of various local irritations. In both these cases the chest and abdomen were severely engaged, and in both the early exhibition of wine not only did no harm, but was productive of the happiest effects. The existence of signs of bronchitis or enteritis in our maculated fever does not necessarily contra-indicate the free and early use of stimulants.

In examining the efficacy of wine in typhus, if we compare the cases with predominance of enteric, and those with bronchial irritation, we generally find that in the latter group the stimulant is better borne, and there is a class of cases in which wine is scarcely admissible. These cases present signs of enteric irritation of great severity, alternating with violent nervous symptoms, unaccompanied by petechiæ, or other phenomena of putrescence. The use of wine is almost always injurious from its too violently exciting the brain. But in the bad petechial typhus with great prostration of strength, the existence of thirst, abdominal pain and tenderness, diarrhœa and tumefaction, should not prevent us from having recourse to wine.

I beg to draw the particular attention of my readers to the cardiac phenomena in this case; it may be right to state, that the stethoscopic observations in this and the succeeding cases were made with the greatest care.

We observed, in the first place, a progressively diminishing impulse; on the seventh day the impulse was visible at the side, but on the tenth was altogether wanting; it reappears on the twelfth, and continues to increase until the period of the patient's restoration to health.

In the second place we find a singular modification of the sounds of the heart; the proportion between the two sounds was lost on the seventh day, the first being exceedingly feeble, the second comparatively strong; on the eighth day the first sound was scarcely audible, and on the tenth it became extinct, and we had the singular phenomenon, never before observed, of the heart in typhous fever giving but a single sound. On the eleventh day, under the influence of powerful stimulation, the first sound reappears, and the second has more vigour; on the twelfth day both sounds are distinctly audible, and on the fourteenth the phenomena of the heart are natural.

We shall not here enter into speculations as to the cause of these phenomena, but proceed with a detail of facts.

CASE III.

Severe maculated fever, delirium, diminution of the first sound of the heart —Use of wine in large quantities—Recovery.

Patrick Quin, æt. 20, was admitted on the 27th of February. It was stated that he had been ill but five days, but his appearance was that of a person after a much longer period of fever; he was collapsed, cold, and stupid, and covered with an abundant crop of dark livid maculæ; prostration extreme; eyes suffused; tongue covered with brown sordes; pulse 125, small and weak; heart's action feeble; respiration hurried. He was ordered four ounces of wine.

DATE.	GENERAL STATE.	PHENOMENA OF CIRCULATION.	TREATMENT.
Feb. 28.	Violent delirium during the night; he is now in a state of collapse, lying on his back; constant jactitation; subsultus: cold extremities; retention of urine.	Pulse 132, soft, small, and variable; heart's impulse imperceptible; sounds defined; the pulsations in the carotids very feeble.	Wine 24oz. blister to the head, turpentine enema.
March 1.	Slept well; in other respects is nearly the same, but is more easily roused; less suffusion of the eyes; considerable subsultus; he passed urine involuntarily.	Pulse 120, a shade stronger than yesterday; the *sounds of the heart are quite similar to those of the fœtal circulation.*	Wine 24oz. turpentine enema.
" 2.	Slept well; tongue moist; respirations 30; maculæ fading; extremities warm.	Pulse 130, fuller and stronger; heart's action stronger, and sounds much louder—they approach to their natural character.	Wine 14 oz.

DATE.	GENERAL STATE.	PHENOMENA OF CIRCULATION.	TREATMENT.
March 3.	Violent delirium through the night; skin hot; bowels confined.	Pulse 104; heart's impulse stronger.	Wine 12 oz. enema.
" 4.	No change; great thirst.	Pulse 106.	Wine 12 oz.
" 5.	Patient worse; countenance more collapsed; violent delirium; picking of bed-clothes; subsultus; sighing; contraction of the pupils: incontinence of urine; skin hot and dry; mouth covered with black sordes.	Impulse of the heart plainly perceptible; *second sound* much louder than the first: pulse 120.	Wine 16 oz. Turpentine draught, with camphor, musk, and opium mixture; beef tea; swathing with flannel.
" 6.	Generally improved; slept well; much more sensible.	Pulse 106.	Wine 16 oz.
" 7.	Complains of great thirst; extremities warm; maculæ bright red, and less abundant; pupils natural; tongue moist.	First sound of heart much stronger; pulse 96.	Wine 16 oz.
" 8.	Great improvement; desire for food; skin cool.	Heart's action nearly natural; second sound much improved; the abdominal aorta can be felt throbbing with force.	Wine 16 oz.; omit mixture.
" 9.	Skin cool; slept well.	Impulse of heart vigorous; strong action in the arteries of the neck and abdominal aorta; pulse 88, strong and full.	Omit wine.
" 12.	Convalescence perfect.	Sounds and impulse of heart natural; pulse 72.	Full diet.

In this case, as in the one preceding, we observe the *early supervention* of bad symptoms, producing the same necessity for early stimulation. Indeed it has rarely happened, that we were obliged to exhibit so large a quantity of wine on the fifth day of the disease, and I am convinced that nothing else would have saved the patient's life. It is impossible to lay down any rule, as to when the exhibition of wine should be commenced in our typhus, but the point must be regulated, much less by the date of the fever, than by the actually existing condition of the patient. The circumstances which lead to its exhibition on the fifth day were the great collapse, the colour of the petechiæ, the coldness of the extremities, and the feebleness of the heart; on the following day the symptoms pointed out the necessity of a great increase of the stimulants; the prostration was increased; the rapidity of the pulse augmented, *while the impulse of the heart had become imperceptible.* In two days after this a distinct improvement commenced. Yet, though phenomena of reaction showed themselves, the wine was continued, though in diminished doses, to the fourteenth day of the disease, and for the last three days its exhibition was combined with that of camphor, musk, and opium. The latter remedies were resorted to from the increase of the nervous symptoms on the eleventh day. The pulse on the day previous had been 106, it rose on the eleventh day to 120; it fell on the following day to its former standard, after which it gradually subsided to its natural rate.

In most cases in which wine is found to answer, the pulse comes down under its influence gradually and steadily; this I have before alluded to. In a few, however, we observe remarkable variations in the rapidity of the pulse. Of this the preceding case is an example; the increase of pulse, however, was met not by an augmentation of the wine, but by the exhibition of nervous medicines, which were productive of the happiest effect. Beef tea was also given, and the patient swathed with flannel, a measure of the greatest importance and value in the treatment of fevers with collapse, or with a tendency to bronchitis.

As connected with the rising of the pulse in typhus, the following rules with reference to the use of wine will be often found applicable:—

1st. That the increase of rapidity is almost always an unfavourable symptom.

2d. That when it occurs at an early period of the disease with a cool skin, and dark-coloured eruption, it is to be met by an increase of wine.

3d. That when it occurs in the latter period, accompanied by severe nervous symptoms, the patient using wine freely, we must carefully support the system, and exhibit, in conjunction with the wine, musk, camphor, and opium.

On the seventh day, in this case, the impulse and sounds of the heart were remarkably modified, the first was singularly diminished, and the sounds assumed characters closely resembling those of the fœtal heart; this modification is not very common in typhus. In most cases one of the sounds is much more influenced than the other, the proportion between them is thus greatly altered, and there is no resemblance whatever to the sounds of the fœtal circulation. But when there is a great diminution of the intensity of both sounds, and the pulsations vary from 125 to 135 in the minute, the sounds exactly simulate those of the fœtal heart. In this instance the proportion between the sounds was lost on the eleventh day, the first being exceedingly feeble, the second comparatively louder; this character disappeared on the thirteenth day, when the first sound regained its natural character, and it is a most interesting fact, that on the following day the second sound was observed to be exceedingly loud, while the abdominal aorta was throbbing with force.

I shall state the order of occurrence of the cardiac phenomena in this case.

1. Diminished impulse.
2. Impulse imperceptible.
3. Sounds of heart equally diminished (fœtal character).
4. Impulse and sounds stronger.
5. Second sound proportionally louder than the first.
6. First sound stronger.
7. Sounds and impulse natural.

We shall hereafter show the importance of these observations, as bearing on the theory of motions and sounds of the heart.

CASE IV.

Maculated typhus—Absence of the first sound of the heart—Extreme slowness of the pulse during convalescence—Use of wine in large quantities—Recovery.

Matthew Hickey, æt. 30, was admitted into hospital on the 15th of July, having had fever six days. Had been in the habit of drinking, but never to excess; he is the fifth of his family who has had severe maculated typhus; at present his countenance is much flushed; eyes suffused; maculæ abundant and of a bright red colour; tongue covered with a dirty brown fur, especially at the sides; great abdominal tenderness, particularly in the region of the liver. The chest, on percussion, yields a clear sound, and there are no stethoscopic indications of disease in either lung; the impulse of heart is not perceptible; although both sounds are audible, the second is heard to preponderate distinctly; pulse 124; respiration easy and natural; bowels free.

He was ordered—R. Solut. bicarb. ammoniæ, ℥viii.; acet. morphiæ, gr. ¼; tinct. hyosciam. ℈i. Ft. mist. efferv. Capiat coch. amp. ii. tertiis horis.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
July 16.	Slept well; bowels regular; tongue thickly coated and dry; convulsive respiration; skin pale and very clammy.	Impulse of the heart is quite imperceptible, even when he lies on the left side; to the *right of the left nipple the second sound alone is audible;* pulse 120, rather feebler; on sitting up the impulse is not rendered more evident.	Wine 12 oz., blister over the heart, beef tea.
" 17.	There is still some abdominal tenderness; slept pretty well; respirations 28; interrupted by frequent sighing, and partaking of the cerebral character. He got altogether yesterday 20 oz. of wine and a little brandy.	The impulse is felt at the apex, but the sounds are by no means in proportion to its vigour; they resemble those of the fœtal heart; between the fifth and sixth ribs the sounds are barely audible.	Wine 24 oz., two glasses of brandy, arrow root, blister to the scalp; enema emolliens.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
July 18.	Very restless; has not slept; frequently rises from his bed; passes water freely; tongue red at the edges, and covered in the centre with dark brown fur; teeth coated with black sordes; lies on his back in a semi-stupified state; countenance collapsed and pale; maculæ very livid; respirations 32; on the back there are a few ecchymotic patches; abdominal tenderness continues.	The sounds of the heart very feeble; the first almost inaudible, the second is loud and clear, and at a point central between the nipple and sternum, this is much more marked; the impulse can only be felt when the fingers are placed between the intercostal spaces.	Wine 24 oz., poultices to the abdomen.
" 19.	Skin cooler, moistened with perspiration; the respiration although laboured has lost its cerebral character; the ecchymotic patches are fading; tongue cleaner; abdominal tenderness less; is more animated.	Pulse 116; impulse of heart the same as yesterday, the first sound is entirely absent, the second is distinct.	Wine 24 oz., blister and poultice to the epigastrium.
" 20.	The countenance has lost the peculiar typhoid expression; the petechiæ are fading; breathing still laboured.	Impulse of the heart quite imperceptible; the first sound is just audible; pulse 96.	Wine 18 oz.
" 21.	Passed a restless night; breathing much easier. He is quite sensible.	Pulse 80, and of good character; the sounds at the upper portion of the chest are proportionate but feeble; at the apex, and nearer the ensiform cartilage, the second sound still predominates.	Wine 12 oz.
" 23.	Countenance more animated; skin cool; maculæ almost gone; complains of thirst; passes large quantities of pale-coloured urine.	Pulse 76; impulse of the heart perceptible; sounds proportionate.	Wine 6 oz. Haustus Rhei.
" 24.		Pulse 76.	Wine 6 oz.
" 26.	Sleeps well; appetite good; petechiæ gone.	Pulse 60; of very good strength.	Wine 6 oz.
" 28.		Pulse 50.	Wine 6 oz.
Aug. 1.	Is allowed to sit up during the day; is not fatigued; appetite very good.	Pulse 32; counted most carefully twice over.	Gets bread and milk.
" 4.	Feels perfectly well.	He is sitting up in bed, and the pulse at this time is 32.	As yesterday.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
Aug. 6.		He is now eating his breakfast; pulse at this moment 56.	
	Discharged in a few days.	Pulse 60.	

This case was one of extreme interest; the severity of the symptoms, the quantity of stimulants used, and the remarkable modifications of the heart's action, all combined to render the patient an object of the greatest attention to the class.

The diminution of the first sound of the heart was the circumstance which led to the exhibition of stimulants boldly, at an early period of the case. We observed that on the seventh day the impulse was imperceptible, and the first sound was diminished. On the eighth, the first sound had disappeared, and although the other symptoms did not seem to call for active stimulation, we ordered wine in free doses from this indication alone, and the result justified the treatment. Here was a case of a young man of a good constitution, in which, from studying the action of the heart, we were able to anticipate the symptoms of general prostration, and by the early and bold use of wine, to prevent the fatal result which, it is almost certain, would otherwise have occurred.

The order of the succession of the cardiac phenomena in this case was peculiar. We had

1st. The early subsidence of the first sound.

2d. Both sounds audible, but with the fœtal character.

3d. Predominance of the second sound.

4th. Complete absence of the first sound.

5th. Impulse imperceptible, with returning first sound.

6th. The sounds at the base of the heart proportionate, while at the apex the second predominates.

7th. The sounds natural.

The pulse, too, presents some interesting points for consideration. Within a period of twenty days its rate was as follows:

7th	day of	fever . .	124
8th	"	" . .	120
11th	"	" . .	116
12th	"	" . .	96
13th	"	" . .	80
15th	"	" . .	76
17th	"	" . .	60
18th	"	" . .	50
22d	"	" . .	32
27th	"	" . .	56

In a few days it rose to 60.

Laennec has suggested, that the rapidity of the pulse observed during the convalescence of fevers might depend on a softened condition of the heart. As I shall have occasion to notice his opinions on the state of the heart in typhous fever at greater length presently, I shall merely observe, that in those cases in which the pulse continued rapid during convalescence, the fever was seldom of the petechial or putrid character; and one of the most remarkable phenomena in our fevers during the last year, was the return of the pulse to its natural rate, even before the whole group of typhoid symptoms had disappeared; and so far from a quick pulse being common *during the convalescence* in cases which had shown the signs of putridity, we found more frequently a singular slowness continuing for several days, until the patient was able to leave his bed.

CASE V.

Maculated fever—Great feebleness of the heart's action—Free use of wine—Convalescence on the seventeenth day.

Bryan Kean, æt. 24, of strong muscular development, was admitted on the 25th of March, having been then nine days ill: his countenance is dull, stupid, and of a livid hue: eyes heavy and suffused; he is in a state of great stupor and prostration; decubitus on the back. Skin hot, dry, and covered with small livid petechiæ; tongue fissured, brown, and parched; has great thirst, and suffers much pain from pressure on the epigastrium; respirations 40, not laboured, and a few bronchitic râles can be heard in the left lung; the pulse 120, small and weak; the heart's impulse almost imperceptible, and the first sound so feeble as to be inaudible to the left of the mamma, but it can be distinguished between the mamma and sternum. Ten leeches were ordered to the epigastrium, turpentine enema, artificial heat to the extremities, and eight ounces of wine.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	Slept well; countenance more livid; thirst insatiable; teeth covered with sordes; epigastrium less painful; extremities perfectly livid and cold.	Pulse 116, small and weak; impulse of the heart quite imperceptible; sounds are exceedingly feeble, they are almost inaudible below and to the left of the mamma, so that it is very difficult to distinguish between the first and second sounds, the sounds as it were running one into the other; between the mamma and sternum they are stronger, and better defined; the second is much clearer than the first. If the rapidity of the heart was a little increased, nothing could more closely resemble the fœtal circulation.	Wine 16 oz.
	Continued raving; involuntary evacuations; countenance improved; extremities cold and livid.	Pulse 92, small but distinct, stronger, and perfectly regular; the action of the heart can be seen between the fifth and sixth ribs, but can scarcely be felt; sounds of the left side remain as yesterday, those of the right are more distinct.	Repeat wine.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
March 28.	Continued low muttering delirium; great prostration; involuntary passage of urine; extremities very cold, notwithstanding the use of artificial warmth; petechiæ livid; respirations 24; intelligence improved.	Pulse 84; impulse of heart less perceptible, but the first sound has more vigour.	Wine 16 oz., musk, camphor, and ammonia mixture; two glasses of jelly.
" 29.	Great improvement; extremities warm; petechiæ of red colour; tongue cleaning; slept well; respirations 20.	Pulse 84, firmer and steadier; when he lies on the left side the impulse of the heart is very perceptible, when on the back it is less so, but more evident to the touch than on yesterday; sounds increased in strength and distinctness.	Wine 12 oz., omit mixture; to have beef tea.
" 30.	Improvement continues, but the lower extremities are liable to become cold when the artificial heat is removed the urgent thirst remains; tongue still brown.	Pulse 72, fuller and stronger; pulsations of the arteria innominata are distinctly visible at the top of the sternum; impulse of heart as before, but the sounds have improved in strength.	Wine 8 oz., beef tea.
April 1.	Convalescent.	Pulse 72, full and compressible; heart's sounds strong and natural.	Wine 4 oz., beef tea and chicken broth.
2.	Do.	Do.	Omit wine.

We have here another case in which we were led to the use of wine on the ninth day of fever, almost wholly from the observation of the phenomena of the heart. Although the case had a generally bad aspect, yet I do not think that I would have been so bold in the exhibition of wine had the patient been admitted before these researches had been commenced. There were many circumstances which seemed to contra-indicate wine: the patient was a young and robust man; his skin was hot and dry; his tongue brown and parched; he had extreme thirst, and great tenderness of the epigastrium. Some years ago I would not have dared to have given this man wine, from the apprehension of its increasing gastric inflammation. On the other hand, he had great prostration, and the petechiæ were of a livid hue: but it was on the cardiac signs that we relied; we had new and positive guides, and they did not deceive us.

I greatly doubt whether there is any symptom which we can depend on as indicative of gastric inflammation in petechial typhus. That the condition of the tongue is fallacious has been established by Andral and Louis from numerous dissections, and the utility of wine and other stimulants, when the tongue is dry and brown, gives another and different description of proof. In a paper on the use of wine and opium in fever, published by my colleague, Dr.

Graves, in the first volume of the Dublin Journal of Medical Science, he observes: "In the first place, as to the tongue, *at an advanced* period of fever, I have often derived the greatest advantage from wine and opium, although the tongue was dry, the colour of old mahogany, or else coated with a yellowish brown dry fur, and protruded with difficulty, while the teeth and gums were covered with sordes; wine or porter, in moderate quantities, seem generally to agree with this tongue better than opium; in some cases, however, the latter is indispensable. For fear of misleading the reader, I must again remark that I by no means wish to assert that such a tongue uniformly, or even frequently, indicates the use of these medicines: on the contrary, this state of the tongue and mouth will often be observed at a time when leeches and the antiphlogistic treatment are required. Let it be clearly understood, however, that at an advanced period of fever this state of tongue may exist, and yet wine and opium may be given boldly, provided, as I have said before, the general state of the patient seems to require it."

Let it be recollected that in this case we had the symptoms of a dry and brown tongue, great thirst, epigastric tenderness, and heat of skin. On the first day of treatment leeches were applied to the epigastrium, and wine exhibited to the amount of eight ounces. I have frequently leeched the epigastrium, and ordered wine on the same day, and with benefit. In our case the epigastric tenderness was lessened, but the thirst continued insatiable: the quantity of wine was doubled. Two circumstances led to this, one the extreme coldness and lividity of the extremities; and the other, the increasing indications of debility of the heart, as shown by the great indistinctness of the first sound, and the approach of the stethoscopic phenomena to what we term *the fœtal character*.

On the third day of the use of wine, and eleventh of the disease, the pulse fell from 116 to 92, and the first sound began to recover its natural intensity: this change was first *perceived over the right cavities of the heart*. This curious fact I have repeatedly observed, and I think it may be stated, that in all cases in which the first sound is lessened or obliterated, the return to the natural character is first perceived over the right side of the heart. Whatever be the cause of these interesting phenomena, it seems much more to engage the arterial than the venous side of the heart.

CASE VI.

Maculated typhus, with diminution of the first sound of the heart—Use of wine and brandy.

John Smyth was admitted into the Meath Hospital on the 19th of May; the tenth day of his fever. He is a strong, powerful man; has been accustomed to drink ardent spirits, but was not very frequently intoxicated; at present is very low: he was last night constantly getting out of bed; passes his water under him; the petechial eruption is thickly diffused over his body: tongue dry, and red in the centre; intellect this morning clear; pulse 124, very small, and easily compressed; the impulse of heart feebly perceptible; the first sound very indistinct, the second clear; above the mamma the first sound is scarcely audible. Ordered wine ℥viii.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
May 20.	Passed a good night, did not rave; respirations 36; retention of urine; extremities cold.	Impulse of the heart imperceptible, second sound predominates over the first; pulse 124.	Wine 12 oz., glass of hot brandy punch.
" 21.	Slept well, no raving; petechial eruption livid: eyes suffused; respirations 36; tongue cleaner; retention of urine continues, requiring frequent use of the catheter; bowels regular; bronchitis very acute.	Pulse 112; the impulse of the heart is perceptible when he lies on his left side; the second sound predominates considerably over the first.	Wine 12 oz., dry cupping to chest extensively; blisters to the region of the heart.
" 22.	Had some sleep, no raving; countenance improved; eyes less suffused.	Pulse 100, full and regular, *whereas before the additional quantity of wine given yesterday it was intermitting;* sounds of heart feeble, second still predominates.	Wine 20oz. In consequence of his low state he was given 8 oz. of wine additional yesterday; beef tea one pint; pulv. ipecac. gr. ½; ammon. carb. gr. ii., ft. pil. ter die sumend.
" 23.	Passes his urine and fæces under him; respirations 32, not so laboured; extremities warmed by artificial heat; great prostration.	Pulse 84, small; the impulse of the heart is more distinct to-day; the first sound is still below par.	Wine 20 oz., beef tea 1 pt., jelly, a glass; blisters over the heart and nape of neck.
" 24.	Countenance much improved; slept well; when he is raised in bed he complains of lightness of his head; bronchitis considerably better.	Pulse 80; impulse of heart perceptible, the first sound is stronger.	Wine 20 oz.
" 25.	Passes his urine freely; had a quiet night; is much better.	Pulse 80, very good strength; impulse of the heart natural, sounds proportionate.	Wine 16 oz.
" 26.	Scarcely any cough; sleeps well.	Pulse 70, regular; phenomena of heart as in last report.	Wine 16 oz.
" 27.	Sat up yesterday; is still a little nervous.	Pulse 72.	Wine 6 oz.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
" 28.		Pulse 72; sounds and impulse of heart perfectly natural.	Wine 6 oz.
" 29.	Convalescent.		

CASE VII.

Maculated fever, with severe gastro-catarrhal and nervous symptoms—Remarkable modification of the heart's action—Use of wine.

Thomas Cavanagh, æt. 15, was admitted on the 14th of April, being then three days ill: he had a few indistinct pale spots on the back; excessive thirst; diarrhœa, and tenderness of the epigastrium: there was slight cough, with abundant frothy mucous expectoration. Pulse 120, small and easily compressed; but the impulse of the heart is strong, and the sounds distinctly heard over a large portion of the chest. The epigastrium was leeched, and effervescing draughts ordered.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT
April 16.	General symptoms continue; respirations 32.	Pulse 126; impulse of heart not so strong.	Four leeches to the epigastrium; enema emolliens.
" 17.	Maculæ more distinct; the abdominal symptoms continue; respirations 36; some delirium.	Pulse 120, weaker; impulse of the heart scarcely visible, but is quite perceptible to the touch; sounds are natural.	Hip bath; poultice to the abdomen.
" 18.	Copious sweating after the bath; he is worse this morning; constant low delirium; countenance pale and depressed; less heat of skin; maculæ abundant, and becoming livid; tongue dry, brown; great thirst; considerable tenderness in the ileocæcal region.	Pulse 132, still weaker; impulse of heart can be seen and felt; the sounds are exceedingly weak, *particularly the first, which is scarcely audible.*	Eight leeches to the abdomen; small doses of hydrarg. c. creta and Dover's powders.
" 19.	Debility increased; skin hot and dry; petechiæ universally abundant, and of a dark livid hue; respirations 30, less laboured; great thirst.	The sounds of the heart exactly resemble those of the fœtus at the eighth month; an exceedingly indistinct impulse can be felt at the end of expiration.	Wine 3 oz.; arrow root.
" 20.	Slept better, less raving; countenance improved; eyes less suffused; abdominal symptoms continue; respirations 28, interrupted by frequent sighing; sonorous and sibilous rales in posterior portion	Pulse 140, slightly improved in strength; impulse of heart more perceptible, and its sounds can be heard to the right of the sternum.	Wine 3 oz.; arrow root.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	of the chest; two small gangrenous spots on the left ear.		
April 21.	Slept well, and is more collected; complains of extreme thirst; respirations 32; skin hot and dry; maculæ unusually abundant, and livid; one of the ecchymosed spots on the ear has vesicated; extremities warm.	Pulse 132, fuller, more firm; impulse of heart as yesterday, but the sounds to the right of sternum are not so distinct, particularly the first, which is remarkably feeble.	Wine 5 oz.
" 22.	Symptoms as before; respirations 40.	Pulse 125; no change in the heart.	Wine 5 oz.; repeat rest.
" 23.	Raving continues; skin cooler; maculæ not so livid; cough worse, with much stuffing.	Pulse 135. When he lies on the left side, the impulse of the heart is strong, first sound more distinct.	Wine 5 oz.; fetid enema.
" 24.	The typhoid expression quite gone; eye clear and sprightly.	Pulse 110, soft and much improved; impulse and sounds still stronger.	Wine 5 oz.; Ipecac. & carb. ammonia in pills.
	Convalescent.		

The two preceding cases exhibit still the same phenomena, the diminution of the impulse of the heart and of its sounds, particularly the first. In the case of Cavanagh, we observed the change from the natural to the morbid condition, for the patient was admitted at an unusually early period of fever. In that of Smith, the first sound of the heart was altered on admission. In bad cases, the alteration of the sounds may be expected on or about the fifth day. The change does not seem to be accompanied by any peculiar disturbance of the circulation. *We have as yet recorded no evidences, physical or vital, of a local irritation accompanying or preceding the diminution of the first sound;* and our dissections and those of Louis agree as to the absence of the usual appearances of carditis.

In the case of Smyth, the quantity of wine employed was much greater than in that of Cavanagh; for this there were several reasons: the greater age of the patient, and his having been addicted to ardent spirits being the principal: besides, we could not tell how long the morbid condition of the heart had existed before admission; and it was acting on the safe side to assume that it had continued for several days, a circumstance which would indicate great activity in stimulation.

In the fevers of children, and of persons but a few years beyond puberty, the necessity for the use of wine is seldom so urgent as in those beyond twenty, or twenty-five; but we have had several cases of maculated typhus in children, with such prostration as to demand a free use of wine, which had the best effect, notwithstanding the existence of what we consider local inflammations.

CASE VIII.

Maculated fever; with signs of bronchitis and enteritis—Purulent discharge from the nose—Great prostration—Use of wine—Recovery.

Henrietta Wright, æt. 13, was admitted on the 9th of April, after having been in fever upwards of a fortnight; her countenance was collapsed; the face livid; nocturnal delirium; violent headach, with a copious purulent discharge from the nostrils; extreme thirst; she was constantly sobbing and moaning; skin hot, and covered with an abundant crop of small livid maculæ. Intense bronchitis, unaccompanied by expectoration; complains of pain on pressure of the epigastric region; pulse 120, exceedingly feeble; impulse of heart extremely weak, and more distinct with the second than the first sound; the second sound is very clear, the first scarcely audible; it is more distinct over the right than the left side. Ordered, wine 4 oz., blister over the epigastrium, and ipecac. and pil. hydrarg. four times in the day.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
April 11.	Low muttering delirium; eyes suffused; countenance depressed; tenderness of epigastrium increased; pain referred chiefly to forehead; mucous expectoration, with troublesome cough; bowels not opened since yesterday; respiration 46, hurried.	Pulse 125, very feeble; impulse of the heart as yesterday; first sound improved.	Wine 4 oz.; blisters to the head and legs; ice to the temples; turpentine enema; arrow root; barm.
" 12.	General improvement at 4 o'clock P. M.; yesterday her pulse was imperceptible, and extremities cold. Bronchial rales intense over the whole chest; discharge from the nose less profuse; cough troublesome; expectoration copious.	Pulse 120, stronger and fuller; sounds of the heart are more distinct; impulse can be felt.	Wine 4 oz.; chicken broth; flannel waistcoat.
" 13.	No improvement; constant sobbing; headach; abdomen hard, full and very tender; bronchitis continues intense and general; respirations 48.	Pulse 110; heart's action more vigorous.	Wine 4 oz. Blister between shoulders; poultice to the belly; chicken broth.
" 14.	The catarrhal and nervous symptoms continue; she is continually turning up her eyes; respirations 40, convulsive and hur-	Pulse 105, stronger than yesterday; impulse can be felt, but the sounds are masked by the bronchial rales.	Repeat cataplasm. abdom.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	ried, accompanied with sobbing; abdomen exquisitely tender; face more livid.		
April 15.	She is much improved, maculæ indistinct; abdomen still very tender; secretion from the nose has ceased; respirations 40.	Pulse 110.	Repeat all.
" 16.	Improvement continues; abdominal tenderness nearly gone; lividity has disappeared; respirations 50, yet not laborious; musical and crepitating rales predominating in left lung, which is clear on percussion.	Pulse 108; impulse and sounds more distinct.	Wine 4 oz.; antimonial solution.
" 17.	General improvement; respirations 55; *perfectly easy.*	Pulse 84, soft and full.	Wine as before.
" 21.	Complete convalescence.	Pulse 56.	Do. do.

In this case, the circumstances which might seem to contra-indicate the exhibition of wine were, that the patient was not yet arrived at the age of puberty, the heat of the skin, and the violent symptoms of abdominal and thoracic irritation. On the other hand, she had been upwards of a fortnight ill; had a collapsed countenance; the petechiæ were livid, and the first sound of the heart scarcely audible. To these indications must be added that of the purulent discharge from the nose, a symptom not by any means common, but one which doubtless pointed out a necessity for stimulation. I have seen this symptom in but two cases of typhous fever; it is a very peculiar, and in my opinion, alarming one. The pus runs from the nostrils in a copious and continued stream; the nose is somewhat swelled, and the patient lying on the back, and in extreme prostration, presents a close resemblance to an individual labouring under glanders.

It will be observed that on the 16th of April the antimonial solution was ordered: this was done with the view of relieving the bronchial irritation; its exhibition, however, at this advanced period of the case involves a point of practice of great importance, namely that in certain cases the typhoid symptoms prevent us employing an antiphlogistic treatment for many days; a change then takes place, and the patient will bear a reducing treatment for the relief of local disease, which before would have been dangerous: to this I shall hereafter return. It will be seen, in the case under consideration, that while the antimony was ordered the wine was not discontinued.

Great advantage was obtained by poulticing the abdomen in this case; I have the greatest reliance on this treatment in the secondary abdominal irritations of fever. It was, I believe, first recommended by Broussais. It is particularly advantageous where the weakness of the patient forbids the use of leeches.

In the same class of cases, my friend Dr. Lees has treated a great number of patients by the use of the hip bath. For the success of this treatment, in many of his cases, I can vouch; and to his judgment, in the management of the remedy, I can bear full testimony.

CASE IX.

Petechial Fever, with Bronchitis; Diminution of the First Sound of the Heart; Use of Wine; Recovery.

Thomas Wallace, admitted on 10th May, eleventh day of his fever, complaining of intense headach; general eruption of petechiæ; the sounds of the heart were feeble, but proportionate; impulse imperceptible; pulse 98, full but easily compressed. Ordered wine 8 oz., Mist. Camph. c. Carb. Ammon.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
May 11.	Pupils contracted; countenance flushed; decided bronchitic rales.	Impulse of heart just perceptible; the sounds are acquiring the fœtal character: between the fourth and fifth intercostal spaces scarcely any thing is heard but the second sound; pulse 92.	Continue wine and mixture; cupping, and blister to the chest.
" 12.	The bronchitis more severe, but the countenance has a better expression.	The first sound is more distinct; at the mamma both sounds can be heard, although feebly; pulse 84.	Wine 12 oz., Decoct. Senegæ, et Carb. Ammon.; dry cupping between the shoulders.
" 13.	Bronchitis continues.	Both sounds are now distinctly audible under the mamma and below the sternum.	Wine 8 oz.; rept. alia.
" 14.	Slept well; some aphonia, with tenderness of the trachea on pressure; countenance flushed.	The impulse of heart just perceptible; sounds distinct, still feeble; pulse 92.	Wine 8 oz.; Blister to throat.
" 15.	Bronchitis less: passed a good night.	Both sounds of the heart are proportionate; pulse 82.	Wine 6 oz.
" 16.	Bronchitis subsiding in the right lung, but engaging the minute tubes of the left to a considerable extent.	Both sounds proportionate and distinct; pulse 88.	Wine 6 oz.
" 21.		Impulse of the heart perceptible; the sounds natural; pulse 60.	Dry cupping senega mixture, with antimony.
" 24.	On this day he was pronounced convalescent.		

CASE X.

Petechial fever—Diminution and temporary alteration of the first sound of the heart—Recovery.

Thomas Devereux admitted into hospital on the 23rd of May; the eighth day of fever. Petechiæ plentiful, but of healthy colour; respirations hurried; complains of cough, which is accompanied with a frothy mucous expectoration; bronchitic rales are only heard in the upper portion of the right lung,—is very low; pressure on the abdomen gives pain; great thirst: the impulse of the heart is scarcely perceptible; the sounds are proportionate, but feeble; pulse 112. Ordered six leeches to the epigastrium; castor oil 3 oz., in emulsion, with tinct. opii ♏iii.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
May 24.	Complained of intense headach yesterday evening, which was relieved by epistaxis; bronchitic rales very intense; breathing laboured; respirations 40.	Sounds of the heart are feebler than yesterday; pulse 116, fuller and stronger.	Wine 6 oz.; cupping to 8 oz.; emp. lyttæ over the heart.
" 25.	Bronchitic rales not so intense; respirations 48; countenance more animated; abdominal tenderness completely gone; had slight epistaxis yesterday evening; some headach.	Pulse 108; sounds of the heart *somewhat louder over the apex;* impulse perceptible.	Omit wine; leeches to the temples.
" 26.	Three leeches were applied, and gave great relief; respirations 48; slept well.	The pulse taken early in the morning was 108; later in the day 116; the sounds of the left cavities of the heart are exceedingly feeble, *at the apex the first sound can be distinguished, but at the mamma only the second is heard;* the superiority of the second over the first is also perceived over the right cavities; impulse just perceptible.	Mist. efferves.
" 27.	Slept well; bronchitis better; complains of stuffing in his head; countenance to-day is more flushed; had slight epistaxis yesterday evening; respirations 44.	Pulse 100, soft and compressible; impulse of the heart perceptible; the sounds are feeble, the second still predominates over the first.	Omit mixture; porter a pint; arrow root diet.
" 28.	Had slight epistaxis yesterday evening; slept well.	The sounds of heart are yet feeble, the second predominating over the first; pulse 96, good strength.	Senega mixture.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
May 29.	Respirations 28, easy; no headach; slept well.	Sounds to the left of mamma very weak, *distinct however; much stronger to the right.*	Continue.
" 30.	Respirations 28; tongue clean and moist; skin cool; slept well; countenance improved; still has slight bronchitis.	Pulse 76, soft; phenomena of the heart as before.	Continue; porter one pt.
" 31.	Much improved.	Impulse of heart perceptible; the sounds over the left cavities are stronger, the two sounds being now proportionate.	Porter one pt.
June 1.		Pulse 60, natural; the sounds of the heart are stronger; impulse perceptible.	Porter and beef tea.
" 8.	Convalescent.		

CASE XI.

Petechial fever—Supervention of signs of bronchitis on the twelfth day—Slight change in the phenomena of the heart—Moderate use of wine—Recovery.

Rose Devereux, admitted on the 23rd June; eight days ill; at present complains of great pain and soreness in all her limbs; headach; pressure on the abdomen gives pain, especially in the epigastrium and hepatic region; no bronchitis; both sounds of the heart are natural; impulse perceptible; pulse 100, feeble; on being made to sit up in bed, she is obliged to cling for support to the bed-side, in consequence of a feeling of lightness in her head, and dimness of sight; respiration easy; tongue clean; no petechiæ.

Hirudines x. Epigastrio. Haustus Efferves.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT
June 25.	Intense headach; great thirst; nausea and retching whenever she attempts to sit up; no abdominal tenderness; bowels costive; respirations 40.	Pulse 112, compressible; both sounds of the heart are proportionate; impulse perceptible.	Tart. potass. et sodæ, ½ oz. enema purgans.
" 26.	Slept well; no headach; slight epistaxis yesterday evening; bowels free; *no bronchitis or cough.*	Pulse 116; impulse perceptible; both sounds of the heart are natural and proportionate.	Milk whey.
" 29.	Yesterday evening complained of great oppression in her breathing; on percussion the chest was clear, *but a most intense bronchitis engaged the whole of left lung;* did not sleep last night;	The sounds of the heart are much obscured this morning in consequence of the intensity of bronchitis; they are, however, sufficiently clear to enable us to determine that they are propor-	Cupped freely yesterday evening. Pil. hydrarg. gr. iii., pulv. ipecac. comp. gr. ii., ft., pil.

	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	countenance anxious; constant nausea; some cough; sputa viscid; bowels free; respirations 36.	tionate; impulse perceptible; pulse 124.	quater in die sumend.
June 30.	Passed a tolerable night; cough not very troublesome; tongue slightly furred; skin cooler; bronchitis in both lungs; respirations 40; bowels regular; had some vomiting yesterday evening, of a greenish fluid; nausea continues.	Pulse 124; impulse of the heart quite imperceptible; sounds hurried, feeble, but proportionate.	Repeat pill.
July 1.	Vomiting last night; the fluid thrown off the stomach is of a dirty green colour, the consistence of treacle; no headach; complains of great oppression in her chest; bronchitic rales are not so intense; petechiæ abundant.	Pulse 120; impulse imperceptible; sounds very feeble, but proportionate.	Wine 6 oz.; repeat pill.
" 2.	Bronchitis much better; she breathes very easily; vomiting this morning; skin cool; petechiæ paler than yesterday.	Pulse 96, feeble; no impulse to be felt; sounds stronger than yesterday.	Wine 6 oz.; omit pills.
" 3.	Very much improved; slept well last night; complains of thirst; no headach; respirations natural.	Pulse 76.	Wine as before.
" 4.	Countenance much improved; no headach; scarcely any bronchitis; respirations natural.	Pulse 76; sounds proportionate, but the impulse cannot yet be felt.	Continue treatment.
" 5.	As yesterday.	Pulse 60, tolerable strength; impulse of the heart is just perceptible.	Repeat all.
" 6.	Sat up in bed the greater part of yesterday without any inconvenience; appetite very good.	Pulse 60, impulse of the heart is perceptible; sounds proportionate.	Repeat.
" 7.	Convalescent.	Pulse 60; of good strength.	Continue wine 6 oz.
	In a few days was discharged cured.		

In the three preceding cases a general similarity may be observed: in all there was the petechial eruption, and the signs of bronchitis existed at some period of the cases respectively. In the two first, those of Wallace and Thomas Devereux, we had the peculiar phenomena of the heart well marked; while in the third—they were so slightly manifested, that it is difficult to say whether the patient really had any positive affection of the heart. It is remarkable, accordingly, that the necessity for the use of wine was by no means so great in her case. Indeed the quantity of wine employed in the female wards is greatly less than in the male; the phenomena of putrescence being much more often manifested in the male subject.

In the case of her brother Thomas Devereux, the diminution of the first sound was most remarkable. The case illustrates some curious points.

In the first place it shows how little we can judge of the actual condition of the heart by the examination of the pulse. On the ninth day the pulse had increased in frequency, volume, and strength; and yet the sounds were more feeble than on the day before. I have shown that we may have a vigorous heart with a feeble pulse, or even absence of pulse, and here we have the converse of the proposition. The sounds of the heart became more feeble while the pulse was stronger. Indeed we could never determine from the pulse whether or not the phenomena of the heart were altered, and the fact is, that it is by the physical signs, and the application of the hand alone, that we can ascertain how far the heart is affected in typhous fever. In this case, however, the fulness and increased strength of the pulse preceded a certain degree of reaction; for on the next day the sounds were louder, the countenance more animated, and there was headach: we then omitted the wine. The excitement, however, was but temporary, for in twenty-four hours *the first sound was completely lost at the mamma.*

We sometimes meet with cases in which stimulation is necessary, yet the patients do not bear wine well. In such cases I exhibit porter, which answers well.

CASE XII.

Petechial typhus, with diarrhœa and bronchitis—Cessation of the first sound of the heart—Exhibition of wine delayed till the twelfth day—Return of the first sound on the fourteenth—Recovery.

John M'Kone was admitted on the 1st May, on the eighth day of his fever; there is no petechial eruption; complains of troublesome cough; bronchial rales in both lungs; tongue covered with a brown crust; the impulse of the heart *is perceptible; the first sound* is almost inaudible, the second is perfectly distinct; pulse small, 120.

Pil. hydrarg. gr. iii. Pulv. Doveri, gr. ii. ter die sumend.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
May 2.	Raved during the night; got some sleep towards morning; seems much depressed.	Pulse 120, small and quick; impulse of heart is still perceptible; the second sound predominates considerably over the first.	Repeat medicine.
" 3.	Passed a much quieter night than the last; raved	Pulse 120, and fuller; impulse scarcely perceptible.	Ext. hyoscyam. gr. iii.,

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	a good deal towards morning; tongue very much furred; great thirst; bronchitis continues; maculæ are now very plentiful; headach.		pulv. ipecac. gr. ss., tertiis horis sumend.
May 4.	Raved much less last night; no headach; eyes suffused; countenance rather flushed.	Pulse 120; the first sound of the heart is almost lost; the second is distinct.	Beef tea.
" 5.	The petechiæ are not more livid, nor are they paler; some purging yesterday and to-day.	Pulse 124, easily compressed; *the double character of the sounds of the heart is now completely lost; the second alone being audible;* the impulse is not to be felt.	Wine 10 oz. chalk and opium mixture.
" 6.	Has passed a great many bloody stools; much delirium; his countenance, however, is not expressive of great depression; rest broken by being obliged to leave his bed; petechiæ have faded considerably.	Pulse 112; the sounds and impulse as yesterday.	Wine 10 oz.; repeat mixture; beef-tea.
" 7.	Was exceedingly delirious the whole night, so much so as to render the strait-waistcoat necessary; has passed three motions not bloody; subsultus tendinum.	Pulse 92; the impulse is yet imperceptible; the *first sound is again audible to day;* the second distinct and clear.	Wine 10 oz.; draught of muriate of morphia; beef tea.
" 8.	Did not rave at all; slept almost the whole night; countenance much more animated; speaks quite rationally; bowels moved twice, fæces assuming their natural form; tongue cleaning and moist; but little thirst; *he did not get the morphia;* petechiæ quite gone.	Pulse 80, of good strength; the impulse is perceptible; the first sound stronger today, giving less predominance to the second.	Wine 5 oz.; arrow root diet.
" 9.	Slept very well; did not rave; says he could eat a bit of bread if he had it; bowels much improved; two motions yesterday; is much better.	Pulse 80, and of good strength; impulse perceptible; there is very little difference between the sounds of the heart.	Continue wine 5 oz.
" 13.	Convalescent.	Pulse 76, natural.	Has had wine 5 oz., and beef tea daily since last report.

This case is principally interesting from the complete disappearance of the first sound of the heart for at least forty-eight hours; the coming down of the pulse under wine preceded the return of the first sound and the impulse: throughout the whole of this case the second sound continued remarkably clear.

The exhibition of wine was delayed too long in this case; we were misled by the absence of petechiæ on the eighth day; they did not appear till the tenth day, an unusually late period.

The next case is remarkable for its presenting the peculiar cardiac phenomena in fever, with a singular slowness of the pulse during the disease, and also in the convalescence.

CASE XIII.

Maculated fever, with bronchitis—Feebleness of the first sound—Slowness of pulse—Free use of wine—Recovery.

Richard Edwards, æt. 26; admitted into hospital on 8th June, ten days ill; the petechiæ are very plentiful and of healthy colour; countenance much depressed; tongue very thickly coated; great thirst; did not sleep well last night, but was continually raving; complains of irritation in his throat, which is not inflamed; great oppression in his breathing; acute bronchitis in left lung; cough troublesome; expectoration viscid; abdomen full and tympanitic, but without pain on pressure; impulse of the heart is perceptible; the sounds are very weak, and the second predominates over the first; pulse 84, feeble; bowels free; respirations 48. To be cupped freely between the shoulders; blister to the sternum; senega mixture, wine viii. oz.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
June 10.	Raved a good deal last night; countenance anxious; conjunctivæ infected; tongue much coated; no headach; cough not very troublesome; expectoration viscid and scanty; respirations 48; bronchitis in both lungs; more severe in the left; bowels rather too free; evacuations thin and watery; extremities warm.	Pulse 80, small and compressible; the first sound of the heart is so feeble as to be almost inaudible; the second is very clear; impulse just perceptible.	Wine 24 oz.; repeat mixture; blister over the heart in the evening, if necessary.
" 11.	Passed a good night; the blister was applied yesterday evening; is very weak this morning; countenance expressive of great anxiety; tongue coated; breathes easier; coughs less; expectoration profuse and thick; respirations 40; is not purged, but passed two thin watery stools.	Pulse 80, feeble; we could not examine the state of the heart in consequence of the blistered surface being very painful.	Wine 24 oz.; repeat mixture.
" 12.	Countenance much improved this morning; breathes easily; bronchitis better; did not rave; bowels moved three times; character of	Pulse 80, feeble; the impulse of the heart is perceptible; the second sound is still loudest.	Wine 16 oz.; repeat mixture.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	stools somewhat better; respirations 36; expectoration not so profuse; coughs much less.		
June 13.	Countenance considerably improved, and he is much better this morning in every respect; sputa profuse again to-day; does not complain of much thirst; respirations 26.	Pulse 80, and fuller; impulse and sounds as last report.	Wine 12 oz.
" 14.	Slept very well; petechiæ fading; tongue cleaning and moist; bronchitis much better.	Pulse 68, and of good strength; impulse of heart perceptible; sounds improving; the second yet predominates.	Wine 12 oz.
" 15.	Countenance more animated; voice stronger; very little expectoration; bronchitic rales are still loud; bowels regular: no petechiæ.	Pulse 60, soft and compressible; the first sound of the heart much improved in strength, giving little predominance to the second.	Wine 12 oz.; bark mixture.
" 16.	Bronchitis rapidly improving; respirations natural; converses rationally.	Pulse 60; impulse of heart very feeble; the 2nd sound still predominates.	Wine 6 oz.
" 17.	Expectoration is scanty, and tinged slightly with blood; on carefully examining the chest, no signs of pneumonia can be discovered; and the bronchitis is much less intense.	Pulse 54, stronger; impulse and sounds as last report.	Wine 6 oz.
" 18.	Sputa free from admixture with blood; is considerably better; appetite good.	Pulse 56, regular; impulse perceptible; and the sounds of the heart are once more proportionate.	Wine 6 oz.
" 19.	Passed a very good night; tongue clean; no cough; bowels regular; skin cool.	Pulse 52; strong; phenomena of heart natural.	Wine 6 oz.
" 20.	As last report.	Pulse 46, and strong.	Wine 6 oz.
" 21.	Quite convalescent.	Pulse 44, and of exceedingly good strength.	Wine 6 oz.
" 22.	He was out of bed for the greater part of yesterday, and bore the exertion well.	Pulse 44; on walking across the ward and back again, the pulse rose to 60.	Mutton chop.

We have now recorded two cases, in which the phenomena in question coincided with a very slow action of the heart, and in which the pulse during convalescence became singularly diminished in frequency. To this I would particularly direct the attention of my readers, as it bears on a very important practical point, namely, the cause of the anormal conditions of the pulse in the convalescence of fevers.

In my remarks on the fourth case, (see page 13,) I have alluded to the opinion of Laennec, who, after describing the softened state of the heart in putrid fevers, inquires whether this condition could account for the frequency of pulse which exists, sometimes for several weeks, in convalescence from fevers, although the patient continues to regain flesh and vigour.[1]

If the phenomena now described are connected with a softened state of the heart, it will appear that our experience in this matter is opposed to the idea above quoted. It will be observed that in most of the cases the pulse came down to its ordinary rate, and did not exhibit any unusual frequency during convalescence; and that in several, and in two particularly, the pulse in convalescence fell far below its usual standard. And with respect to the frequency of pulse in convalescence, alluded to by Laennec, my experience at present is, that it is more likely to occur after fevers of a *non-putrid* character; and that it often points out the existence of some local irritation, or a tendency to it. Future observations must settle this point.

I might add several other cases presenting analogous phenomena, but refrain from doing so, as they do not exhibit any features different from those already described.

It will be seen that, in all the preceding cases, the modifications of the heart's action was either the diminution or obliteration of the first sound, or the equable diminution of both, so as to produce the fœtal character: but there is another modification, which, though of rare occurrence, is most interesting: in this we find the *first sound preponderates.* Of this variety but two cases have been observed: the first occurred in my own practice, and the second was of a patient treated by Dr. Graves, for the history of which I am indebted to one of our most accurate observers, Mr. William M. Murphy.

CASE XIV.

Petechial fever, with bronchitis and diarrhœa—Vigorous action of the heart up to the ninth day—Preponderance of the first sound on the sixteenth day—Use of wine—Recovery.

Thomas Keefe, æt. 30, a strong muscular man, was admitted on the 11th May, being then nine days ill; he was abundantly maculated; well marked bronchitic rales in both lungs; the action of the heart was vigorous, and both the sounds natural; pulse 108, full. The chest was cupped and blistered, and pills of blue pill and ipecacuanha exhibited.

[1] Laennec, Art. Softening of the Heart.—See Dr. Forbes' Translation.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
May 13.	Severe diarrhœa.	Pulse strong; both sounds are distinct and proportionate, but they seem as if distant.	Omit the pills; poultices to the abdomen.
" 14.	The diarrhœa continues; maculæ abundant and florid.	Sounds of the heart more feeble; the impulse is imperceptible except at the termination of expiration; pulse 100, strong.	Saline mixture; arrow root.
" 15.	The bronchitis is more severe.	Impulse quite imperceptible; both sounds feeble but distinct; pulse 100, feeble.	Wine 6 oz.; dry cupping; blister to the chest; pills of ipecacuan. hyosciamus, and carb. ammonia.
" 16.	Pupils contracted; bronchitis continues; tongue glazed and red.	Impulse imperceptible; sounds as before; pulse 92, a shade stronger than yesterday.	Wine 12 oz.; beef tea; antimonial mixture, with 3 grains of tart. emet.
"	Some diarrhœa; no vomiting; bronchitis diminished; the petechiæ are not more livid; pupils less contracted; tongue improving, becoming moist and pale at the edges; the wine was given warm.	Impulse again perceptible; pulse 82; both sounds of the heart can be heard.	Wine 10 oz.; senega mixture; musk and camphor pills.
" 18.	Tongue improving; petechiæ fading.	Sounds of the heart not so distinct as yesterday; *the second can scarcely be heard;* impulse perceptible.	Repeat all.
" 19.	Slept well; diarrhæa continues.	Sounds as yesterday; impulse imperceptible.	Wine 10 oz.; blister to the heart; bark mixture.
" 21.	General improvement; slept well; perspiration.	*Both sounds can now be heard; they are feeble but proportionate;* impulse imperceptible; pulse 72.	Wine 8 oz.; repeat the mixture.
" 22.	Improvement continues.	The sounds over the right cavities are proportionate; *over the left the first is much more feeble than the second;* no impulse.	Repeat all.
" 23.	Skin cool; appetite good; no bronchial râles.	First sound much more distinct; impulse plainly perceptible; pulse 72.	Wine 4 oz.
	Convalescent.		

CASE XV.

Petechial typhus with palpitation of the heart and bronchitis—Preponderance of the first sound of the heart—Recovery.

William Hawkins, æt. 34, tall, not very robust; admitted into hospital October 18th, 1838; eleven days ill. Illness commenced after exposure to a draught of air, by rigors, succeeded by heat, &c., also by violent palpitations of the heart, which he says lasted for seven days. On admission the pulse was intermitting; there was a strong action of the heart, but it was also intermitting.

19th, (twelfth day). Abundantly maculated, severe headach, impulse of the heart feeble, no intermission of sounds. *First preponderates considerably, most marked at the sternum;* abdomen tympanitic; he is constipated; a blister was applied to the abdomen; camphor mixture, chalk mixture, and rhubarb wine ordered, and a turpentine enema; the pulse was regular 100.

20th, (thirteenth day). The pulse was 104, stronger but intermitting; no impulse; the sounds more feeble, and intermitting synchronously with the pulse, *first preponderating considerably;* bronchitis in both lungs; was cupped, blistered, and ordered 5 grs. of hydrarg. c. cret. every fourth hour. Was visited in the evening, and the pulse and heart were regular. The bronchitis became very severe, for which he was repeatedly blistered, and the mercury pushed to slight salivation; the pulse and heart continued without intermission, *but the first sound preponderated all through.*

On the 24th, (seventeenth day of illness), he got 6 oz. of wine. On the 28th, (twenty-first day), the pulse was 64; no impulse of heart, the sounds became proportionate. On November 4, (twenty-ninth day), the impulse was felt, sounds proportionate, pulse 64.

November 12th. Left the hospital quite well.

We have thus two cases in which the first sound preponderated. In the first this peculiarity was not observed until the sixteenth day; while in the second it was recognized on admission, (the ninth day,) and the sounds did not become natural until after the twenty-first. In this case it will be observed, that the pulse was intermitting, and that the patient complained of palpitation from an early period of the fever.

Let us now examine the results of dissection in a few cases in which feebleness of the heart's action was recognized.

CASE XVI.

Severe maculated typhus complicated with intense bronchitis—Gastritis—Perspiration on the 13th—Employment of wine—Death.

John Harris, of full plethoric habit, had always enjoyed good health, and although in the habit of taking whiskey, never drank to excess; has had fever for six days; his chest and arms are covered with well defined bright red petechiæ, complains of much pain in the head and dimness of sight; tongue furred, epigastrium very tender on pressure, bowels constipated; passes small quantity of urine; pulse 96, and full; respirations 28; some wheezing and sibilant ronchi are heard in anterior portion of lungs, face very much flushed. He was ordered efferv. draughts.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
June 8.	Presents the same appearance as yesterday; slept badly; bowels relieved.	Pulse 96.	Wine 6 oz.
" 9.	Has had another bad night; is very restless; countenance flushed.	Sounds of the heart very feeble; pulse small and compressible, 96.	Continue wine.
" 10.	Better night than he has yet had.	Pulse much stronger and fuller, 104, and by no means so compressible; sounds of heart a shade stronger than yesterday.	Continue wine.
" 12.	Did not sleep so well as on the previous night; extreme debility.	Pulse 116; sounds of the heart precisely resemble those of the fœtus in utero.	To have a glass of hot punch immediately; wine 12 oz.; blister between the shoulders and terebinthinate enema.

From this period the patient got worse. The bronchial disease became intense and general, so much so that it was hardly possible to make any accurate observation of the sounds of the heart; the impulse, however, was imperceptible; the pulse became intermitting, and increased in frequency to 120, and on the next day to 136. He died on the following day, the seventeenth of his disease. On the sixteenth day his extremities were cold. In this case active stimulation was employed. The patient got nearly eighty ounces of wine; he was dry-cupped and blistered, and used emetics, from which he experienced great relief three days before his death.

Post Mortem, eleven Hours after Death.—The heart is of its natural size, livid, and feels extremely soft, pitting on pressure, particularly over the left ventricle; some white patches may be seen on the right ventricle; the lining membrane of the left auricle presents nothing remarkable; the left ventricle was divided from its base to apex; the muscular substance presents a very singular appearance, not a trace of fibre being visible; and for more than two-thirds of its length, a layer presenting a darker colour and of more homogeneous appearance, of one-eighth of an inch in thickness, was found; into this layer it is very difficult to trace the muscular fibre. The substance of the ventricle is infiltrated with a gummy matter, causing the fingers to stick together; the structure has some resemblance to the cortical structure of the kidneys; a transverse section gave the same appearance. The net-work of fleshy fibres exhibits more firmness, though analogous in condition; the posterior columns seem but little altered, being only pale, their firmness remaining perfect; the same may be said with respect to the anterior; the right ventricle is harder and firmer, and does not exhibit the same aspect as the left; the auricle of the same side contains a coagulum; nothing remarkable in the colour and appearance of the membrane; the septum cordis presents the same appearance as the left side. On examining the abdomen, nothing abnormal presented itself. The ileum is perfectly healthy; no enlargement of the glands.

CASE XVII.

Maculated typhus with severe nervous symptoms—Predominance of the second sound on the sixth day; complete absence of the first sound on the tenth day—Death—Softened state of heart—Ulceration of the ileum.

Richard Cashel, æt. 46, admitted 5th November; six days ill; he complains of pain in back, neck, and extremities; considerable prostration; maculæ abundant, of light colour on chest and abdomen, but much darker on back; slept very little last night; raved a good deal, but was not violent; has no headach; pupils slightly contracted; very little cough unaccompanied by expectoration; stools thin and watery; abdomen soft and tender on pressure; great thirst; tongue brown and dry in centre; teeth covered with sordes; pulse 116, rather feeble; respirations 28; auscultation detects slight bronchitis in both lungs; while the patient lies on his back the impulse of the heart cannot be felt, but becomes imperceptible when he turns on his left side; both sounds are audible, and the second predominates slightly over the first; ordered an anodyne enema.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
Nov. 7.	Raved much; skin hot and dry; maculæ dark; respirations 28.	Pulse 116, as yesterday; the impulse of the heart cannot be felt to-day; sounds more feeble than yesterday, scarcely audible above the mamma, and to the left: more so at the sternum; the second preponderates.	Repeat wine, 8 oz.
" 8.	No raving; extreme prostration; considerable fœtor from body; maculæ very dark coloured; sordes on teeth and tongue excessive; is unable to raise himself without assistance.	Pulse exceedingly feeble and irregular, being from about 116 to 124; no impulse of heart; sounds very feeble, almost inaudible to the right of nipple; the *second* is still loudest.	Wine 16 oz.; beef tea.
" 9.	Was very restless all night; picking at the bed-clothes, and muttering constantly; passes his water under him; lies on his	Pulse 120, exceedingly feeble, obliterated on the slightest pressure; when lying on his left side the impulse could then be felt,	Wine 20 oz.; brandy 2 oz.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	side; maculæ very abundant, and quite livid on the back.	but on turning on his back it was felt to be vigorous; *the double sound of the heart was completely lost, the distinct clear "rap" of the second alone being heard; most distinct also at the base of heart.*	
" 10.	Lies on his back; mouth wide open; constant spasm of the muscles of lower jaw; constant moaning; *is in profuse perspiration;* excessive fœtor from body; respiration 40; stools involuntary.	Pulse 150, exceedingly weak and irregular; impulse of heart evident and pretty strong; in consequence of his moaning, no accurate accounts of the sounds could be taken.	
	Died at 1 o'clock, P. M.		

Dissection twenty Hours after Death.—The body was more than usually livid; the petechiæ were pale on the forepart of the body, but very dark and livid on the back; abdomen tympanitic; the pericardium contained about half a pint of straw-coloured serum; the heart was of large size, and so extremely flabby, that it was capable of retaining any shape in which we placed it; the *right cavities* were softer than natural, admitting the fingers through their walls without much resistance; in the muscular structure of the left cavities, however, this change was much more remarkable; the weight of the finger was almost sufficient to penetrate its walls, they were so exceedingly softened; it is very easily torn, and the edges thus separated have no longer the moistened appearance, but seem as if quite dry. The septum cordis was equally softened; there was some dark fluid blood in the right cavities. The stomach presented some red patches, slightly elevated; towards the pylorus, the mucous membrane was thickened and softened, and was easily removed by the handle of the scalpel. The duodenum was tolerably healthy, having only in two or three places slight blushes of inflammation. The ileum was more extensively involved; this was particularly observable in the last two feet of its length, near to the ileo-cæcal valve: there were five ulcerated points; the superficies of the ulcers were covered by a delicate membrane, beneath which there was a yellow-coloured fluid, resembling pus; the largest was about the size of a silver penny: round these infiltrated points the intestine was much inflamed, and several minutely injected capillaries were seen ramifying around these points, but they could not, even by the aid of a good lens, be traced into the ulcers; when the membrane was removed under water, and the puriform matter washed off, a decided depression was left, at the bottom of which was easily seen the muscular coat of the intestine: dispersed further throughout the intestine were several of the elliptical patches. The glandulæ aggregatæ were very prominent in many places.

The general type of fever in this case did not at first seem worse than in many others in which recovery took place. But the patient had been greatly exhausted before admission by hypercatharsis, induced by two enormous doses of castor oil which he took on the second and fourth days of his disease. This circumstance is not unfrequently met with in our wards; and I do not know a worse preparation for the struggle in the advanced stage of typhus than over purging in the commencement. The medicine commonly employed is glauber salts, in a very large dose; this is taken independent of any medical advice, and in several cases the ulceration of the intestines seems to have been promoted by its action.

The pulse in Cashel's case rose from 116 to 150, *under the use of wine.* This and the extreme fœtor of the body led to the worst prognosis.

In the phenomena of circulation, the most interesting point is, that while the first sound was absent, *the impulse continued. On the day of his death the impulse was very evident, and yet we found a softened left ventricle.* We shall see that the diminution or cessation of the first sound, and of the impulse, are not always co-existent. It is hardly necessary to observe on the difference between these phenomena and those in the case in which wine was successfully employed. On two occasions we were forced to omit the wine, and ultimately we abandoned its use.

In this case, also, the peculiar diminution of the first sound was not observed until the day before death; and on the previous day, (two days before death,) the impulse and sounds were strong. I conceive that the morbid change in the left ventricle did not occur in this patient so early, or to the same extent, as in other cases.

In observing on the cases of Cavanagh and Smyth, (see page 19,) I have stated that we have not yet recorded any instance in which the alteration of the first sound was accompanied with or preceded by signs of irritation. In this case, however, and in that communicated by Mr. Murphy, *where the first sound predominated,* the symptom of irregularity of the heart existed; and in Mr. Murphy's case there was pain. How far these circumstances indicated inflammation we cannot now determine; but it must be remarked, that the effect of wine was totally different in the two cases.

CASE XVIII.

Severe maculated typhus, with cerebral irritation, and great prostration—Diminution of the first sound of the heart on the day before death—Use of wine—Death on the nineteenth day.

Catherine Murphy, æt. 30, of good constitution; six days ill on the 10th of June. She complains of pain of the forehead and temples, for which she was leeched, without relief. The petechiæ are abundant, and very livid; no thoracic complaint; has much abdominal tenderness, and diarrhœa. Was ordered six leeches behind the ears.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
June 11.	Tongue furred, and dry; purging still continues; respirations 44.	Pulse 120, feeble; impulse of the heart perceptible; both sounds of the heart proportionate.	Wine 4 oz. arrow root.
" 12.	Had a restless night; passes her urine involuntarily, and is much weaker than yesterday; pain of forehead and temples continues; respirations 32.	Pulse 120; sounds of the heart louder than yesterday.	Wine 12 oz.
" 13.	Raved a good deal last night; *after having taken eight ounces of wine, pulse rose to* 130, *and was very small;* has no purging; tongue coated, and dry.	Pulse 130, very feeble; sounds of the heart proportionate, but feebler than yesterday; impulse scarcely perceptible.	Blister applied over the sternum; continue wine as yesterday.
" 14.	The blister was applied yesterday, but in consequence of her changing the position so very frequently, it did not rise; the acetate of cantharides was then used and proved efficacious; very low; respirations 32.	Pulse so irregular that it cannot be counted; impulse not perceptible; sounds of heart as yesterday.	Wine 24 oz.
" 15.	Raved all night; does not pass her water under her, but gets up whenever it is necessary.	Pulse 124, and full; impulse and sounds of the heart as yesterday.	Continue treatment.
" 16.	Did not rave last night; the wine produced so much excitement yesterday afternoon, that it was found necessary to stop its further exhibition.	Pulse 112.	Wine 12 oz.
" 17.	Was again obliged to stop the wine; after taking eight ounces; bowels regular; tongue cleaning.	Pulse 100; impulse of the heart again perceptible, and the sounds proportionate and stronger.	Omit wine; beef tea.
" 18.	Raving and moaning throughout the night; respirations easy and natural.	Pulse 104; impulse and sounds of the heart as yesterday.	Anodyne draught.
" 19.	Raving all night; on pressing the larynx, she complains of pain, but will not allow an examination.	Pulse 120, and full.	Anodyne enema; flannel waistcoat.
" 20.	Did not rave last night; sacrum very sore; pupils contracted; allowed her throat to be examined this morning, when several diphtheritic patches were seen.	Pulse 130, and very feeble.	The strong muriatic acid to be applied to the throat; blister to neck.
" 22.	Extreme prostration, but	Pulse 120; heart's ac-	Decoct. cin-

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	is perfectly sensible; voice much clearer than yesterday; respirations 40.	tion morbidly excited; sounds proportionate.	chon. 6 oz.; tinct. cinchon. 3 oz.; sumat ℥ i. secundis horis; porter one pint, and beef tea.
June 23.	Is still sensible; countenance expressive of great anxiety; is very low; moaning, and tossing her arms about considerably; respirations hurried, 64; teeth thickly covered with brown sordes.	The first sound of the heart is scarcely audible, while the second is distinct and clear; pulse extremely feeble, and so irregular that it cannot be counted.	As yesterday.
" 24.	Died at half past one.		

Dissection twenty hours after death.—The body presented an unusually livid appearance. On the abdomen were observed numberless minute vesicles, and on the sacrum there was a large sloughing sore. The muscular structure was firm and healthy. On opening the chest the lungs presented a healthy appearance; posteriorly they were rather congested, but this seemed to be the result of gravitation of blood. The pleuræ were not adherent. On slitting up the pericardium it was found to contain about half a pint of straw coloured fluid; the covering itself seemed healthy. The heart was of small size; the muscular structure of the left ventricle was softened, but not to the same extent as in the preceding cases; on cutting into it, the fibres were perceptible, but they presented, nevertheless, a rather homogeneous appearance, and a peculiar glairy semi-gelatinous fluid was found between them; there was no valvular disease. The intestines were bound down by old adhesions, and were free from ulceration; the smaller were much congested and softened.

The circumstances worthy of remark in this case, are, that wine did not agree with the patient, and that the phenomena of the heart were very different from those detailed in most of the preceding cases. Under the use of wine the pulse rose from 120 to 130, and then became exceedingly irregular; it next fell to 124, and was full; it continued to diminish in frequency; again increased, and became irregular. Its rate was as follows:

Seventh day, 120.
Eighth day, 120.
Ninth day, 130.
Tenth day, irregularity so great that it could not be counted.
Eleventh day, 124.
Twelfth day, 112.
Thirteenth day, 100.
Fourteenth day, 104.
Fifteenth day, 120.

Sixteenth day, 130.
Seventeenth day, 120.
Eighteenth day, irregularity as before.

CASE XIX.

Petechial typhus, with severe nervous and catarrhal symptoms—Great feebleness of the heart on the twelfth day—Use of wine—Vigorous action of the heart for four days before death.

Eliza Bourke, æt. 35, admitted on the 7th March, the eleventh day of fever. On admission she was delirious; in a state of great collapse, with cold extremities, and miserable pulse. She was given 4 oz. of wine, and artificial heat applied to the feet; during the night she never ceased howling and screaming; lies on the back in an extreme state of prostration, raving immoderately, moaning, and sometimes screaming aloud. Countenance flushed, wild, and ferocious; eyes suffused; pupils natural; sordes on teeth and lips; she points to the head as the seat of much distress; thirst urgent; skin hot, dry, and covered with livid coloured petechiæ, evidently on the decline; tongue fissured and brown; pulse 136, small and weak; respirations 40, laboured and interrupted; intense general bronchitis; impulse of the heart imperceptible; no accurate observations could be made as to the sounds, from the loudness of the râles.

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
March 9.	Thirteenth day of fever; slept well; delirium much less; pupils somewhat contracted; upper and lower extremities quite cold; tongue covered with black crust; respirations 28.	Pulse 140, small and weak but a degree stronger than yesterday; impulse of heart slightly perceptible; both sounds can now be heard below the mamma, and are much stronger than yesterday.	Wine 24 oz.; turpentine enema.
" 10.	She is more tranquil, but the countenance retains the wild expression; extremities warm; respirations 32, laboured.	Pulse 128, much fuller and stronger; the impulse is much improved, and the heart can be felt pulsating over several square inches; the sounds are louder, and the first sound has increased in strength.	Repeat wine; blister to the head.
" 11.	After each dose of wine, which has been given mulled, her general appearance became much improved, but the bronchitis is very intense; and in both lungs, inferiorly, a moist crepitating râle can be heard.	*No change* in impulse and sounds of heart; pulse 132.	Repeat wine.
" 12.	Breathing more difficult and laboured; great wheez-	The impulse of heart still more perceptible, but its	Repeat wine; pills of ipecac-

DATE.	GENERAL SYMPTOMS.	PHENOMENA OF CIRCULATION.	TREATMENT.
	ing in the throat; respirations 44; and râles in all parts of the chest more sonorous and intense.	sounds much obscured by the râles.	carb. ammon., & hyoscyam.
March 13.	She is sinking rapidly; respirations 64 in a minute; congestion of the lung much increased.	Pulse 124; no change of the impulse or sounds of the heart.	Wine 24 oz.
" 14.	Died.		

There were many circumstances which led us to form a bad prognosis in this case; I would particularly specify the advanced period of fever at which she was admitted, the violence of the bronchitis, and great rapidity of pulse. Among the secondary diseases of typhus, there are few more dangerous than the bronchial affection, or one that demands the same decision in treatment *in the earlier periods of the case;* and there can be little doubt that had the chest been relieved by proper means, within the first week of this woman's illness, the chance of recovery would have been much greater.

It will be recollected that the pulse, on the thirteenth day of fever, was 140; and that after 24 oz. of wine had been given, it fell to 128: so far there was evidence that the wine was acting well; and on the fourteenth and fifteenth days there was an improvement in her condition generally. The respirations, however, became more and more difficult, and she sunk with all the symptoms of suffocation.

In the cases detailed in the beginning of this paper, it will be seen that the returning impulse and sounds were accompanied by other and decided marks of improvement; but here we had the action of the heart suddenly becoming less frequent and much more vigorous, with preservation of both sounds, while the catarrhal symptoms were increasing. The heart was not merely restored to its natural standard, so far as impulse and sounds were concerned, *but it was obviously excited;* and this excitement continued for four days before death.

The action of wine upon the heart in typhus may be said to be both sedative and stimulant; sedative in diminishing its frequency, stimulant in restoring its impulse and muscular sounds; but in its favourable action, the vigour of the impulse, and the intensity of the sounds do not pass the limits of health.

There is a point where its stimulating effect should cease, and if this is passed, wine is either useless or injurious.

I have now given such cases as I conceive are sufficient to introduce the subject of the state of the heart in typhous fever to the consideration of the profession. I might add other cases, but they do not elucidate any new point, and I have given the results of the fatal cases.

If we examine authors on the subject of the state of the heart in typhus, we find, that, with the exception of Laennec and Louis, there is but little information given. Laennec does not seem to have examined the point to any extent; and Louis contents himself with recording the state of the heart in a certain number of subjects who died of fever; but in neither author do we find observations on the physical phenomena of the heart during life.

In his chapter on Softening of the Heart, Laennec writes as follows:

"The variety of softening which accompanies idiopathic fevers does not in general present any change of colour in the heart, or it is attended with a deeper colour than natural, approaching purple; sometimes, however, it is yellowish. I think it may be compared to that adhesive softness of the other muscles, often observed in these cases, and which is also accompanied by a degree of redness greater than natural. This softening of the heart, as well as the analogous gluey or fishy state of the muscles, is particularly observable in putrid fevers, more especially when these exhibit the phenomena formerly considered as marks of putridity, viz. livid intumescence of the face; softening of the lips, gums, and internal membrane of the mouth; black coating on the tongue and gums; earthy aspect of the skin; distended abdomen; and very fœtid dejections. I cannot assert that this softening of the heart exists in all kinds of continued fevers, but I have met with it constantly in such cases as I have attended to; and I have always thought it more marked in proportion as the signs of an alteration in the fluids were more evident. Could it account for that frequency of pulse which exists sometimes for several weeks in convalescence from fevers, although the patient continues to regain flesh and vigour?"

I shall next quote from Louis—Dr. Bowditch's translation:

"The heart had the size, consistence, and colour natural to it in half of the cases, or in twenty-three subjects; rather less frequently, *ceteris paribus*, among those who died between the eighth and twentieth days of disease, than among those who died after this epoch.

"It had less consistence than natural in twenty-four other subjects. This diminution of consistence was slight in seven cases, and as when in this degree one might consider it less as a morbid state than as a variety of the natural consistence, or as it is called, of its physiological state, I shall not consider these cases in what follows, and thus the number of patients we must examine is reduced to seventeen.

"The softening of the heart was, moreover, very slight in two of these cases. But as it was limited to the left side of the organ, we cannot consider it as the result of natural disposition; but there is a still more important reason for this opinion, viz. it happens sometimes, when the softening is considerable, that it is more so at the left than at the right. In the other cases, it was universal and very marked, the heart was very flaccid, so that in many cases it had no precise form, but like a wet cloth, retained any shape into which it might happen to be placed. Its substance, in these cases, had very little power of cohesion, was easily torn, and was very easily penetrated by the finger.

"At the same time that it was softened, the heart had less colour than usual in many cases; it was of an onion-peel colour, which varied in intensity, and was generally livid and purplish on its surface as in its substance. The internal face of the ventricles and auricles was, on the contrary, of a deep violet-red colour, which colour sometimes penetrated beyond the lining membrane, and appeared owing to an imbibition of blood, which it resembled more or less in colour.

"When thus softened and pale, the heart had no longer, when cut, the slightly moistened aspect it has generally, but it was, as it were, dry and unpolished, such as we have seen the liver appear in analogous circumstances. Its size was not larger than usual, and it appeared smaller in two cases (Obs. 14, 33), and, therefore, it appears to me, we ought not to consider this as an effect of the softening of the organ, but rather as a natural *disposition* which existed in other patients likewise, in whom the heart presented nothing else remarkable, (Obs. 31, 39, 41).

"Another fact, which it is important to notice is this, viz., that in nearly all the cases of softening, the walls of the ventricles were evidently much less thick than usual, those of the left especially, which were often three lines thick only. And as this diminution of thickness was limited to cases of softening, we must consider it as a morbid affection.

"If these facts are insufficient to enable us to discover the cause of the softening of the heart, at least they exclude the idea of one of those affections which usually cause a great number of affections, viz., inflammation. For how can we allow that inflammation is the cause of an acute softening, accompanied by a diminution of thickness, paleness of colour, and a kind of dryness of the texture which is the seat of it? Such a supposition would truly imply a contradiction, and, as I remarked in relation to the softening of the liver, if we knew any cause of disease exactly the reverse of inflammation it would be proper to refer this softening to it.

"Other considerations which I have already given in relation to the spleen support these reflections. The walls of the heart, although more or less softened, had never any pus in them, and there was never any inflammation of the pericardium, which would have been the case rather frequently in softening of the heart, had this softening been caused by inflammation. And in opposition to this opinion, we cannot produce cases of pericarditis observed after other acute diseases, inasmuch as softening of the heart was found in two cases out of eight in which there was pericarditis.

"Moreover, the frequency and severity of the softening were much more marked according as the disease was more early fatal. Thus the heart was softened in nearly half of those patients who died between the eighth and twentieth days of disease, in a third of those who died during the following period, and in a somewhat smaller proportion among those who died afterwards. Besides, in seven cases in which the softening was extreme, not one was relative to individuals who died after the thirtieth day of the disease, and I found

4 out of 17 patients of the first and second series,
3 " 20 " third "

"Hence we see, that whatever was the degree of softening, the proportion of cases in which it took place in the different series of patients was very nearly the same; and it was like that of the liver and spleen, more serious in those who died early in the disease, than in those who died after the twentieth day, and we did not find it at its *maximum* in patients belonging to the fourth series. The rapidity of its development showed the extreme violence of the cause to which it was owing in certain cases, and as other lesions of the same kind, it necessarily contributed much to produce death and hasten its arrival.

"Another fact which seems to me to be not less remarkable than the rapid softening of the heart is this, viz., no similar lesion was found in any other muscular organ; as all the muscles which preside over voluntary motions preserved, amidst the general disorder, the consistence and colour which are natural to them."[1]

In these extracts I have given all that has been discovered on the subject; no series of observations on the action of the heart in typhous fever has been published; I have commenced this inquiry, and have sought to derive some important indications of treatment from the existence of the phenomena now described. In the present state of the inquiry I wish it to be understood, that my observations are to be taken as referring principally to the epidemic of last year. Further researches must be made to establish how far they may be applicable to typhus in general; but I have little doubt from studying the researches of Louis, and connecting the facts relative to the anatomical state of the heart, with those now observed as to its vital phenomena, that my observations will be found to have a very extensive application.

The epidemic of last year was marked by all the signs of putridity. Dark coloured and abundant petechiæ; sordes of the mouth, fœtor of the surface, extreme prostration, and stupor, were the prominent features of the disease; and in many cases bronchial and gastro-enteric irritation existed to a great degree.

In many of the cases the bad symptoms were developed at an unusually early period, yet though recovery by crisis was by no means common, the convalescence was generally satisfactory, and the ultimate restoration to health complete. In several instances the disease was traceable to contagion.

We may thus arrange the cardiac phenomena obtained in our typhous fever:—

1. Impulse and sounds remaining unaltered; the action of the

[1] Louis. Bowditch's translation.

heart corresponding with that of the pulse.

2. Vigorous impulse, with distinct and proportionate sounds, with absence of pulse for many days.

3. Diminution of both sounds of the heart, with absence of great diminution of the impulse, (fœtal character).

4. Diminution of the first sound; with cessation or great feebleness of the impulse.

5. Complete extinction of the first sound, the second remaining clear.

6. Predominance of the first sound, the second being extremely feeble.

Of these the fourth and fifth were the most common.

I have before remarked, that in the progress of a single case we may observe first one and then another of these groups of signs. Thus in the third case, (see page 8,) the sounds on the seventh day were proportionate, but so much diminished as to resemble those of the fœtal heart. On the eighth day this character was lost, and both sounds were much louder, with returning impulse; while on the eleventh the second greatly preponderated. Nearly the same phenomena were observed in the fourth case, (see page 11,) and in he seventh, (page 18). In the case of T. Keefe the second sound was most distinct in the early periods of the case, while the first became predominant towards its close.

In the great majority of cases, however, the phenomena were as follows:—

I. Diminished impulse.

II. Diminished first sound, particularly of the left cavities.

With respect to the impulse we arrived at some unexpected results. In most cases, considered through the whole progress, the diminution and return of the first sound were accompanied with the diminution and return of the impulse. So far the phenomena were what we might expect. *But in some instances, at particular periods of the case, this accordance between the impulse and sound did not exist.* In the second case, (page 7,) the sounds became distinct before the impulse returned. In the third case, (see page 9,) the impulse became distinct on the eleventh day, while the second sound greatly predominated. In the fourth, (page 11,) we found that on the eighth day the sounds were not in proportion to the impulse; and on the tenth, the impulse continued, but the first sound was totally absent. On the next day no impulse could be felt, yet the first sound was feebly audible. In the fifth case, (page 15,) the impulse on the twelfth day was less perceptible than on the day previous, but the first sound had more strength.

It is difficult, or impossible, in the present stage of the inquiry, to offer any satisfactory explanation of these apparent anomalies; but it seems certain, that under the influence of the typhoid condition, the heart may have sufficient force to give an impulse with little or no sound, on the one hand; and on the other, its contractions may be accompanied by a sound, although the impulse be absent. Whether we are to explain these facts by referring to particular states of innervation of the heart, or to organic alteration in the muscular fibres, or their connecting cellular membrane, is still to be determined.

My friend Mr. Hopper has suggested, that, if there be any anormal liquid secretion between the muscular fibres, the production of sound might be materially interfered with, though the muscle might contract with a certain degree of vigour. In two of our fatal cases, we found that there did exist a liquid tenacious secretion in the fibres of the left ventricle; and it becomes a question, whether the softening of the heart in typhus is dependent on an alteration of the muscle itself, or an infiltration between its fibres. Analogy would lead us to conclude, that in the early stages of the alteration at least, the fibre itself is but little affected; and the fact of the rapid restoration of the functions of the organ, in the convalescence of fevers, and the occasional excitement of the heart before death, seem to point out, that *in such cases* the injury of the muscular fibre itself has not proceeded very far.

That the cause of the want of impulse, and feebleness or cessation of the first sound, is a softening of the heart, I have no doubt. The evidences in favour of this opinion may be thus stated:—

I. That softening of the heart exists in typhous fever as a local disease, and without any analogous condition of the muscles of voluntary life.

II. That in our dissections in the last epidemic, we met with this softening of the heart, in cases which during life had presented the phenomena in question.

III. That the physical signs indicate a debility of the left ventricle principally, and it is this position of the organ which is most often altered in consistence.

IV. Laennec has stated, that in proportion to the severity of the putrescent phenomena, is the liability to softening of the heart. And the same observation is found to be true of the physical signs now described.

If this softening of the heart be one of the secondary diseases of typhus, we should, as in the case of other lesions, observe something like periodicity in its phenomena. It should appear at a certain time, and decline after its proper period had expired. I have analysed my cases with a view to these points, and the result is, that in most instances the signs of diminished impulse and first sound were developed at or about the sixth day, and the heart seemed again healthy at or about the fourteenth day. It is difficult to determine the period of the first development of the signs in many cases, as they existed on the admission of the patient, but still taking in these cases the dates of the disappearance of the signs, we get the following general results:—

Average date of appearance, sixth day.
" date of cessation, fourteenth day.

One case has been excluded from this analysis; the patient was admitted on the tenth day, and the heart was not reported healthy till the twentieth.

We thus get, as the duration of the phenomena, a period of about eight days. It is very probable, however, that the disease begins to be developed before the sixth, and that it subsides before the fourteenth day; for, as physical signs are our only means of detecting it, it is not likely that they would be well marked in its very first development, or indicate exactly the time of its subsidence.

In the softened condition of the ventricle, particularly the left, we have the explanation of the diminished impulse and first sound, and a new evidence of the truth of the theory which attributes the first sound to the ventricular contraction; and the theory which explains the second sound by the reaction of the arterial column of blood on the semilunar valves, receives also from these facts an additional though indirect verification. With respect to the second sound, we must consider it in two sets of cases: first, where both sounds were equally diminished, and secondly, where the first greatly predominated. The phenomena of the first class might seem explicable, by referring to the diminished vigour of the ventricular systole and diastole, which would affect the physical relations of the arterial column, as noticed in the Report of the London Committee of the British Association, communicated at the meeting of 1837; but when we find, in many cases, that the first sound became greatly diminished, or even extinct, while the second remained clear, we encounter a difficulty. In the second class of cases, of which I have recorded but two examples, we have no means of explanation, unless by assuming that there existed a diminished resiliency of the arterial trunks.

I am decidedly of opinion, that we cannot consider the softening of the heart in typhus as the result of carditis; it seems rather to be one of that class of affections not yet sufficiently examined, in which an infiltration of some peculiar substance takes place under the influence of the typhoid condition.[1] This occurring in the heart seems to impair its functions to a great degree; but the rapid restoration of the heart to health points out that the disease has not materially impaired its organic condition. It is obvious that we can never meet with the affection in a very advanced condition, for death by syncope would occur after the contractility of the heart had been altered up to a certain point.

Finally, I would draw the particular attention of my readers to the fact, that in the great majority of these cases the use of wine was followed by the happiest effects. I may safely refer to the cases in proof of this proposition; *and I believe that in the diminished impulse, and in the feebleness or extinction of the first sound, we have a new, direct, and important indication for the use of wine in typhous fever.* In some cases the existence of these phenomena at an early period of the disease, led us to anticipate the bad symptoms, and to commence in good time the use of the great remedy;

[1] On this point it will be seen that I adopt, with respect to the heart, the views which Dr. Staberoh, of Berlin, has put forward with reference to the follicular disease of the intestines in typhus. See his paper, Dublin Medical Journal, vol. xiii.

and in others, notwithstanding the existence of severe visceral irritations, the use of stimulants has been adopted with the best success, from the same indication.

It will be seen that the quantity of wine employed in the foregoing cases was considerable. I shall exhibit in the following table the quantity given, the day on which its exhibition was commenced, and the period of the fever, as nearly as we could calculate it.

NAME.	QUANTITY OF WINE.	DAY OF COMMENCEMENT OF WINE.	DURATION OF FEVER.
Cavanagh,	26 ounces.	8th day.	13 days.
Wright,	36 "	14th "	22 "
Devereux,	42 "	14th "	16 "
McKone,	60 "	12th "	16 days; wine continued to the 20th day.
Wallace,	66 "	11th "	18 days.
Kain,	88 "	9th "	16 "
Smyth,	144 "	10th "	18 "
Edwards,	156 "	10th "	20 "
Quin,	158 "	5th "	14 "
Hickey,	170 "	7th "	17 "

These cases may serve as illustrating the line of treatment which we adopted in our last typhus. In no epidemic did I ever before give so much wine. I never had such success in treatment. The list might be greatly enlarged, but no advantage could be gained by so doing. One case, however, may be mentioned, in which the whole quantity of stimulants employed was greater than in any of those now detailed. The patient was an elderly woman, who was admitted after having been three weeks ill, in a state of extraordinary prostration. There were no decided petechiæ, and the fever was of a more purely nervous character than is common. The disease ran on to nearly six weeks. The following is the account of the stimulants employed:—Wine, 292 oz.; brandy, 20 oz.; porter, 7 bottles; ethereal enemata, 2; jelly, beef tea, &c.

Her recovery was perfect.

The form of fever under which this woman laboured has been but rarely observed in our wards; it is characterised by extreme adynamia *unaccompanied by the phenomena of putrescence;* its duration is much longer than that of the ordinary disease, its termination less critical, and it seems uncomplicated with any distinct visceral affection. If any disease deserves the name of a "pure nervous fever," this one does. The disease to which it is most closely allied is the febris lenta nervosa of Frank, but it differs in the absence of signs of abdominal irritations.

In this patient the disease ran on to nearly six weeks; the principal symptoms being extraordinary prostration, coldness of the surface, feebleness and irregularity of the heart's action; and it was not until the end of the eighth day of the exhibition of wine, and other stimulants in great quantities, that any favourable influence was produced on the circulation; and the case strongly illustrates the advantage of persisting in the supporting system, although no amendment seems at first to follow its employment.

If, on the one hand, an inflammatory and excited condition is not produced; and if, on the other, the vital powers, though greatly sunk, are preserved from further sinking, we have an indication that stimulants are to be continued in their original, or in increasing doses.

I may now state the conclusions to which we have arrived from our investigations of last year:—

1. That the condition of the heart in typhous fever must be determined by the application of the hand and stethoscope, the pulse being an uncertain guide.

2. That a diminished impulse, or a complete absence of impulse, occurs in certain cases of typhous fever.

3. That in such cases we may observe a diminished first sound, or even an absence of the first sound.

4. That both these characters may exist with a distinct pulse.

5. That although in most cases the diminution of the impulse and first sound co-exists, yet that impulse may exist without corresponding first sound, and conversely, that the first sound may be heard although unaccompanied by impulse.

6. That these phenomena are most evident as connected with the left side of the heart.

7. That when the impulse and first sound are lessened or lost, the return to the healthy character is observed first over the right cavities.

8. That in some cases both sounds are equally diminished.

9. That in a few cases the first sound preponderates.

10. That these phenomena indicate a debilitated state of the heart.

11. That they may occur at an early period of the disease, and thus enable us accordingly to anticipate the symptoms of general debility.

12. That the existence of these phenomena, in a case of maculated adynamic fever, may be considered as pointing out a softened state of the heart.

13. That this softening of the heart seems to be one of the secondary local lesions of typhus.

14. That the diminution or cessation of impulse, the proportionate diminution of both sounds, or the preponderance of the second sound, are direct and nearly certain indications for the use of wine in fever.

I cannot conclude this paper without bearing testimony to the singular zeal displayed in this investigation, by many gentlemen who fulfilled the duties of clinical clerks during the last year. To Dr. Bovelle, of Barbadoes, and Mr. K. Kowalewski, of Warsaw, I am deeply indebted. And I beg also to mention the name of Messrs. W. M. Murphy, Thomas Moore, James Brady, Thomas Rogers, and W. Barrington, gentlemen whose practical knowledge of medicine, charity to their patients, and devotion to science, have earned for them the respect and admiration of all who were cognisant of their unostentatious exertions and untiring zeal.

ON

PERFORATIONS OF THE STOMACH,

FROM

POISONING AND DISEASE.

BY ALFRED S. TAYLOR.[1]

Much has already been written on perforations of the stomach; but it is a subject which still appears to me to demand investigation. The great difference of opinion, among many eminent authorities, as to the origin of some of the morbid changes observed in the stomach, and the difficulty of forming a diagnosis between perforation from poisoning and disease, show that we have yet much to learn. Perforation from natural causes has, in more than one instance, been mistaken for perforation from poisoning; an error which is easily accounted for, when we consider the circumstances under which diseased perforations frequently manifest themselves, and the appearances in the body with which they are attended.—A case, that will be more particularly related hereafter, occurred during the last summer; and in this, combined, with a somewhat similar train of symptoms and appearances, there were strong moral grounds to justify a suspicion of poisoning. The investigation of this case led me to turn my attention particularly to this subject; and I have here collected some cases and observations, which, if they do not add to what is already known, may at least serve to draw the attention of others to the importance of these enquiries.

Perforation of the stomach, leading to fatal peritonitis, from extravasation of the contents of that organ into the peritoneal cavity, is a most insidious disease, the existence of which is scarcely suspected until the alarming symptoms which it occasions show that the patient is beyond the reach of medical treatment. This disease presents the following general characters of irritant poisoning:—1. It commonly attacks a person apparently in good health. 2. The symptoms are, chiefly, violent pain in the abdomen. With or

[1] Guy's Hospital Reports, Aug. 1839. p. 8.

without vomiting. 3. These symptoms are often suddenly developed soon after a meal. 4. The case proves rapidly fatal; death commonly taking place in from eighteen to thirty-six hours, which is about the period within which arsenic destroys life. Besides these characters, which may well render a diagnosis often uncertain during life, there are morbid changes in the stomach that sometimes closely resemble those produced by the more powerful irritants. There are, it appears to me, four cases in legal medicine wherein a knowledge of this subject will be required of a medical practitioner:—

1. A person may have died from perforation of the stomach through disease, and not from poison.

2. A person labouring under the disease may be the subject of poison.

3. A person labouring under the disease may have received blows or injuries on the abdomen: in which case it will be necessary to state whether the perforation did, or did not, result from the violence used.

4. Perforation of the stomach from post-mortem changes may be mistaken for perforation from poison.

One case I have purposely omitted, because I do not think it likely to occur; namely, that perforation from poisoning should be mistaken for perforation from disease. So far as my knowledge extends, there is no case of this kind on record: and we shall see hereafter, that when the stomach has been perforated by poison, the symptoms and post-mortem appearances are, in general, such as to leave no doubt of the real cause of the perforation. In the four cases which I have supposed, a diagnosis is indispensably necessary to the course of justice, when a criminal charge is raised; and the first case is that which most seriously demands the attention of the practitioner; since it is not merely of the most frequent occurrence, but, if moral circumstances exist to support the suspicion of poisoning, it is very apt to mislead even a shrewd and experienced witness. There are other morbid appearances of the stomach, arising from disease, which simulate strongly the effects of irritant poisons; but it is not my purpose to enquire into these. The remarks in this paper are intended to refer to those changes only which are more or less connected with perforation of the parietes of the organ.

PERFORATION FROM POISONS.

Poisons are capable of inducing perforation of the stomach in two ways:—1. By corrosion. 2. By leading to ulceration, and the destruction of the parietes in a circumscribed space by that process. —Some poisons have a powerfully corrosive or destructive action on the living fibre; such is the case with the concentrated mineral acids and alkalies, corrosive sublimate, nitrate of silver, and a few others. The action of these poisons, in corroding the living organs, is purely chemical, and takes place immediately on contact. During life, the action of the corrosives is known by the symptoms *immediately* following the injection of the poison; and after death if this have taken place speedily—which is commonly the case when the poison is swallowed in a large dose or in a highly concentrated state—by the distinct traces of their chemical action on the mouth, fauces, œsophagus, and stomach. Other poisons appear to have a purely irritant action, giving rise to inflammation and its consequences: they do not chemically corrode or destroy the parts with which they come in contact. This description applies to arsenic and the salts of barytes, among the more common poisons; but all the corrosives when taken in a diluted form, are capable of acting as irritants. In estimating the action of poisons on the stomach, we must then consider whether the substance taken be of a corrosive or irritant nature.

The *perforation by corrosion* is the most common variety of perforation from poisoning; and as its name implies, it is a simple result of the chemical action of one of the corrosive poisons on the stomach. Among these, the mineral acids are commonly taken or administered; and of the mineral acids we might point to the sulphuric, as furnishing us with the most frequent examples of this kind of lesion. Perforation, in this form of poisoning, is not unusual when it has been swallowed in a concentrated state; if taken, diluted—or if, at the time, the stomach be filled with food—then the parietes may escape destruction.

The characters of the aperture are these:—It is generally large and wide, occupying sometimes a considerable extent of the organ. The mucous membrane around is of a dark-brown or black colour, having, for a considerable space, a sooty appearance. This black matter which results from altered blood, as well as from the carbonising action of the acid on the mucous membrane, is often disposed in insulated or striated patches, taking the course of the rugæ. On removing this, if life have been sufficiently prolonged, marks of inflammation may be found beneath; but this is by no means constant. The edges of the aperture are rough, irregular, and often softened and pulpy. The action of the acid will be found to extend through the œsophagus, into the fauces; and as a portion generally escapes from the stomach through the opening, the adjacent organs are frequently affected by its corrosive action. The perforation is produced either immediately or very soon after the ingestion of the acid; and death is commonly a very speedy consequence. The acid may be, in general, easily detected, either in the contents of the organ, or, if these have escaped, in the liquid effused in the abdomen or pelvis. If no liquid can be discovered, a small portion of the corroded mucous membrane, digested in water, will yield traces of its presence.

Among the preparations of the museum, is one marked 1799^{32}; which is the stomach of a man who destroyed himself by swallowing concentrated sulphuric acid. The stomach was extensively perforated by the corrosive action of the poison. It presents the characters above described. Death, in this case, took place very speedily.—The drawing marked 304 represents the interior of the same stomach. The brownish-black extravasation is here very well displayed. The mucous membrane is free from all appearance of vascularity. Its vessels are strikingly brought out by the action of the acid upon their contents. The aperture in the stomach is large, nearly circular, and situated at the cardiac extremity.—The drawing marked 303 represents the effects of the acid, which escaped through the perforation, on the liver, spleen, and pancreas.

One dram and a half of concentrated sulphuric acid was given to a rabbit; the animal did not appear to suffer much pain: the abdomen swelled considerably; death speedily took place; and on inspection, the cardiac extremity of the stomach was found extensively destroyed. A large irregular opening had formed; the edges of which were softened, pulpy, and of a black colour. The mucous membrane was not in the least reddened; but the blood-vessels ramifying over the stomach were prominent, and their contents appeared dark-coloured, and consolidated. The acid had partly eacaped into the abdomen, and had attacked the surrounding viscera; the marks of its action were distinctly traceable, through the whole course of the œsophagus, to the fauces and mouth. The contents of the stomach, as well as the coats of the organ, gave the clearest evidence of the presence of sulphuric acid in large quantity.

Nitric acid is capable of perforating the stomach like the sulphuric; but it is a poison not often taken, and therefore we cannot speak as to the frequency of perforation by it in the human subject. Among the cases collected by Orfila, there is only one in which perforation was observed. The aperture in the case of nitric acid presents all the marks of corrosion; and the edge is generally tinged of a yellow colour; or if bile be present in the contents of the stomach, then the mucous coat may have a greenish hue.

Half a dram of nitric acid was given to a rabbit. The abdomen began immediately to swell as in the former experiment. The animal did not appear to suffer any pain; it became insensible and soon died:—a small quantity of vapour escaped from the nostrils. On inspection, the stomach was found softened, tinged yellow, but not perforated; which I attributed to the large quantity of food present in the cavity. Nitric acid was detected in the stomach; and the marks of its action were very apparent in the mouth, fauces and œsophagus. All these parts were corroded, and tinged of a deep yellow.

Oxalic acid is said to have occasioned perforation of the stomach; but this appears to be a rare circumstance. A solitary case is referred to by Dr. Christison; but he does not seem to have met with any instance of the kind, in the course of his own observations. In many experiments on animals, and in some few observations on the human subject, I have found nothing to bear out the view, that perforation is an effect of this poison. In a concentrated state, it corrugates; and softens the mucous coat, so as to render it easily removable by pressure or friction; but I have not observed any breach of continuity in the coats:—the substance of the stomach beneath has always been firm.

We have but little knowledge of the effects of the alkalies, as corrosives, in the human subject. Orfila thinks, chiefly from experiments on animals, that potash, of all corrosive poisons, most frequently perforates the stomach. In the only two experiments on dogs reported by him, one was attended with perforation; and the other, not. The aperture is described as having been eight lines in diameter, circular, surrounded by a projecting livid hard border; and situated near the pylorus. The mucous membrane of the œsophagus and stomach was of a deep-red colour throughout.

Besides the above mentioned substances the bichloride of mercury, nitrate of silver, and perhaps the sulphate of copper, might be ranked among the common poisons capable of perforating the stomach, by corroding its parietes. The nitrate of silver and sulphate of copper are so seldom taken as poisons, that the idea of their perforating the stomach is founded more on the knowledge of their chemical properties, than on any experience of their action on man or animals. Neither Orfila nor Christison reports a case in which these substances produced perforation of the stomach. Our remarks may then be confined to corrosive sublimate.

Comparatively speaking, corrosive sublimate is not often taken as a poison; but when introduced into the stomach, it is liable to perforate the organ, by corroding its parietes to a greater or less extent. This accident is, however, rare; and is only likely to be witnessed when the poison has been taken in a very large and concentrated dose. Out of many cases reported by Orfila, there is not a single instance in which perforation was produced by it; and Christison alludes to one only. The reason why corrosive sublimate so rarely perforates the stomach, is properly ascribed to the facility with which it is decomposed, and rendered inert, by the mucus and other contents of the organ. Although the characters of the aperture produced by it are not described, yet the perforation may be expected to be accompanied by great vascularity of the stomach and œsophagus, with other unequivocal marks of poisoning.

We have next to speak of perforation from ulceration caused by irritant poisons. This may be regarded as an extremely rare variety. Those substances which destroy the stomach by corrosion are capable, when diluted, or taken in less concentrated doses, of giving rise to ulceration of the coats; the eschars first formed, sloughing off. Of all the irritants—and, indeed, it may be said of all poisons—arsenic is the most frequently taken. Notwithstanding this, cases in which it has produced ulceration are not common; and those in which the ulceration has proceeded so far as to perforate the coats, are very rare. Death usually takes place long before the process has advanced to this degree. Out of a great number of specimens in the Hospital Museum illustrating the effects of arsenic on the stomach, there is not one in which this organ has been perforated. It is by no means unusual, in toxicological works, to find perforation described as one of the effects of arsenic. Thus Orfila mentions this among the post-mortem appearances met with in arsenical poisoning; but the statement is not supported by a single case. Out of the numerous cases reported by him, there is not one in which perforation occurred. Dr. Christison has met with one instance; and he refers to two others which occurred abroad. In a case of alleged poisoning by arsenic we must then remember that perforation of the stomach is an extremely rare appearance. Indeed the discovery of this state of the organ ought, in my opinion, to lead us to suspect, *cæteris paribus*, that death may have been due to morbid causes, and not to poison. The only other common irritant which is alleged to have produced perforation is the muriate of barytes; but the solitary case which is reported by Wildberg is far from bearing out this view. The facts rather tend to show that the perforation either existed, or was actually being produced, when the poison was swallowed.

Such then is the history of perforation of the stomach as occasioned by corrosive or irritant poisons. The variety most likely to present itself in practice, is that dependent on the action of sulphuric acid; but its characters are so prominently marked, that it is difficult to understand how it should ever be mistaken for the effect of disease. We have to remember, that when perforation is thus caused, death is usually a speedy consequence; the corrosive action of the poison is discoverable in the fauces and œsophagus, as well as in the stomach; if any have escaped through the aperture, the surrounding viscera will also be attacked, and present evident marks of corrosion. In the perforation from ulceration by poison, well-marked characters may be wanting, and the aperture more closely resemble that observed in certain forms of disease; but the previous history of the case, the manner in which the symptoms occur, their order and succession, as well as the morbid changes throughout the whole alimentary canal, will, with a chemical analysis, remove any disease that might arise. Thus, then, we feel justified in saying that perforation from poisoning is not likely to be mistaken for the effect of disease. The difficulty, if any, would exist in the case of irritant poisons, where the stomach alone was examined, and the state of the œsophagus and the intestines, with the previous history of the symptoms, was left wholly out of consideration. By the creation of a series of possibilities, we might form a case, wherein a diagnosis would be difficult, if not impossible; —as where the person is found dead, and no account of the circumstances under which death took place is to be obtained. Arsenic may really have caused death:—none may be found in the stomach, which we will suppose to be perforated; and the alimentary canal may not present those well-marked characters of inflammation which we commonly meet with. The admission of all these facts merely shows that a case may, by possibility, occur, in which neither medical nor general evidence can furnish satisfactory proof of the cause of death. In the mean time, the life of no person is compromised, and no error is committed; there is a simple want of evidence to establish a supposed crime; for which deficiency a medical practitioner cannot be held responsible. When it is affirmed that the perforation from poisoning may be confounded with that from disease, the opinion seems to me to have arisen from the fact, that the stomach alone has been submitted to examination, and that all the collateral circumstances, indicative of poisoning, have been excluded. Now, although a diagnosis may be in some instances obtained when the examination is thus restricted, it appears certain that, in others, the examiner is very liable to be led into error.

The next branch of the enquiry involves greater difficulties; and therefore requires a somewhat closer examination, since it is here that mistakes are most liable to occur. Perforation of the stomach may take place from causes independent of poison, and the symptoms and appearances sometimes closely simulate those of poisoning.

PERFORATION FROM MORBID CAUSES.

Perforation of the stomach may be a result—1. Of simple ulceration; sometimes of an acute but more commonly of a chronic character; 2. Of scirrhous ulceration; 3. Of a solution of the parietes, which is supposed to take place after death.

Ulceration of the stomach, proceeding to perforation, is one of the most formidable and insidious diseases. It often attacks persons, more especially females, in the prime of life, and in the full vigour of health; and previous to the sudden and fatal illness, there will be no warning of the impending danger. In general the previous symptoms are only those of dyspepsia, or ordinary derangement of the stomach; the illness is so slight, as not commonly to attract the notice of those with whom the person is living. The following case will show the usual course of this disease:—

"The deceased, a girl aged 21, residing in the neighbourhood of Guy's Hospital, and assisted her father in conducting his business. She appeared to have generally enjoyed good health; but had latterly felt occasional nausea, with frequent craving for food of which she could take but little. She had had one or two attacks of pain in the abdomen, which she referred to articles of food that had disagreed with her. Some castor oil gave her relief. One morning, while walking in her usual health, she was seized with sudden and acute pain in the abdomen, chiefly referred to the right iliac region. When seen, she was extremely faint, and covered with a cold perspiration. Vomiting came on: and the vomited matters were of a bilious character. In spite of the application of proper remedies, the symptoms continued without diminution, and she died about forty-two hours from the time of her seizure, evidently from peritonitis. Nothing had passed through her bowels during the whole of the atttack, although castor-oil had been administered. Previous to death, she complained of great pain between the shoulders; and very soon after death, the skin, at this part, became extremely livid.

Sectio Cadaveris.—The body, generally, was pale. The abdomen was much distended. On opening it, a considerable quantity of dirty liquid was found in the peritoneal cavity. On the surface of this, a quantity of oil floated—the castor-oil which the deceased had taken shortly before death. The peritoneal surface of the intestines was in many places mottled with numerous small spots of a florid red. There were, likewise, many flakes of tender coagulable lymph. The stomach was feebly glued to the concave surface of the liver, which was pale. On the cardiac side, and on the lesser curvature of the stomach, there was a small opening through the parietes, about large enough to give passage to a crow-quill. The mucous membrane of the stomach, at the spot corresponding to the external opening, presented a circular patch of ulceration, about half an inch in diameter, with clearly defined and not elevated edges. The opening in the muscular coat was of less diameter; and near the centre of this was the hole through the peritoneal coat already described. At a short distance from this ulcerated opening was a much smaller patch of ulceration, about the size of a split pea. This was confined to the mucous coat: it was circular, and had a well-defined border. For some distance around these ulcers the mucous membrane was speckled with small opaque white points, but little elevated, and scarcely perceptible to the touch. The mucous membrane was healthy; but there was a slight redness around the ulcerated aperture. The interior of the alimentary canal was in other respects healthy.

This was a case of perforation from simple ulceration, proving fatal by peritonitis. There was no scirrhous hardening of the border of the ulcer, nor any appearance to indicate that it was of long standing. The portion of the stomach with the aperture may be seen in the preparation marked 1806^{24}; and the appearance of the mucous membrane, in the recent state, is illustrated by the drawing 298.

Dr. Abercrombie mentions a case similar to this, of a young woman, aged 18, who, although troubled with variable appetite, appeared generally in good health. She was seized suddenly with the most violent pain and vomiting, and died in twenty-nine hours from peritonitis. On the upper part of the smaller curvature of the stomach, near the cardia, there was a perforation which admitted the point of the little finger. Internally, this opening communicated with an ulcerated space, about the size of a shilling, with slightly-thickened edges. In other respects the stomach was healthy. Other cases, very similar in their symptoms, progress, and post-mortem appearances, are referred to by this author.

It is not so common to find the aperture one of simple ulceration.

It is, I believe, more generally of a chronic and scirrhous character; the margin, including the coats of the stomach for some distance round, having often a hardness almost cartilaginous. The application of the term "scirrhous" to this kind of perforation may be objected to by those who limit it to cancerous disease; but as the word is merely intended to distinguish those forms of perforation which are accompanied by a hard border, with a thickening of the parietes of the stomach, from perforation through simple ulceration, in which the parietes are unaffected, there can be no harm in retaining it; more especially since it is, in this sense, frequently employed by practitioners. Besides, it would not be easy to draw a line of distinction between these cases and those strictly termed scirrhous; for, obviously, the mere extent to which the parietes of the stomach are diseased cannot be a fair ground of difference.

Dr. Abercrombie enumerates three kinds of ulceration of the stomach, which may lead to perforation:—1. Small defined ulcers, with evident loss of substance, and round and elevated edges; the stomach healthy. 2. Ulcers of about the size of a shilling; the parietes of the stomach being thickened and indurated for some extent around. 3. Extensive and irregular ulceration of the inner surface of the stomach, generally complicated with thickening and induration of the coats and fungoid elevations. This division appears to me to justify the distinction above drawn, as to the varieties of perforation.

It is not my intention to speak here of cancerous disease of the stomach, since this cannot be easily confounded with the effects of poison. The long-standing nature of the disease, the well-marked gastric irritation, and the constitutional disturbance, with the morbid appearances after death, must at once indicate the cause of the symptoms and death. Dr. Carswell has remarked, that, in these cases, a commnnication with the abdomen does not commonly take place; since, as the structure of the stomach is destroyed, the parietes of the organ become glued to the surrounding viscera. The preparation marked 1813^{66} shows the degree to which malignant ulceration of the stomach will extend. The whole tract from the œsophagus to the pylorus is involved; the coats are destroyed in places; but throughout there are strong adhesions. The preparations 1802^{84} and 1806^{4} show apertures resulting from ulceration, which have been closed by adhesions. These are interesting; because they will account for the fact, that an individual may be seized with alarming symptoms resembling irritant poisoning, at one period of his life, from which he may recover; and subsequently die of another disease. A remarkable case of this kind is mentioned by Dr. Abercrombie. The subject of this was a gentleman, aged 60. He ultimately died from peritonitis, through perforation. On inspection, one aperture was found sealed up by the liver; while another, of recent formation, situated near to it, had led to the fatal symptoms.

In pursuing the subject of scirrhous perforations, or those accompanied with thickening and induration of the parietes of the stomach, to a greater or less extent around the ulcerated opening, I shall now describe a series of cases, of recent occurrence; so that we may endeavour to determine from them whether any well-defined diagnosis can be established between the disease and irritant poisoning.

In the following case, the deceased, aged 22, was a steady healthy young woman, acting as housemaid in a family in the neighbourhood of London. One morning, after breakfast, she complained of intense pain in the left hypochondriac region, accompanied with flatulence. Her bowels being confined, she took some tincture of rhubarb. In the space of half an hour, the intensity of the pain subsided; but there was great uneasiness, with distention of the abdomen. She was not seen by a medical man until about twelve hours after her first seizure: her pulse was then small and quick; there was great prostration of strength, great tenderness over the whole of the abdomen, coldness of the extremities, and general pallor. She was bled: leeches and warm fomentations, with other means, were used to relieve her sufferings, but without effect: the symptoms continued, with but little abatement, until the following morning, when she died; *i. e.* about twenty-six hours after the first attack.

Sectio Cadaveris.—The body was examined twenty-nine hours after death. On laying open the abdomen, the peritoneum had a general blush of redness over its surface, but there was no agglutination of parts. The liver was remarkably pale. Three quarts of fluid, resembling a mixture of turbid serum and ill-formed chyme, were removed from the cavity. On exposing the stomach, a small opening was found on its anterior surface, about two inches below, and rather to the right of its junction with the œsophagus. The circumference of the opening was thickened; and the diameter was about an inch on the outside, and about an inch and a half on the inside; so that the mucous membrane, as is frequently the case, had been removed to a greater extent internally than the peritoneal covering, externally. The small intestines were nearly empty: the large, loaded with scybalæ. The rest of the abdominal viscera were healthy. The stomach is preserved in the Museum, and may be seen in the preparation marked 1806^{60}.

From the account given by the fellow-servants, it appeared that for the three or four months preceding the attack, the deceased had complained of pain in her left side, uneasiness after her meals, flatulency, and habitual constipation.

There are many other preparations which give a good idea of the characters of this kind of perforation, but the history attached to which is somewhat imperfect. 1806 represents the stomach of a person who died in thirty hours from the first attack. The opening is about half an inch in diameter externally, but larger internally.—1806^{12}: In this the stomach is seen perforated, in the smaller curvature. The aperture is about the size of a crow-quill. The surrounding parts, for some distance, are thickened and indurated. The mucous membrane is generally thickened, granular, and rugous. It was taken from a middle-aged man, who died very suddenly, and had previously complained of but slight indisposition.—1806[8]: A similar preparation; the aperture is about half an inch in diameter.—1802[78]: The aperture in this stomach is of an oval form, and is situated near the cardia. The mucous membrane appears thinned.—1806[36]: The ulcerated aperture is here situated in the smaller curvature, about one third from the pylorus. It is much larger internally than externally; and on the mucous membrane is circular, about two thirds of an inch in diameter. Somewhat nearer the cardiac orifice there is a much smaller spot, from which the mucous membrane is partially removed.—1804[48]: This stomach presents two ulcers of a scirrhous character; one of which has perforated the organ.

Among the cases which remain to be alluded to, are the following:—

A girl aged 18, who had laboured some months previously under slight gastralgia, was suddenly seized with the most acute pain in the umbilical region. Vomiting supervened: the pulse became quick, small, and depressed: the abdomen tender, and the extremities cold. The bowels were only slightly open. No treatment gave relief; and, after the most intense suffering, she died twenty-four hours from the attack. On inspection, it was evident that the deceased had died from peritonitis; the contents of the stomach having become effused through an opening in the lesser curvature of the stomach, near the œsophagus. The aperture was circular, about the size of a duck-shot, and had a dark margin. The stomach was slightly adherent, in this spot, to the under surface of the liver. Internally, the diameter of the aperture was greater, so that the ulcerated opening was funnel-shaped from within outwards. Before death, she complained of pain between her shoulders. This case occurred to Mr. Prichard of Leamington.

S. M., a female aged 25, was suddenly seized with severe pain in the region of the stomach and nausea, after eating a small portion of lobster. She was seen by Mr. Bibley in about an hour and a half, when she complained of great pain in the abdomen, and between her shoulders. Her countenance was much sunk: there were cold perspirations, tenderness of the abdomen, and a small and feeble pulse. Medicines were exhibited with but little effect; the pain between the shoulders became much more severe; the bowels were not opened, but the vomiting abated. She gradually sank, and died in twenty-one hours from the time of the attack. Mr. Bibley ascertained that about three months before she had some dyspeptic symptoms, which disappeared under treatment. Her health seemed to have been otherwise good. On inspection, adhesion and agglutination of the peritoneum were found, and two quarts of fluid were effused in the cavity. On the anterior and upper part of the stomach there was an ulcerated opening large enough to admit the thumb. It was of a circular form; the circumference hard and thick: internally, it was irregular. The posterior wall of the stomach presented another ulcer of nearly similar dimensions. The mucous membrane was not vascular.

A young woman, aged 22, who had previously laboured for some months under slight dyspeptic symptoms, was suddenly seized shortly after breakfast, at which she had taken a single cup of tea, with violent pain in the lower part of the abdomen. When seen by a medical man, her extremities were cold, her pulse 120, low and feeble. There was great tenderness of the abdomen; and continual retching, without the power to vomit: the bowels were moderately open. The pain, which became very severe, was relieved by opium. Intense thirst came on, so that she took five pints of lemonade during the night. She died in twenty-one hours from the first attack. On inspection, the abdomen was found filled with a turbid fluid: there were slight adhesions, with coagulable lymph. In the lesser curvature of the stomach, about midway between the cardia and pylorus, there was a circular opening about the size of a shilling. The edges were smooth, stiff, and almost cartilaginous: they were partially adherent to a thickened and solidified portion of omentum. There was no appearance of ulceration, nor any other lesion of the mucous coat, with the exception of two or three minute points of a vivid scarlet, near the cardiac orifice.

A female, aged 18, after eating a hearty supper of beef and potatoes, of which four other persons of the family had partaken, was seized with severe vomiting, and violent pain at the stomach. During the day, she complained of pain in her side, but had performed her work in her usual health and spirits. She had no sleep during the night; and on the following morning, early, she walked a distance of a quarter of a mile, to her home. Mr. Cripps of Liverpool, who was called to her, found her lying with the knees drawn up, and her face expressive of great anxiety. The abdomen was distended, and tender on pressure: pulse 138: intense thirst, and bowels confined. The symptoms continued to increase: she experienced great pain in all her joints, especially in her shoulders; and in spite of treatment, she sank, and died about twenty-four hours after her first seizure. The body was inspected thirty-four hours after death. Marks of acute peritonitis were found in the abdomen. The stomach was perforated in two places; one perforation being on its anterior, and the other on its posterior wall. The coats of the organ, for some extent around the perforations, were thickened and hardened. The posterior opening, which was about the size of a shilling, was sealed up by adhesion to the pancreas, which was also diseased. The anterior opening was smaller: through it the contents of the stomach had escaped, and caused the fatal peritonitis.

A young woman, aged 21, stout and healthy looking, had experienced for some months pain in her left side, and uneasiness in her stomach after eating; when one afternoon, after drinking a cup of hot tea, she suddenly screamed out, and complained of the most violent pain in her stomach. Whatever she drank, was instantly rejected. When seen by a medical man, she was found labouring under cold shivers, hurried respiration, and her pulse scarcely perceptible. At every inspiration, she complained of great pain in the back, and between the shoulders. She continued to discharge, by vomiting, a yellow bitter liquid, like bile. The bowels remained obstinately constipated: she died, as it was presumed, about thirty-seven hours of the attack. On inspection, the whole peritoneum was found highly inflamed. A perforation was discovered in the stomach, between the cardia and pylorus, nearer to the former: it was about half an inch in diameter, and of an irregularly circular shape. The mucous coat which was partially thickened, was found removed to a greater extent internally than the peritoneal externally; and the latter was thinned off. The mucous membrane of the pyloric half of the stomach presented numerous minute points of ulceration; and two or three detached patches of redness, about an inch in diameter.

A young woman, aged 20, was seized with violent pain in the region of the stomach, about half an hour after breakfast. She vomited every thing she attempted to swallow: her bowels remained obstinately confined. There was great pain, with tenderness, in the abdomen: and there were all the symptoms of severe peritonitis. She died in twenty-four hours from the first attack. The symptoms and death were acounted for by the discovery of two apertures in the stomach. One was situated at the posterior part of the lesser curvature, about midway between the cardia and pylorus, and was about the size of a pea. Directly opposite to this, in the anterior part of the stomach, was another opening, about the size of a shilling; with smooth defined edges, presenting the appearance of having been cut with a sharp instrument. The mucous membrane was corrugated, but neither reddened nor ecchymosed in any part. Mr. Crisp, to whom this case occurred, ascertained that for eight or nine months previously the deceased had generally suffered from pain and vomiting after eating. The suspicion of poisoning was so strong, that it was considered necessary to remove it, by analysing the contents of the stomach. No poison was found.

The following case shows that the disease occurs in the aged and in the male sex, without any difference in its characters. A temperate man, aged 60, acting in the capacity of gardener, after complaining two or three days of loss of appetite and shivering, was suddenly seized, while at work, with the most excruciating pain in the abdomen. Symptoms of peritonitis came on, under which he died in twenty-four hours. There was no vomiting, and the bowels were obstinately confined. On inspection, an aperture was found in the smaller curvature, near the pyloric orifice. It was surrounded by a thick fleshy circle, forming a ring.

Numerous other cases might here be brought forward; but it appears to met, hat the foregoing, which are of recent occurrence, and well authenticated, are sufficient to warrant us in drawing a few conclusions respecting the characters of this remarkable disease, so that we may contrast them with those peculiar to irritant poisoning.

1. Perforation of the stomach seems to attack frequently young females from 18 to 23 years of age, generally unmarried. According to Andral, females who have been recently delivered, and those persons who have undergone severe operations, are likewise subject to it. The disease is not exclusively confined to females, or to a particular age. In the preceding observations, two cases of males, at 60, have been referred to.

2. The preceding illness is commonly slight, rarely amounting to more than simple dyspepsia or slight irritation of the stomach after eating, with want of appetite. These symptoms may have existed for some weeks or months before; but have been altogether disregarded, and perhaps not even noticed by those, with whom the deceased associated. In other cases, the gastric disturbance is more severe; but as a medico-legal fact, it is important to remember, that these cases, with severe precursory symptoms, appear to constitute the smaller number. Dr. Abercrombie remarks, that "this affection may run its course, almost to the last period, without vomiting; and with scarcely any symptom, except the uneasiness which is produced by eating, and which subsides entirely a few hours after a meal." Some have considered that a chlorotic state of the system might dispose young females to this affection; but there does not appear to be any sufficient ground for this opinion. It has happened, in some few instances, that chlorosis co-existed with this disease of the stomach; but in others, the females are described as having been stout and healthy. Besides, the same disease, with the same characters, occurs in male subjects at various periods of life.—Evidence is then wanting to show that there is any connection between chlorosis and a tendency to this disease of the stomach.

3. The individual is suddenly seized with the most severe pain in the abdomen, generally soon after a meal. It seems probable that this pain takes place at the moment the parietes of the stomach give way, and the contents of the organ are effused into the peritoneal cavity. The pain is of that excruciating kind, that the individual feels, unless it be removed, he cannot long survive. The attack coming on soon after a meal, may be, perhaps, dependent on the coats of the organ having become so thinned at the spot, that the slight action required for chymification may lead to the entire destruction of the thinned peritoneal tunic, which at this time must form the only partition between the cavity of the stomach and that of the peritoneum. At other times, the occurrence of the attack under these circumstances seems to be a pure coincidence; as where, for instance, in one of the cases the perforation took place immediately after a cup of tea had been swallowed. We cannot

be surprised, however, that poison should be suspected to exist in the food, when an individual, apparently in full health, is suddenly seized with such alarming symptoms; and therefore the greater caution is required in investigating the case. We ought to be well aware of all the particulars, before we countenance, in the least degree, the suspicion of poisoning; and among the diagnostic marks of the disease, we must not therefore forget the suddenness of the occurrence, and the intensity of the pain.

4. In several of the cases reported, pain in the abdomen was accompanied or succeeded by pain between the shoulders. How far this deserves to be regarded as a pathognomic character, must depend on further observation; but its having been already so frequently met with, seems to render it something more than an incidental occurrence. The pain in the abdomen commonly undergoes a remission before death; and the mental faculties are usually clear until the last.

5. There is commonly vomiting; this, however, is sometimes absent; and in other instances very slight, the stomach simply rejecting what may be given as medicine or food. There is no diarrhœa; in general, the bowels are obstinately confined. The symptoms, after the first attack, when carefully examined, are those of peritonitis, not of irritant poisoning.

6. Death takes place in from eighteen to thirty-six hours: in most of the cases mentioned, death occurred within twenty-four hours. The time at which the disease proves fatal, closely approximates to that at which a person dies in severe cases of arsenical poisoning.

We may next direct our attention to the appearances met with in the dead body.

1. On opening the abdomen, there are all the marks of severe peritonitis:—effusion of serum, with coagulable lymph; agglutination of the viscera; and extravasation of the contents of the stomach.

2. An aperture in the stomach, of an oval or rounded form; its shape depending, in some degree, on the manner in which the parietes of the stomach are placed, to observe it. It is commonly from half an inch to an inch in diameter; and is situated in or near the lesser curvature, between the cardia and pylorus. This almost constant situation of the ulcerated aperture is a circumstance worthy of remark. It has not, as yet, so far as I am aware, received any explanation from pathologists. The edges of the aperture are smooth, soft, and fleshy-looking. The tunics appear to be thinned off, from within outwards; so that the mucous membrane is usually removed to a greater extent than the muscular coat; and this than the peritoneal coat. The last is thinned off to a sharp edge, so that there is no appearance of laceration or ulceration. Near the circumference of the aperture, the coats of the stomach are thickened, sometimes hard, and even cartilaginous. This thickening may be disposed in a slight ring, or extend to some distance: and it may be confined to one part of the circumference, or extend all round. I

have here described what I have actually seen; and although I do not presume to say that these are the invariable characters of the perforation, yet they agree closely with the descriptions given by other and more experienced observers than myself. The hardening and thickening of the parietes of the stomach, around the aperture, seem to indicate what Andral long ago stated—that the ulceration is of a chronic character. The smoothness of the borders of the aperture renders it probable that the tunics are gradually thinned off by slow absorption; and that before the perforation is complete, the peritoneal coat is reduced to the thinnest stratum of membrane. Were it not so, we should expect to find the margin always fringed and lacerated; an appearance which is not, I believe, very usually observed. The peritoneal coat does not seem to have undergone laceration or rupture, but to have become entirely removed. In some cases, where this fringed appearance has been met with, the circumstance may probably be explained by some mechanical cause having accelerated the rupture of the thinned membranes. Dr. Abercrombie thinks that the smoothness of the edges of the perforation is tc be accounted for by supposing them to have cicatrised.

When the aperture is the result of simple ulceration, then the appearances will be modified:—there is no thickening of the coats of the stomach, and marks of ulceration are apparent. The edge of the aperture may be very slightly or not at all raised above the surface of the surrounding membrane. Several cases of this kind have been adverted to, and are illustrated by the museum preparations.

Sometimes there are two openings in the stomach near each other: or, instead of the second opening, there may be marks of ulceration scattered over the organ.

3. The mucous membrane of the stomach is either pale or presents slight patches of inflammatory redness over its surface; sometimes the margin of the ulcerated aperture is slightly reddened, the other parts of the stomach being healthy.

From the description here given of perforation as a result of ulceration, in the stomach, it is scarcely possible to conceive that it should be confounded with perforation as a result of corrosive poisons, such as sulphuric acid. The general evidence may or may not show that some such substance had been taken recently before the appearance of the symptoms. If this be proved, the enquiry is at an end; if it be not proved, then an examination of the mouth and fauces, as well as of the matters vomited, consisting of shreds of membrane and altered blood, and abounding in sulphuric acid, will convey something more than a suspicion of poisoning, while the individual lives. Under any circumstances, an individual whose stomach is thus perforated is not likely to survive long: and after death, the discovery of the corroded state of that organ, and perhaps of the surrounding viscera, as well as of the œsophagus and fauces—with the detection of the acid by analysis, in the corroded parts, or in the liquids extravasated in the abdomen—will remove any doubt that might remain. With regard to the detection of the poison, either the individual will have vomited, or he will not: if he have vomited, then the vomited matters will furnish abundant evidence of its presence; if he have not vomited during life, then the acid will be easily discovered, in analysing the corroded viscera of the abdomen, or their extravasated contents.

It may not be so easy, however, to distinguish a perforation resulting from this disease, from one produced by the action of an irritant like arsenic. Arsenic is selected as an example, because it is so common a poison, and because the symptoms of the disease may be supposed to resemble particularly those produced by this poison. To form a diagnosis for medico-legal purposes, let us take into account the following circumstances:—

1. Perforation of the stomach is comparatively frequent as a result of disease. We have also seen that it is apt to attack a particular class of persons; namely, young females. Perforation is so rare an effect of arsenic, that, out of a vast number of accurate reports of by death this poison, there are not, so far as I am aware, more than three cases in which this morbid change has been observed; and only one of these occurred in Britain. This fell under the notice of that accurate observer, Dr. Christison. Here, not the smallest doubt could exist that arsenic had been administered, and was the cause of death. The question of the origin of the perforation which was about the size of a pea, and situated in the anterior wall of the stomach, was not entered into at the trial; but there seems no reason to doubt that it resulted from the action of the poison.

2. In perforation from disease, the symptoms may not occur until three or four hours after any substance has been swallowed. In arsenical poisoning, the symptoms commonly occur in about half an hour after the substance containing the poison has been taken. Sometimes this criterion will not be available: since, as we have seen by the reports of several cases, the attack commenced within a short time after a meal. It is well to bear in mind, however, that arsenic does not commonly produce symptoms immediately, nor is it usual to find their appearance delayed for several hours.

3. In perforation from disease, the pain in the abdomen occurs suddenly, and is of the most intense character. It is sometimes felt in the lower part; and at others, over the whole of that cavity. In arsenical poisoning, the pain comes on gradually, slowly increases in severity, is commonly described as of a burning kind, and is chiefly confined to the region of the stomach. Gerard, long ago, suggested this sudden occurrence of severe pain as a characteristic of perforation from disease. Chaussier denied that this was a criterion; because certain cases had occurred in which this symptom did not exist. Although, from some cases to be hereafter related, it would appear that extensive disease, even to perforation, may go on in the stomach, without any indication from symptoms during life,

yet it is probable that Chaussier classed what are now regarded as post-mortem perforations among those resulting from disease. The objection here, however, amounts to nothing; since we are speaking of the diagnosis of those cases in which pain has been actually felt. Besides, it is not more probable that pain will be absent in cases of diseased perforation, than in cases of arsenical poisoning; and a suspicion of poisoning would not be likely to arise, where no pain was felt.

4. In perforation, vomiting, if it exists, is commonly slight; and it is chiefly confined to what is swallowed. There is no purging: the bowels are generally constipated. In arsenical poisoning, the vomiting is usually severe, and diarrhœa is seldom wanting.

5. The time at which death takes place in perforation, is in from eighteen to thirty-six hours, very often within twenty-four hours. This is certainly the average of severe cases of arsenical poisoning: but the question now more particularly to be considered, is, how far arsenic may have been the cause of a perforation found in the stomach? Can arsenic produce perforation of the stomach within twenty-four hours? This is a question to which medico-legal reports will only allow us to return a speculative answer. In the solitary case of perforation produced by arsenic, to which I have alluded, the individual survived four days: and as arsenic is not a corrosive poison, it seems probable that some time must elapse before the morbid changes produced by it in the stomach will have proceeded to such a degree of intensity as to lead to their destruction. In the absence of more cases, illustrating this rare effect of arsenic, our judgment ought to be suspended; but this we may safely say, of the number of reported cases, in which arsenic has destroyed life within twenty-four hours, in not one instance has the stomach been found perforated. In a somewhat doubtful instance of perforation by arsenic, alluded to by Foderé, the individual lived sixty hours. We must then attach some little value to the shortness of the period within which diseased perforations destroy life, from the time of the first appearance of the symptoms.

6. In perforation, peritonitis is the sole cause of death. In arsenical poisoning, the fatal result takes place under the peculiar symptoms produced by the poison.

On inspection of the body the stomach is found perforated. The following characters may perhaps assist us in forming an opinion of the cause of perforation.

7. In diseased perforation, marks of severe peritonitis are discovered in the abdomen, effusion of turbid serum and lymph, with agglutination of the viscera. The peritoneal coat of the small intestines is found inflamed. In perforation resulting from arsenic, we may also find marks of peritonitis; but this must depend greatly on the time which the person survives after perforation has taken place. Peritoneal inflammation appears to have existed in Dr. Christison's case; but along with morbid changes of this descrip-

tion there were those due to the action of arsenic alone. In this instance, the deceased was not seen till after death: therefore it is not easy to say, whether she died directly from the effects of the poison, or from peritonitis induced by extravasation of the contents of the stomach, owing to the poison having caused perforation of its coats. The symptoms, so far as they could be collected from description, were more or less vomiting, purging, thirst, and general uneasiness:—these certainly are the symptoms of poisoning by arsenic.

8. In diseased perforation, the mucous membrane of the stomach and small intestines is not commonly inflamed. There may be circumscribed patches of redness in the stomach, or a faint diffused redness; or the ulcerated aperture may be surrounded with a more or less vascular areola. In perforation from arsenic, we may expect to find the mucous membrane of the stomach and duodenum highly inflamed, more especially that of the stomach. The fauces, œsophagus, and rectum, may also be inflamed. In Dr. Christison's case the surface of the stomach was very vascular, marked in different places with dark-brown spots of various sizes, and here and there abraded. The intestines were internally very red. The circumstance of perforation occurring, does not then interfere with the presence of the usual post-mortem changes of poisoning by arsenic; on the contrary, as there is reason to believe that at least two or three days would be required to bring about perforation, the effects of the poison ought within that time to become well marked. In forming an opinion from the state of the mucous membrane it must be borne in mind, that in perforation from disease, the stomach is sometimes vascular; and that in arsenical poisoning, unaccompanied by perforation, the mucous membrane has been found, in some very rare cases, to be free from vascularity.

9. It has been said, that a diagnosis might be formed from the appearance of the aperture: but this is somewhat doubtful. It unfortunately happens, that only one side of the question has, as yet, received the attention of pathologists; cases of perforation by arsenic being so extremely rare. 1. *Situation.*—In perforation from disease, the aperture is commonly placed in or near the lesser curvature; but arsenic may perforate the parietes in any part of the stomach. In Dr. Christison's case, the perforation was in the anterior wall. 2. *Size.*—No criterion exists on this ground. In the above case, the aperture was about the size of a pea—the size which is often found in perforation from disease. In regard to other characters, we may observe, that, in perforation from disease, the border is sometimes smooth, presenting no mark of erosion; it is thickened; and the thickening extends occasionally, for some distance around, into the parietes of the stomach, which are indurated. In the case of perforation by poison, already alluded to, the aperture had a dark ragged margin. The inner coat was more extensively destroyed around it; but this, we have seen, is commonly met with in perforation from disease. The parietes of the stomach are not

stated to have been thickened and indurated: but this is an effect which may follow the action of arsenic, of which a striking example was reported in a late number of this Journal (April 1837).[1] The thickened part of the stomach may be seen in the Preparation marked 1798^{80}. It is, however, a question worthy of consideration, whether the aperture produced by arsenic can ever possess the smooth well defined border which is occasionally seen in that from disease. Will not the aperture from arsenic always present the marks of erosion, or of rapid destruction?—If this question be answered in the affirmative, we may have the means of distinguishing, at least, some perforations resulting from disease. The perforation by arsenic, it must be remembered, is produced in two or three days, or even in a shorter period: that of disease is commonly the result of insidious morbid action, slowly working for several months. We may then expect, pathologically, that the apertures will present somewhat different appearances, from the very different circumstances under which they are produced. Until more cases of well ascertained perforation by the irritants have occurred, it is difficult to say how far the observation of the aperture will be practically available in forming a diagnosis. Some have asserted, that the presence of two apertures will justify an opinion in favour of their origin from disease; but this is surely an error: for if arsenic may produce one perforation, why may it not two, or more? In one of the cases referred to by Dr. Christison, the stomach was perforated by numerous small holes; so that, when held before the light, it appeared riddled, like a sieve. Again; the discovery of patches of ulceration on the mucous membrane does not favour the suspicion of the aperture having resulted from disease: for if arsenic can produce perforation in one part of the organ, it may, by its irritant effects, easily produce ulceration in other parts; and of the two, ulceration is more commonly produced by it than perforation.

10. In perforation from disease, no poison will be discovered in the stomach or intestines. In perforation from poison, we may expect that the application of appropriate tests will lead to its detection, either in the matters vomited during life, in the contents of the viscera after death, or in the substance of the viscera themselves. Accordingly, in two cases of perforation, of which we have a history, arsenic was discovered in the perforated stomachs in one, both in the contents and in the parietes. On the other hand it may be said, arsenic is not always discoverable in the stomach, even where it has been taken in large quantity, and has undoubtedly caused death. For a remarkable case of this kind, see Guy's Reports, Vol. II. p. 78. To account thus for the absence of poison in a case of perforation, and still maintain that arsenic had caused the aperture, would, in the absence of strong corroborative evidence, certainly be taking every advantage of an exception;—a proceeding occasionally justifiable, in criminal charges. This line of accusa-

[1] Vol II. p. 70.

tion would, however, be entirely defeated, if the practitioner had taken the precaution to analyse the matters vomited during life;—a duty which should on no account be omitted, where the slightest suspicion of poisoning arises. Let us assume that arsenic had really been the cause of perforation: it follows, if the person have vomited, that the poison will be found in the vomited matters: if he has not vomited, or vomited but little, then we may expect certainly to find it either in the stomach or its contents, after death. Vomiting sometimes continues for days in arsenical poisoning, without effectually clearing the stomach of the poison. In general, the absence of poison from a perforated stomach ought to be taken as a fair presumption against the origin of the perforation from poison.

Lastly: Let us suppose that the fatal symptoms first showed themselves within half an hour after a meal, a case in which there would be, *cæteris paribus*, the strongest ground to suspect irritant poisoning;—we sometimes have it in our power to rebut this suspicion, by a very simple investigation. Others probably partook of this same meal in company with the deceased, without manifesting any symptoms of disturbance. This must be conclusive against irritant poisoning, more especially if we examine a portion of the food taken. When the deceased has taken food alone, chemical evidence cannot be dispensed with; but when in company with others, the simple fact, of no other but the deceased having afterwards suffered, will go to disprove the fact of poisoning.

The previous symptoms of perforation from disease are so slight, that the discovery of their existence can benefit us but little in our diagnosis. Dyspepsia is so common among individuals, that but little stress could be laid upon this having existed for some time prior to the fatal illness. A person whose stomach was perforated by arsenic might really have suffered from all the symptoms which precede the formation of an ulcerated aperture in the stomach. But when, in addition to other facts favouring the opinion that the perforation was caused by disease, we find the deceased to have laboured, for some months preceding the attack, under loss of appetite, acidity and uneasiness, and a distension of the stomach after eating, we have strong additional evidence to support the opinion, and to lead us to pronounce for disease.

Such, then, are the circumstances which we have to guide us, in forming a diagnosis in these obscure cases. By a careful investigation of the symptoms and appearances, it is not easy to conceive that much difficulty will commonly arise.

A medico-legal question may incidentally occur in relation to perforation of the stomach; namely, whether an individual labouring under it has the power to perform acts of volition and locomotion? This question we are able to answer in the affirmative. In one of the cases which has been reported, it was clearly ascertained, by the surgeon who attended the deceased, that she walked to her home, at the distance of a quarter of a mile, after she had been seized with the first alarming symptoms.

One of the most remarkable facts connected with perforation of the stomach from disease, is, that the process of destruction may advance so far, without being indicated by a symptom sufficiently striking to attract notice. This is a point of some importance, when we attempt to found a judgment on post-mortem appearances only; as also where a counsel in sustaining a charge of poisoning against an accused party, would endeavour to draw a statement from a medical witness, that extensive disease in the stomach, leading to perforation, would not be likely to have existed without symptoms indicative of mischief. But, as preceding observations show, the fact is exactly the reverse; the non-existence of previous alarming symptoms does not in the least degree favour the assumption of poisoning. The following case, which occurred in the hospital, a few years back, will show that ulceration of the coats of the stomach may proceed, almost to their entire destruction, in the ulcerated spot, without being indicated by a symptom.

The deceased was a middle-aged man, of a spare habit, and had formerly acted as a carrier. His habits had been irregular. When admitted into the hospital, he had a sore on his leg; his extremities were anasarcous; and he laboured under great general indisposition. There was oppression of the chest, with cough, and sanguinolent expectoration. There was nothing to lead to the suspicion that his stomach was diseased. The man did not long survive his admission. On inspection, disease of the chest was found to exist, sufficient to account for the urgent symptoms. On examining the stomach, the mucous membrane was throughout reddened. At the smaller curvature, near the pylorus, there was an ulcer, nearly circular, about the size of a sixpence, and without elevated edges. Its surface was of a light yellowish colour; and was depressed below the level of the mucous membrane, by about the thickness of the membrane. The other viscera, with the exception of the kidneys, were healthy.

The model 2772[1] represents the stomach in its recent state. The preparation 1801[32] shows the stomach itself, with the ulcer.

Had there not been other organic disease to destroy life, this man might have become the subject of perforation, when, for the first time, the existence of the disease would have been suspected. The redness of the mucous membrane seems to have been unusually great in this case: it seems, besides, diffused over the whole stomach. Indeed, so far as appearances go, the stomach might have been easily taken for one acted on by arsenic: this will be strikingly seen on comparing the model with the other models showing the effects of that poison on the stomach. This could not have been mistaken for a case of arsenical poisoning, because there was not a symptom to indicate irritation of the stomach during life; and no poison would have been discovered by chemical analysis, had it been resorted to.

It would appear, from a case observed by Dr. J. Beck, that not merely ulceration, but perforation of the stomach, may take place, and no pain or other symptoms be experienced, unless the contents be effused into the peritoneum. Indeed, death may, in such a case, be a result of a totally different cause. The subject of this case was a female, aged sixty, labouring under hydrothorax: she had no pain in the stomach, and was neither troubled with nausea nor vomiting. She died in a few days, evidently from disease of the chest. On inspection, the stomach was found perforated in the lesser curvature, midway between the cardia and pylorus; the aperture being about the size of a shilling. On laying open its cavity, the mucous membrane was highly vascular; and there were four other ulcers along the lesser curvature, the edges of which were a good deal thickened, and very smoth. All of them were surrounded by vascular borders. The stomach contained about a pint of fluid: none of its contents had escaped into the abdomen. The other viscera were healthy. An enquiry into the previous history of the deceased showed that she had never complained of pain or uneasiness in her stomach, and that her appetite had remained good until within three or four weeks of her death. This is a very remarkable case; and it illustrates some points of great importance in a medico-legal view:—1. That perforation from disease may take place without exciting a symptom. 2. That the stomach may, under this morbid condition, present marks of great vascularity. 3. That the perforation may take place without the contents becoming extravasated. 4. That a person may labour under perforation of the stomach, and yet die from another cause. In such a case, a suspicion of poisoning could have been entertained by those who judged from the appearances in the stomach only:—the history of the case, during life, would at once have rebutted it. Perforation of the stomach from disease cannot therefore be said to present any difficulty to the medical jurist, unless peritonitis follow. It is the rapid death, under symptoms of violent irritation, from a state of health, that excites suspicion.

PERFORATION BY SOLUTION.

This kind of perforation is often called spontaneous; because, formerly, it was thought that, with this exception, all apertures in the organ resulted from the action of corrosive substances. But the perforation by simple or scirrhous ulceration might with equal reason be called spontaneous. Chaussier, and other French writers, class under the head of "spontaneous" all that are not produced by poison. There is considerable doubt, among pathologists, as to the circumstances under which, and the time at which, this kind of perforation takes place. Some regard it as the result of disease in the parietes of the stomach, analogous to softening in other organs, and consider that the aperture is formed during life: others, on the contrary, believe that it is a simple post-mortem change, resulting from the action of the gastric secretions on the coats of the stomach after death. The latter is the view more generally adopted by English pathologists; a circumstance which has induced me to give to this the name of "perforation by solution." There are, it appears to me, difficulties to the admission of either view exclusively; but, before noticing these, it will be perhaps better to state the characters of the aperture, and the means by which we may distinguish it from the perforation by poison.

This kind of perforation is generally met with at the greater extremity of the stomach, occupying sometimes a large portion of the fundus. It is large and irregular: the edges are thin, ragged, commonly much softened for a considerable space around, and present that fringed appearance which the stomach might be conceived to acquire by the scraping of its parietes with a blunt knife. So far the characters may be well seen in the Museum preparations marked 1802^{12}, and 1802^{24}; and several other preparations, which I have had an opportunity of seeing in the museums of this country and the continent, are perfectly similar. Never having met with this condition of stomach in the recently dead subject, I must avail myself of the observation of others to complete the description. The mucous membrane around the aperture is stated to have sometimes a black or brown colour; and the blood in the vessels, ramifying on the coats, is similarly changed. The mucous membrane of the whole stomach is pale, and free from vascularity: indeed, Dr. Carswell, who adopts the view of chemical solution, asserts "that redness, whether arising from the effusion of blood or vascularity, is incompatible with perforation from this natural chemical agent." It is clear, that if it be a post-mortem change only, it cannot be accompanied with vascularity; or that the vascularity, if it exists, must be incidental, and depending on some other cause. The contents of the stomach are not always effused; and when they are, there is no evidence of peritoneal inflammation, nor any morbid change whatever, to indicate that the effusion had taken place during life. The absence of all marks of peritonitis seems to indicate, in the most positive manner, either that the perforation and extravasation occurred recently before, or at some period after death. The viscera opposite the perforated spot, whether the spleen, liver, or diaphragm, are commonly found softened, and in a dissolved state; having almost the impress of having been acted on by some fluid which has escaped from the stomach. Lastly, this singular change is either not indicated by symptoms during life; or they are of so slight a kind, as to lead to no suspicion of the mischief which is going on. It is said that, in some instances, general febrile disturbance, with vomiting or diarrhœa, has shown itself: but, on the other hand, the appearance has been met with in persons who have died a violent death; and, again, in the bodies of individuals who have clearly died from disease in a remote part of the body. On the chemical hypothesis, no symptoms could be admitted to indicate it it, unless it were supposed that disease of the stomach, favourable to the solution of the parietes, might be going on during life, either by preparing them for the more ready action of the gastric secretion, or by rendering that secretion itself more highly solvent. This, it is true, is pure conjecture; although, as we shall hereafter see, somewhat supported by facts: in the mean time, it is quite opposed to the opinion of those who rest their views upon the stomach and its secretions being in a healthy state. Thus, then, whether this perforation be vital or cadaveric, it seems clear that it is not indicated by symptoms during life, or those symptoms are of a very trivial character. So again, death does not appear to be caused by it; for there is no evidence of the deceased having suffered from peritonitis.

The preceding observations will perhaps suffice to show that this kind of perforation is not likely to be mistaken for any other, whether resulting from poison or disease. In the first place, if there be any account of the state of the person during life—of the symptoms under which he laboured, or the manner in which he died—it will be at once evident, although on inspection the stomach be found perforated, that he could not have suffered from the effects of corrosive or irritant poison. But, supposing that the evidence is confined to the dead body alone, a little more difficulty may arise from the resemblance of the aperture to that resulting from the action of corrosive poisons; and also from the singular fact, that the viscera opposite or near to the aperture have the appearance of being acted on by some corrosive substance. The mucous membrane of the stomach, in perforation by sulphuric acid, is often destitute of vascularity, and is covered around the part where it has given way, by black extravasation. In the aperture by solution, something of the same kind is witnessed; but, according to Dr. Carswell, the discolouration in the latter case is confined to the softened part of the stomach, the alteration being due to the action of the gastric acid on the blood: in the instance of sulphuric acid, it will be diffused more or less over the whole of the membrane. A far better criterion, it appears to me, will exist in examining the state of the fauces and œsophagus. If the aperture have resulted from a post-mortem change, these will be found in their usual state: if from the action of a concentrated acid, these parts will also be found softened and corroded. Should the stomach or intestines present any vascularity—should there be any marks of peritonitis from the extravasation of the contents—these circumstances will, of course, tend to show that some corrrosive poison had been swallowed; unless we adopt the very improbable view, that the perforation might still have been cadaveric, and these morbid changes coincidental. I have hitherto purposely abstained from alluding to the evidence derivable from a chemical analysis; but this we might certainly expect to show the presence of poison, in the corroded parts of the stomach, or in the contents of the abdomen. The discovery of muriatic acid in the corroded parts, without unequivocal evidence of its action on the fauces and œsophagus, might not be conclusive evidence of poisoning, for a reason to be presently explained. Lastly, cadaveric perforation is extremely rare:—perforation from a concentrated mineral acid, a neither uncommon nor unexpected result. But we may fairly ask the question, How often shall we be obliged to trust to post-mortem evidence alone for the basis of an opinion? The occurrence of such a case is only barely possible; and therefore the difficulties just alluded to must be regarded as more speculative than real. One case may truly occur of unquestionable difficulty; namely, where, with cadaveric perforation of the stomach, we find that there have been pain and irritation in the organ during life. The discovery of a corrosive poison, either in the vomited matters, in the stomach and its contents, or in the liquid extravasated in the abdomen, would here alone save us from falling into error. The state of the fauces and œsophagus, likewise, must not be overlooked. Should these sources of evidence fail, there would be no ground for an inculpatory opinion.

Can the cadaveric perforation be confounded with that produced by irritant poisons? It does not seem possible. In the perforation caused by irritants, the individual dies evidently under the symptoms of poison: in cadaveric perforation, he dies without symptoms of gastric disturbance; or they are very slight, certainly not to be confounded with those of irritant poisoning. On inspection, the aperture from the irritants is wholly different in character: the stomach and intestines are commonly highly vascular: if extravasation has followed, then the marks of peritonitis will be perceptible: lastly, either the matters vomited, or the contents of the viscera, will yield poison, on analysis.

Neither is it easy to conceive that this kind of perforation should be mistaken for the ulcerated aperture of disease, whether dependent on simple ulceration or scirrhus. This, as we have seen, is attended during life by severe and characteristic symptoms, leading rapidly and surely to death, through peritonitis. Besides, in the perforation by solution, the viscera opposite to the aperture are commonly more or less softened and acted on. The aperture itself is also wholly different: there is no mark of ulceration, or of scirrhous hardening: on the contrary, the parietes of the organ are rendered soft and pulpy, for some distance around.

What renders the history of this kind of perforation so obscure, is its extreme rarity. The following is the only case which during a period of many years, has found its way into the records of the Museum.

In October 1828, James Boulding was admitted into the hospital, with an old ulcer on the back. He had suffered from this for some months; and it had evidently much reduced him. It appeared to communicate with an abscess, as a quantity of unhealthy pus escaped from it. In spite of every attention, he sank, and died in about a week after his admission. The day before his death, he had dark, or nearly black, vomiting: some time afterward he became convulsed, and continued quite insensible until his death; although, by his moaning, it appeared that he was in considerable suffering. He had never before evinced any symptoms of cerebral affection.

On inspection, the lungs and brain were found in a diseased state; and there was a communication between the spinal canal and the abscess on the back. In the cavity of the left pleura there was a large quantity of dirty brown fluid, on which oily matter was floating. This led to a supposition that a communication had taken place between the stomach and the thorax: and on examination, the diaphragm was found perforated by two openings of considerable size, opposite to the cardiac extremity of the stomach. It had the appearance of having been acted on by some solvent, rather than by ulceration. The peritoneum was generally healthy: the little fluid which it contained was but slightly discoloured; and the extravasation of the contents of the stomach, which had taken place to a small extent, had probably occurred after death. A very considerable portion of the cardiac and of the stomach was softened and destroyed, so that it was extensively perforated; but, except in the immediate vicinity of the perforation, the mucous membrane did not appear deranged. The mucous membrane of the alimentary canal was also free from any morbid appearance. Both the liver and spleen were healthy, except where in contact with the cardiac portion of the stomach: here they were extremely discoloured, by the dark matter effused from that organ; but their structure, to some little depth, was much paler than elsewhere. The stomach may be seen in the preparation marked 1802^{12}.

Notwithstanding the irritation of the stomach which existed the day before death, as manifested by vomiting, the description of the appearances in this case seems to show that the perforation took place after death, and that it was in no way connected with that event. There were no traces of peritonitis, although the contents of the stomach had become partially extravasated; and the viscera contiguous to the great end of the stomach were softened, the diaphragm being itself actually perforated. These facts are in favour, not merely of a post-mortem origin of the perforation, but of its having been produced by some kind of solvent, acting, by contact, through an opening in one viscus on those organs situated beyond it. Could this have been confounded with perforation from any corrosive poison, or from ulceration? For reasons already assigned, it is impossible to conceive that any such mistake could have been made, even by one who was ignorant of the history of the case during life, and only had the post-mortem appearances to guide him.

A child, aged two years, of a scrofulous habit, died of phthisis, and the body was inspected thirty-six hours after death. Sufficient disease of the lungs was found to account for death. On opening the abdomen, the cardiac end of the stomach was seen to be extensively destroyed; and the edges of the perforation were irregular, ragged, and much softened; the mucous membrane being, in some parts, almost in a pulpy state. There was no mark of inflammation or disease in any part of the organ. A portion of the contents had become extravasated; but the parts with which it had come in contact were perfectly healthy, and free from any sign of inflammation. With the exception of the mesenteric glands, the other abdominal viscera were healthy.

Here again we have a case in which it does not seem possible to assign any other than a post-mortem origin to the perforation. The want of symptoms during life, and the nature of the appearances after death, clearly distinguish it from every other kind of perforation yet noticed.

The following case, mentioned by Laisné, is very similar to one just now related. A pregnant woman was seized with convulsions, and premature labour followed: she was delivered of dead twins, and died in about four hours. On inspection, the contents of the head and chest were found healthy: but in the abdomen, the stomach was perforated, to the extent of three inches, at its larger end. The edges of the perforation were thinned off, pulpy, and of a dark colour. There was no adhesion to the surrounding viscera, and no extravasation of the contents of the stomach into the peritoneum. In the contiguous part of the diaphragm there was, however, an aperture about two inches long, the edges of which were irregular, fringed, and of a dark colour, having a somewhat gangrenous appearance. The perforation occupied partly the tendinous, and partly the muscular portion of the diaphragm: the stomach projected through the opening; and there was slight extravasation of its contents in the thorax.

This case is reported by the author; and was considered by Chaussier to be an instance of perforation during life, and leading to the death of the woman. It corresponds so closely, in its details, with the foregoing cases, as irresistibly to lead to the conclusion, that the aperture must have depended for its origin on a similar cause, and have taken place under similar circumstances.

It will now be necessary to say a few words on the probable cause of this perforation; as, notwithstanding the well marked characters which distinguish it, it is said to have been mistaken, in more than one instance, for perforation by corrosive poisons. It has been already remarked, that the opinions of pathologists are divided in respect to it. Some consider that it is the result of disease, and that it takes place during life; while others, constituting the majority, regard it as a purely post-mortem change, depending on the solvent power of the gastric secretion on dead animal matter.

In favour of the last view—namely, that it occurs after death, there are the following facts:—1. The absence of any symptoms during life, to indicate that so serious an injury as extensive perforation of the stomach, and extravasation of its contents, has taken place. Although in Dr. J. Beck's case already related, there was perforation without symptoms, yet in this the aperture was small, and there was no extravasation. The contents of the stomach are not always effused, even in the perforation by solution; but whether they be effused or not, the lesion is unattended with symptoms indicative of so great an injury to an important organ; and thus we may regard it as improbable that it should have taken place during life. 2. Substances effused into the peritoneum during life are well known to excite peritonitis; but here liquids of the most irritating character have become effused, and no appearances of inflammation have been found in that cavity. This is not, perhaps, positive evidence of a post-mortem change, because the perforation and extravasation might be said to have occurred recently before death; and it does not seem to have been yet settled, how long a time is required for effused matters to remain in contact with the peritoneum, in order that they should leave the undisputed morbid changes of peritonitis. Again, no marks of inflammation have been found in the stomach; this point, perhaps is not yet established in the affirmative; but it is clear, if the edges of an aperture present any traces of inflammation or adhesion to the surrounding viscera, it could not have a post-mortem origin assigned to it. 3. The perforation generally occurs at the cardiac extremity; the most depending part of the stomach, where digestion is chiefly carried on. The viscera at or near the aperture are discoloured and softened; just as if some corroding liquid had escaped through the opening, and had accidentally come in contact with them. It is thus we have seen, in two cases, the diaphragm has been found perforated. 4. Experiments made on animals, and on animal matter, in relation to the gastric secretion, show that a liquid is poured out capable of thus acting on the coats of the organ after death. John Hunter first called the attention of the profession to this subject; he having found the stomach thus acted on in the case of three persons who had died a violent death, as well as in some animals killed for the sake of experiment. It was then considered that a healthy state of the body was necessary for this change to be observed; and thus the rarity of its occurrence was attempted to be accounted for. It was also believed, that, in a state of abstinence, the gastric juice continued to be secreted, accumulating more especially at the greater end of the stomach; and that, so soon as the vital properties of the organ were lost in death, its coats underwent digestion, just as its contents might do during life. Experience has, however, shown that both of these positions require to be modified. The stomach has been found equally destroyed in diseased subjects:—it has not been found destroyed in all cases of violent death, from a state of health; nor in those instances where men or animals have perished from starvation. Besides, the liquid poured out by the stomach in a state of abstinence is found to be entirely different, in its nature and properties, from the secretion which really acts upon the food introduced. After long fasting, the liquid contained in the stomach is viscid, neutral, and destitute of albumen: it yields not more than 1.64 per cent. of solid residue, which consists of the salts of ammonia, potash and lime, chiefly muriates and sulphates. Such a liquid cannot, of course, act chemically on animal matter; and thus it is attempted to explain, why, in a large number of subjects, this perforation of the stomach is not found. When any substance is introduced into the organ—such as, mineral matter or food—a copious secretion of a liquid possessing very different properties immediately takes place. This is believed to be the true gastric-juice ; it has an acid reaction, due, according to the experiments of Prout and Chevreul, to the presence of free muriatic and acetic acids. Besides these bodies, it contains mucus and salts; the latter consisting of the muriates and sulphates of potash, soda, and ammonia. The solid matter varies from 1.5 to 2 per cent.; and the proportion of free muriatic acid, as determined by Prout, in a case of dyspepsia, did not amount to more than five grains in sixteen ounces of liquid!

The effects of this liquid, considering its composition to be as thus determined, are perfectly extraordinary. Several experimentalists had remarked, that if rabbits were killed shortly after having taken food, and the bodies were examined four, six or eight hours after death, the stomach was found, at its greater end, softened, perforated, and the food projecting through the parietes, or extravasated. Litmus-paper, placed in contact with this digested food, was found to indicate acidity ; and Dr. Carswell considered that the destruction of the coats was to be ascribed to the action of this "gastric" acid ; because, when neutralised by magnesia, immediately after death, no softening was observed. On transferring the liquid of a healthy animal to the stomach, intestines or urinary bladder of another, it was found that softening and perforation took place. In the case of a young man who was killed by an accident soon after his breakfast, Dr. Carswell found the coats of the stomach softened, but not perforated.

Other experiments have since been made by Professor Müller and Dr. Schwann, with artificial mixtures of diluted acids and mucus, to resemble the gastric juice. Diluted muriatic acid, mixed with mucus, was found by them to have the property of dissolving most kinds of animal substances used for food, by the aid of a temperature of 98°. They consider that the acid acts, not by any corrosive property, but as a predisposing agent ; and that it does not act without admixture with mucus.

These experiments bear less on the subject of our present enquiry than those performed with the gastric secretion on recently dead animals. A heat of 98° is not required, in the dead subject, for this action on the stomach to go on : if it were, the perforation would, of course, be accomplished within the first few minutes after death ; whereas it appears that some hours are required : so that if the body of the animal be too early inspected, it will not be observed. In addition to this an observation made by Mr. Burns shows that there must be some difference between this process of destruction and that of digestion, unless we consider a high temperature unnecessary for the latter. This gentleman found the stomach perforated on the first examination of a human body, at the usual period after death : but when he made a second inspection, two days afterwards, he found the stomach more extensively destroyed, and the liver acted on and softened. Besides, there is another objection to the statement of a high temperature being necessary for the destruction of this organ by its own secretion. Can we consider the stomach of a person who had recently expired, so long as it retains a temperature of, or approaching, 98°, in the condition of dead animal matter? It appears to me that we cannot; and, therefore, that no fair inference can be drawn, one way or the other, from experiments made with pieces of dried stomach in artificial acidulous mixtures.

Another material question, in reference to this phenomenon, is, Whether the gastric secretion acts on the stomach by its vital or chemical properties? Most physiologists adopt the latter view; and, indeed, we can scarcely imagine that any secretion of the body should preserve vital properties longer than the solids, or that the coats of the stomach, for instance should pass to the state of dead matter before the liquid actually secreted by them; which would be the case were we to assign this solvent action to the vital properties of the secretion. On the other hand, it is not so easy to admit that the action is purely chemical. In a chemical view the free muriatic acid of the secretion would be considered as the sole agent capable of acting on the coats of the stomach: but if the quantity contained in the secretion were ten times as great as that discovered in it by analysis, it would have but very feeble solvent powers; and certainly, as a chemical result, we should hardly expect that muriatic acid so diluted would have the power within twenty-four hours of destroying the great end of the stomach, softening the spleen and liver, and softening and perforating the diaphragm. Concentrated muriatic acid might effect all these changes; but we cannot suppose that the vessels of the stomach, in the state of health and life, have the power of secreting an acid so highly concentrated as to be capable of corroding and destroying so extensively after death, more especially when the living stomach cannot resist the action of the mineral acids, unless in a certain state of dilution. To account for this corroding property being possessed by an acid so diluted, it has been said, that the admixture of mucus converts it into a new body, which is called a digestive liquid. Those who adopt this hypothesis must of course abandon the ordinary view of the chemical action of the gastric secretion; since it would be an entirely new fact, that an inert substance like mucus should confer such remarkable powers upon an acid so diluted. Among the circumstances which yet remain to be cleared up, with regard to this doctrine, are the following:—1. Is muriatic acid capable of being detected in a free state, in any quantity, in the softened parietes of the stomach, spleen, diaphragm, or liver, when these organs are affected in the manner already described? 2. Will muriatic acid, diluted to the extent to which it exists in the gastric secretion, and introduced into the stomach of a recently dead animal cause changes similar to those which have been observed? This last experiment would test the correctness of the chemical doctrine, on either assumption; because in the stomach it would meet with mucus.

It was formerly supposed that the stomach should always be in a healthy state; but it is probable, as Dr. Abercrombie remarks, that in some cases this post-mortem change is preceded by disease during life;—certainly, as we have seen, it has taken place in diseased subjects. From the present views, regarding this perforation, we may never expect to find it, unless some food has been taken recently before death; for the secretion is not poured out, except by the introduction of some stimulus. Yet, if this explanation were true, it ought to be very frequently met with; for it is by no means unusual to find half-digested food in the stomach after death:—so again, in the inspection of bodies of persons who have died suddenly from disease while in the act of eating, or have been killed, soon after a meal, by accident, how seldom do we hear of the stomach being found dissolved or perforated. In the case already mentioned of James Boulding, there was no reason to suppose that he, out of many hundreds, inspected during the course of many years, should have been the only individual who took food at the very time, or whose body was inspected the exact number of hours after death required for this change to be met with. Yet, out of hundreds of subjects, who have died and been inspected under exactly the same circumstances, no other instance, so far as I can ascertain, has occurred. In one of the cases, in the human subject, observed by Hunter, the man had died by hanging;—yet a vast number of hanged subjects have been inspected since his time; and, so far as I know, not another instance has been reported of the stomach being found perforated. Is it to be supposed that, in Hunter's case alone, food had been taken the requisite time before death, and the inspection conducted at the requisite period afterwards for discovering this perforation of the stomach? We cannot assent to so improbable a view:—and if not, what becomes of the common explanation of this phenomenon, that food should be taken recently before death—the individual die suddenly in a state of health—and the stomach be in a healthy condition? It will surely be deemed inadmissible. Perhaps this explanation might apear to derive stronger support from the results of experiments on animals; but the analogy appears to me to fail, when we consider the whole of the circumstances.

These experiments have been performed on animals in the state of the most perfect health; if killed during digestion, the stomach has been found perforated: but in how many human beings accidentally killed, dying under the same circumstances, has perforation been discovered? The preceding observations show that it is an extremely rare occurrence; and that it has been as often observed in diseased, as in healthy subjects. Even previous disease of the stomach evinced by symptoms during life, is not incompatible with its occurrence.

The preceding facts and observations may perhaps be considered to justify the following conclusions :—

1. That perforations of the stomach, from solution, are very rare in the human subject.

2. That they may occur in healthy and diseased states of the body.

3. That the perforation takes place after death ; and depends on the action of the gastric secretion, which, in the opinion of some, is facilitated by a diseased state of the parietes of the stomach. But that the secretion is the chief, if not the sole cause, seems probable, from the fact, that the liver, spleen and diaphragm have also been found softened, the latter even perforated where lying near the aperture in the stomach. We must then imagine either that these accidentally contiguous parts partake of the same disease as the stomach, or that disease of that organ is not necessary for its coats to become destroyed by the secretion.

4. That the secretion cannot be the healthy gastric juice, but some altered state of that liquid. This is rendered probable by the facts—1. If it were the ordinary secretion, perforation would be much more common in healthy persons, dying suddenly soon after a meal. 2. It would not be met with in diseased subjects, or those labouring under disease of the stomach.

5. That the exact nature of the liquid producing the change, and the circumstances to which it owes its solvent power, are unknown.

We shall now consider the medico-legal applications of this subject by reference to cases.

1. *A person may have died from perforation of the stomach through disease, and not from poison.*

In June 1838, a female in a noble family, aged twenty-three, was taken ill, and died somewhat suddenly, under suspicious circumstances. She had been unwell for about three weeks, and was subject to occasional vomiting and disturbance of the stomach. Still, her illness was so slight, that it did not in the least interfere with the performance of her usual duties. On a Saturday afternoon about four o'clock, and therefore probably three hours after her last meal (although this could not be ascertained with certainty), she was taken suddenly ill, suffering from the most excruciating pain in the abdomen, and violent vomiting. The skin was cold and clammy : there were other signs indicative of a mortal collapse, and the abdomen was tender and painful. It being suspected that she had taken poison, magnesia, and afterwards sulphate of magnesia, were exhibited. No poison was found in the room, and she strongly denied the imputation. As there were some grounds for believing that she had been the subject of an improper intrigue with a male person in the establishment—and symptoms resembling irritant poisoning had occurred suddenly and without apparent cause while she was in tolerable health—it is not a matter of surprise that such a suspicion should have arisen. In spite of treatment the symptoms continued to become worse; the vomiting was violent; and she died the following morning, as nearly as could be ascertained, about fifteen hours after her first seizure.

Mr. Hilton inspected the body, and found all the organs healthy, except in the abdomen. There were strong marks of peritoneal inflammation: the intestines were loosely adherent to each other, and a quantity of lymph was effused upon their surfaces. The cavity contained about a pint of liquid; which was collected, and reserved for analysis. This had evidently escaped from an aperture in the stomach, which was empty. The uterus was enlarged; its internal surface vascular, but presenting no appearance of embryo. The ovaries were vascular; and on one of them was seen a recent corpus luteum. The organs were in such a state, as to lead to a strong suspicion that intercourse had recently taken place.

Mr. Hilton requested me to assist him in the investigation of the case; and we accordingly examined the stomach and its contents. The stomach was laid open, by making an incision along its greater curvature; and the following appearances were met with:—At the upper and posterior part, near the pyloric end of the smaller curvature, was an opening of an oval shape, and about half an inch in its longest diameter. The edges were firm, hard, and smooth; presenting not the least appearance of laceration or ulceration, even when examined with a lens; they were beveled off from within outwards, being thinned towards the peritoneal coat; in short, the aperture presented the appearance of having been obliquely punched out; its diameter being greater internally than externally. There was no sign of inflammation in the mucous membrane, immediately around the aperture; but when examined from without the margin appeared somewhat black, compared with the general whiteness of the peritoneal surface. On cutting through the perforation, the coats of the stomach were found to be four lines thick at the lower part; and they were involved for some distance around, but were less thickened superiorly than inferiorly. At the lower part the parietes had almost a cartilaginous whiteness and hardness, and were decidedly in a scirrhous state. The mucous membrane was firm throughout; it had a somewhat yellowish tinge, but in its central portion there were slight patches of inflammatory redness, shaded off into the yellow colour. At the lower part, near the larger curvature, there were thick irregular black striæ: the mucous membrane being raised and blackened, but not in the least softened. These striæ appeared like those produced by the action of sulphuric acid; but there was no corrosion or softening; and on applying test paper, there was not the least mark of acidity. The black matter was here and there covered with a yellowish coloured substance, streaky, not easily removable, and apparently embedded with it in the mucous membrane. The appearance was similar to that produced by loosely painting a dark surface with gamboge, or mustard mixed with water. A portion of the blackened mucous membrane, with and without the yellow colouring matter, was scraped, and cut off, but with some difficulty, and set apart for analysis.

The duodenum contained a yellowish green liquid—apparently, altered bile. Its mucous surface had a deep yellowish green colour, but there was no abnormal change.

The contents of the stomach, found extravasated in the abdomen, were first examined: they were of a dark brown colour, mixed with mucus and flocculi of lymph, and amounted to about twelve ounces. Four ounces diluted with a little distilled water, were boiled for two hours and then filtered. The filtered liquid was of a pale yellow colour, and perfectly neutral. It was tested for arsenic, sulphuric and oxalic acids, and the salts of barytes, lead, and copper; but not a trace of any of these poisons could be discovered. The liquid from the duodenum appeared to be nothing more than altered bile: it contained no poisonous matter. The yellow substance on the blackened portion of mucous membrane was next examined. The mucous membrane containing it was boiled for an hour in distilled water acidulated with muriatic acid. A portion, neutralised by ammonia, was treated with sulphuretted hydrogen gas, but there was no change. In another portion acidulated gold-foil, with zinc, was suspended for twenty-four hours; at the end of which time the gold was as bright as when first immersed. This proved the absence of mercury. The yellow matter was in too small a quantity to be collected separately: it was probably some substance taken with the food, while the black colour of the mucous membrane was due to melanotic extravasation. The experiments then clearly negatived the presence of poison in the contents of the abdomen.—No portion of the matters vomited during life could be obtained for analysis.

This case is interesting; because it shows how easily symptoms and post-mortem appearances may be mistaken for those of poisoning, where they result from disease. The circumstances in favour of poisoning—leaving out those of a moral nature, which were somewhat strong—were:

1. The deceased having been taken suddenly ill, while in pretty good health.

2. The nature of the symptoms—severe pain in the abdomen, violent vomiting, and collapse.

3. Death in about fifteen hours after the first seizure, with but little abatement of the symptoms.

4. The appearance of inflammation, and other morbid changes about the stomach.

Against poisoning were the following circumstances:

1. The deceased's declaration that she had not taken poison, corroborated, as it was, by the non-discovery of any poison about her person or in the apartment.

2. The time of the occurrence of the symptoms.—The poison could not have been a mineral acid, alkali, or oxalic acid: for these operate instantaneously, or within a few minutes after they are

swallowed; and a vessel or some liquid is discovered near the person. The poison, if any, was not likely to have been arsenic, mercury, barytes, or lead; since these rarely have their symptoms protracted for three hours: and there was no reason to suppose that the deceased had swallowed any thing subsequently to her dinner.

3. The nature of the symptoms.—Irritants, although they produce violent pain and vomiting, are generally attended with diarrhœa. Here there was no diarrhœa; and pain and vomiting alone, coming on suddenly, are far from being conclusive evidence of poisoning.

4. The absence of poison from the stomach, duodenum, and contents of the abdomen.—This, although it does not absolutely negative the fact of poison having been taken, is, *cœteris paribus*, a strong presumption against poisoning, in a case where death was so rapid.

5. The nature of the post-mortem appearances—inflammatory redness, black striated extravasation, and perforation of the stomach.—Inflammatory redness is of little importance, where so slight as in the present case, unless there be other strong evidence to show that it was probably produced by poison. It is not unfrequently met with in the dead body, where there can be no suspicion of poisoning; and it was probably, in this case, a concomitant of other more active disease in the stomach. Black striated extravasation on the mucous membrane is certainly seen in poisoning by sulphuric or oxalic acid; and this stomach bore very much the appearances that I have observed in cases of poisoning by those substances. But there were these striking differences; in poisoning, the striæ are highly acid and soft, easily removed by scraping, and, on analysis, give evidence of the presence of the poison: in disease, there are none of these characters; and there were none in the present case. Besides the manner in which the deceased was seized, and the circumstances under which she was found, showed that neither of these bodies could have been taken by her.

Lastly, Perforation.—This as a consequence of poisoning and disease, has been already amply noticed. The aperture in the deceased's stomach had taken place during life; for there were all the marks of peritonitis. The appearance of the aperture did not resemble that produced by a corrosive, nor was there the least reason to suppose that it was produced by an irritant, poison: for, independently of the absence of ulceration or erosion about the aperture and intense vascularity in the stomach and duodenum, the facts of the case entirely removed the idea of its having been produced by an irritant. The deceased clearly died from peritonitis, produced by the effusion of the contents of the stomach through the perforation, whatever the perforation may have depended on: but peritonitis requires some hours for its establishment, and the deceased only lived fifteen hours after her first seizure. Admitting that it requires a period of at least twelve hours for peritonitis to be set up to the degree in which it was here found, the irritant must have caused perforation through the parietes of the stomach in three hours; but this is in the highest degree improbable, and sufficient alone to induce us to seek some other cause for the perforation. This cause we shall at once find in the insidious disease, to the history of which so much of this paper has been devoted: namely, scirrhous ulceration, leading to perforation of the stomach. The correctness of this view will be perhaps at once apparent, when we consider, the age of the deceased—the slight preceding indisposition, indicating the disorder of the stomach—the suddenness of the seizure, and severity of the pain in the abdomen generally—the vomiting without diarrhœa—and death in fifteen hours under symptoms of peritonitis. The post-mortem examination bears out the inference from the symptoms; in the discovery of the marks of peritonitis, and of an aperture in the stomach, the situation, form, and characters of which were exactly those of disease. Hence then the conclusions to which Mr. Hilton and myself came respecting this case were: 1. That the deceased had died from peritonitis, caused by extravasation of the contents of the stomach. 2. That this extravasation arose from a perforation in the organ, caused by slow and insidious disease, and not by poison.

In consequence of this opinion, it was not deemed necessary that a coroner's inquest should be held on the body.

2. *A person labouring under the disease may be the subject of poison.*

This we must regard as a rare coincidence; but still likely to occasion some embarrassment when it occurs. There are two recent cases on record. The first question which may arise, will be whether the perforation, or the diseased state of the stomach leading to it, was due to poison; and, 2dly, whether the disease or the poison was the cause of death. The first question will be answered by considering the nature of the substance. Thus, knowing that corrosives and irritants alone are liable to cause perforation of the stomach, the discovery of a narcotic poison will show that the disease, and the substance taken, could not have had any connection with each other. So again, among irritants, there are some, perhaps the greater number, not likely to be followed by perforation of the stomach. The second question will be answered by attending to the symptoms under which the person dies, and the appearances found in the body. The discovery of poison, by chemical analysis, in the alimentary canal, avails but little in a case of this kind; because it is not disputed that poison has been taken:—the main question is whether or not it was the cause of the symptoms and death.

A woman swallowed, by mistake, half an ounce of powdered muriate of barytes, dissolved in warm water. Nausea, and vomiting, of a watery mucus, supervened, with twitchings of the facial muscles, and convulsive motions of the hands and feet. The symptoms continued to increase in severity; and she died about two hours from the time of taking the poison, under the most violent convulsions. On inspection, the stomach was found perforated, posteriorly in the lesser curvature, near the cardiac orifice. The aperture was of an oval form, three lines in diameter externally, and almost twice as large internally. The margin appeared swollen, and the mucous membrane, for about two inches round, was much thickened, and covered with a bloody mucus. The stomach and small intestines were highly inflamed; the cavity of the former contained mucus and coagulated blood. The pharynx and œsophagus presented slight marks of inflammation. The poison was found in the stomach, by chemical analysis.

This case is, in many points of view, worthy of attention. Wildberg, who reports it, suggested that the perforation was due to previous disease, and not to the poison taken. This is, certainly, the more probable opinion; for the characters of the aperture are those of disease, somewhat modified by the irritant effects of the poison. Certainly, it is not likely that muriate of barytes, although an irritant, should have produced perforation of the stomach in two hours, if it were capable of producing it at all. It is not stated whether the woman suffered from any symptoms indicative of gastric irritation, prior to taking the poison; nor whether the contents of the stomach were found extravasated, and the peritoneum inflamed: hence a decision on the cause of perforation is uncertain, although it is in the highest degree probable that the poison did not occasion it. But, whatever may be the view adopted on this point, there can be no doubt that the woman died from the effects of the poison. This was clearly indicated by the nature of the symptoms and post-mortem appearances. Admitting that no mistake was made respecting the time at which the poison was taken, it must be considered as remarkable, that this irritant should have destroyed life, and left such extensive marks of irritation in the alimentary canal in the short space of two hours.

About two years ago, a woman was tried, on the Western Circuit, for poisoning her husband with arsenic. The deceased was attacked with severe pain in the abdomen, and vomiting, after having eaten his dinner, which was prepared for him by the prisoner. Medical assistance was called in; but he continued to become worse, and he died in about sixty hours after the first attack. It was shown, that arsenic had been probably given to him at the dinner; and also on several other occasions, when it was supposed to have been substistuted for some medicine prescribed for him; since his symptoms were uniformly aggravated after each dose. The chemical evidence was very clear: arsenic was discovered in the vessel in which the dinner was dressed, also in the stomach of the deceased; and the poison was traced to the possession of the prisoner. On examining the body, a scirrhous ulcer was found in the stomach, near the pyloric orifice; which was evidently of long standing. It was about the size of a shilling, had a dark appearance, and the margin was inflamed. The mucous membrane of the stomach, as well as the duodenum, was in such a high state of inflammation, as to resemble red velvet. The defence on the trial was, that the symptoms and death of the deceased were due to this scirrhous ulcer, and not to poisoning. It was shown that the deceased had suffered from a gnawing pain in the stomach for a very long period; and it was thought by himself, as well as by others who saw him, that this last attack of illness was nothing more than aggravation of his old complaint. The medical witness did not hesitate to refer the symptoms and death to arsenic, for the following reasons:—the symptoms occurred suddenly and violently, after a meal at which arsenic was proved to have been administered; some of them were peculiar to poisoning by arsenic, and totally unconnected with disease. Pain and vomiting might be ascribed to either cause; but the intense thirst, well-marked inflammation of the conjunctiva, coldness of the body, and, before death, paralysis of the extremities, with loss of sight, were unquestionably owing to the operation of arsenic, and not to the effect of chronic disease. This, besides, was not likely to destroy life with such rapidity, and under such severe symptoms.—The post-mortem appearances corroborated the opinion founded on the symptoms, and showed that death was really due to an active irritant poison. The woman was convicted and executed upon this evidence.—The manner in which this investigation was conducted reflects the highest credit on the medical witnesses.

3. *A person, labouring under the disease, may have received blows or injuries on the abdomen: in which case it may be necessary to state, whether the perforation did or did not result from violence used.*

It is evident, from the insidious nature of this disease of the stomach, that a person labouring under it may become the subject of violent treatment, and the fatal symptoms not show themselves until after the violence. I have met with only one case of this kind which is recorded by Mr. Watson.

A healthy stout boy, aged 11, was ill-treated by another boy; but it does not appear that he was struck on the abdomen. After the ill-treatment, he complained chiefly of the pain in his bowels and head—seemed in great pain and could not take food; notwithstanding which he went out in the afternoon. The same evening he was much worse, and vomited greatly. Some medicines were given to him, which he could not retain on his stomach. On the second day after the injury, there was a little coagulated blood in the vomited matters. He died on the fourth morning, suffering throughout from pain and vomiting; but his bowels were confined during the whole period. On inspection, there were no external marks of injury. Within the abdomen there was a considerable quantity of pus; and extensive agglutination of the intestines, which were much inflamed, by effused lymph. At the concave part of the stomach there was a perforation through its coats, about the size of a sixpence; and near to this, two large spots of a purplish colour.—The other parts of the body presented a healthy appearance.—The medical witnesses referred death to inflammation of the bowels caused by violence. The perforation of the stomach was described as having a post-mortem origin, the result of erosion; they did not think it had been caused by ulceration. The prisoner was discharged by a verdict of "not proven."

The description of the aperture, imperfect as it is, seems to show that it must have been produced during life, and was not a perforation by solution. The deceased evidently died from peritonitis, caused by an effusion of the contents of the stomach into the abdomen; and there is no doubt, from the history of the case, that the perforation took place at or about the time of the violence;—but whether it was the result of this, or of insidious pre-existing disease, the effects of which were accelerated by the violence, it is not so easy to say, the characters of the aperture not being sufficiently detailed. The latter is, however, the more probable opinion; because violence, such as a blow on the stomach, even had this been proved to have been given, was not likely to have occasioned merely a round aperture no larger than a sixpence, in the concave part of the organ. Hence, although it is plain that the perforation led to death through peritonitis, it is doubtful on what cause the perforation exactly depended.

4. *Perforation of the stomach from post-mortem changes may be mistaken for perforation from poison.*

The only case in which this can possibly happen is, where, conjoined with the discovery of perforation after death, there may have existed symptoms of irritation in the alimentary canal during life, from accidental causes. It is quite possible that a person may die under symptoms somewhat resembling irritant poisoning, and after death, the gastric secretion destroy the parietes of the stomach; but such a singular combination of circumstances would be most unusual. That, however, signifies little in a legal point of view; for persons charged with crimes, are frequently acquitted on the barest medical possibilities. One case of this doubtful kind is on record;—I allude to that of Miss Burns, for the murder of whom, by poison, a Mr. Angus of Liverpool was tried about thirty years ago. It is not necessary to enter into the particulars of this case, since the reports of the post-mortem appearances are somewhat imperfect. Although the symptoms, resembling irritant poisoning, under which the deceased laboured, were not accounted for, yet there was strong reason to believe they were not connected with the perforation found in the stomach, which, on the whole, bore the characters assigned to that produced by the gastric secretion. The charge of poisoning was not sustained by chemical or pathological evidence, and the prisoner was acquitted. The evidence given on this trial is well worthy the attention of every medical practitioner. It shows on what a nice balance of proofs charges of poisoning sometimes rest; and how important it is that we should make ourselves acquainted with all the circumstances under which perforations of the stomach may take place.

These are, I believe, the principal medico-legal questions connected with this subject. From all that has been said, it will be seen how little individual experience is fitted to serve as a basis for our opinions; since it is not possible, even in the widest field of observation, that every variety of case can occur to one individual. We are bound, in all medico-legal questions, to take the most enlarged view of the subject; and to supply what is deficient in our own experience, by that which has fallen within the observation of others. It is a full conviction of the necessity for this generalisation of facts and principles, to render them useful in medical jurisprudence, which must be my apology for having, in the course of this paper, drawn so largely on the experience of others.

ON INCISION

IN

CASES OF OCCLUSION,

AND

RIGIDITY OF THE UTERUS

BY SAMUEL ASHWELL, M. D.[1]

I am desirous to make a few brief and practical observations on the safety of incision, in most cases of entire closure of the os uteri; and in some, of the rare examples of its extreme rigidity at the time of labour. It is essential to be thus explicit in defining the cases where such an operation is required, to guard against a rash and unwarranted use of the knife; and it may unhesitatingly be affirmed, that the practitioner, before such a procedure is determined on, ought to be most fully convinced that the patient's safety can be better secured by this than by any other method. It may too be observed, that the medical attendant should not, except when a consultation cannot be obtained, adopt the plan now proposed on his own responsibility. When the operation is sanctioned by others, should the event be unfavourable—which will rarely happen if the incision be practised sufficiently early—not only will the operator's own feelings and reputation be spared, but the immediate relatives of the patient will entertain no doubt as to the propriety of the practice.

There is sufficient novelty about both the points under discussion, to justify the few remarks I am about to make: and if I shall succeed in throwing a little additional light on these perplexing cases, my purpose will be fully answered. Happily, entire closure, and such extreme rigidity of the os as to preclude the birth of a child if help be not afforded, without more or less extensive laceration, are rare. Still, two such examples—the one of closure, and the other of rigidity—where incision has been successfully practised, have fallen under my own observation within a short time. More may occur; and I shall therefore be excused if I occupy a few

[1] Guy's Hospital Reports, No. viii. Apl. 1839, p. 126.

pages of the Guy's Reports in bringing the history and the treatment of such instances of morbid structure before the profession.

It may, I think, be shown,

1st, That incision is the safest remedy, where the os is in a state of firm and complete closure; or, in other words, where the uterus, so far as its lower orifice is concerned, is imperforate: and,

2dly, That in examples of such extreme rigidity of the os, where, after hours of strong uterine effort, the power of dilatation is entirely absent, whether such rigidity arise from disease in the structural organisation of the part, or has resulted from previous laceration and ulceration, incision is the best and safest treatment; far preferable to protracted and powerful dilatation of the os by the finger; or, on the principle of non-interference, to leaving the case to the natural efforts.

Examples of the entire closure of the os uteri at the time of labour are recorded by Dr. Nægele, jun., in his Thesis on "Conglutination of the Os Uteri," published at Heidelberg in 1835. And there is by no means a paucity of allusion to them by other writers. I have, in a former paper, pointed to the cause of the simple agglutination or closure of the os. It is well known, that normally, this orifice is sometimes very small; at others, instead of a transverse chink—its most usual form—there is merely a diminutive circular aperture. In either of these conditions of the orifice, complete obliteration may easily be produced, by an amount of local inflammation following conception, which would not seriously interfere, either with the pregnancy or the health of the individual. It is important to bear in mind, that such closure may not be attended by any other disease of the parts: the adhesion may be firm and complete, but there may be no scirrhous induration—no distinct nodule of hard substance; the neck of the uterus will be forced down by the pains; and the sensation imparted to the finger, on examination, during labour will be quite natural; excepting only, that no aperture will be found. There is therefore a marked difference, so far, between the cases of closure occurring as the result of adhesive inflammation, where the orifice is, naturally, unusually small, and the instances of occlusion which are the consequence of previous morbid deposit about the os and cervix, produced either by chronic inflammation, or occurring as the result of former laceration or ulceration. In the latter class of cases, where there is evident organic disease of structure, a long delay in the employment of venesection—and of the incision, if the bleeding fail—is not probable; whereas in the cases of simple but firm closure, where there is no other disease, delay is far more probable. It will be urged as extremely unlikely that there should be no os uteri;—that there is one perhaps, but that, owing to obliquity, it is very high up posteriorly; and that, being thus unnaturally situated, twenty-four, thirty-six, or forty-eight hours, or even a longer period, will be required for its development and dilatation. The unfortunate instances of occlusion recorded by various authors may be attributed to this very delay; and they show how necessary it is that every circumstance should be explained, and if possible removed, which may tend to mislead in a newly observed and hazardous malady. M. North, an experienced and able obstetric practitioner and lecturer, dwells at great length on malposition of the womb uterus; and does not hesitate to express his belief, that most of the reputed instances of imperforate uterus were really nothing more than cases of anterior obliquity; and the names of Baudelocque, Desormeaux, Velpeau, Denman, and Dewees, are adduced as holding these opinions. For myself, I may say, that I have never met with any seriously protracted labours from obliquity; and I think I could mention many highly respectable writers, whose experience corresponds with my own in this particular. Allowing, however, to this supposition of Mr. North its full weight, it must be recollected, that every hour of urgent uterine effort tends to rectify obliquity, if such be the cause of an undiscovered os uteri; and that if the pains are really powerful, and protracted for ten or twelve hours, the os uteri being still undiscovered and undiscoverable, it may fairly be assumed that it is wanting, and it is time then to think of the dangers of uterine rupture and laceration. So far as the case and its continuation, so correctly reported by Mr. Tweedie,[1] can illustrate this point, it may be cited as an example of the facility of diagnosis, and of the safety of the treatment by incision. The error of the first operation, performed by myself, consisted in its delay. From anxiety not to incise the uterus if it could be avoided, the woman was permitted to incur more risk than was justifiable; and from the excitement and fatigue of the labour, the collapse was alarmingly dangerous—much more so than after the second operation, when, confirmed in a favourable view of incision by its previous success, the division of the parts was earlier resorted to by Mr. Tweedie, and the collapse was proportionably slight and transient.

There can be but little difficulty in the diagnosis of instances of complete and firm closure of the os. When parturient effort is really established, the lower portion of the uterus, in the form of a tense and large globular mass, is generally forced down very low, sometimes so far as nearly to reach the external entrance of the vagina. Thus a finger—at all practised in these enquiries—*must* detect an aperture, if there be one; and, if not, the spot where the os uteri, at the time of conception, had been.

A repetition of uterine action will afford abundant opportunities for careful re-examination, so that no apology for indiscreet and dangerous delay can exist. If, too, a spot shall be discovered—more depressed, and of different structure to the surrounding parts, indicating the site of the os uteri at the time of impregnation, it is impossible then to doubt about the nature of the case; and the only question remaining to be determined, is the precise method of relief.

It may be a matter of hesitation, whether bleeding to some

[1] See Vol. II. p. 258.

extent—say, eighteen, twenty-five, or thirty ounces—should not precede the use of the bistoury.

In some critical remarks on Mrs. Pursell's case, in the "British and Foreign Medical Review," Vol. III. p. 375, the writer says: "Under the circumstances, we believe the incision (made by Dr. Ashwell) into the cervix was justifiable; though we think it not impossible, *that, had a free venesection been premised, and some further time given*, an os uteri might have been found." From which opinion I entirely dissent.

Practitioners should be extremely cautious on both the points now alluded to—I mean bleeding and delay. It would be difficult to justify a large venesection in cases of closed os, like those now described, where there was no other disease about the parts than the occlusion: if there were malignant deposit, a general scirrhous induration of the cervix, or cicatrices of cartilaginous hardness, the abstraction of blood in a case thus complicated would be highly judicious: and certainly, if there be so much doubt resting on any case, as to leave it a matter of question, whether there be an os uteri or not, venesection and delay are less censurable, than the continuance of the doubt and uncertainty. If, however, the practitioner has decided that there is an occluded os, without other disease, and that the head of the child cannot pass, till a way be made for its transit, little else than exhaustion, and danger, are to be anticipated from bleeding and delay.

I purposely avoid, in this part of the paper, more than allusion to those cases of occlusion of the os uteri complicated with marked and decidedly morbid altered structure. These examples are so closely connected with the cases of extreme rigidity, and so generally arise from the same causes—viz. organic disease, and the injuries or lacerations of previous labours—that it is quite proper to place them in the same part of the Essay.

Having abandoned all hope of discovering an os uteri by venesection and delay, there are two methods of remedying the closure of this important orifice:—

1. By such an amount of pressure, by the finger, female catheter, sound, or bougie, as shall puncture or open the occlusion; and,
2. By incision, made by a bistoury or knife.

Dr. Nægele, jun., of Heidelberg, advocates the first of these plans; and condemns the use of the knife, except as a last resource, the other means having failed. My friend Dr. Waller has, in the present number of the Reports, furnished a case so treated.

When the occlusion is slight, depending on a thin membrane, interposed between the margins or filling up the circumference of the os, similar to the membrane found between the adherent labia of female children, the finger, as recommended by Nægele, in his very interesting Thesis, may produce a separation or orifice; or, if this digital pressure be insufficient, the catheter, sound, or bougie, may enable us to do what we wish. It is afterwards to be expected, if the structure of the cervix be healthy, that dilatation of the os will proceed as satisfactorily as in the many cases where this orifice is naturally small. In such, we rarely find the power of dilatation absent.

Nægele proves, that, in such examples of conglutination, the finger will succeed remarkably well. His reasons for preferring the digital puncture to the knife, are given in the following quotation from his Essay:—

"Conglutinationis orificii uteri sanatio in quam plurimis casibus nullis obnoxia est difficultatibus. Aut digito aut instrumento satis obtuso, e. g. cathetere femineo, digito duce in vaginam immisso et orificio uteri leniter adpresso conglutinatio, sine ulla parturientis molestia, facile disrumpitur; plerumque nonnullæ sanguinis guttulæ inter operationem effluunt, testes materiam organicam operatione ruptam esse."

"Digitum autem ad operationem perficiendam instrumento præferendum esse censeo, tum quia ad destruendam conglutinationem plane sufficit, tum quia digito adhibito minus timendum est, ne ovi membranæ lædantur; tum quia si digitus non sufficit, ab instrumento obtuso auxilium vix exspectandum erit.

"Hanc autem medendi rationem operationi per incisionem præferendam esse, nemo certe in dubium vocabit; quanquam enim incisio a manu perita et caute instituta non omnino periculosa est, cum experientia uterum satis graves læsiones sine infelici successu tolerare doceat; negari tamen nequit, incisione ab homine in arte chirurgica minus perito facta, utique deploranda parturienti inde evenire posse mala. Nonne enim, e. g. bulla aquarum incisione læsa, dolorum vi subito jam aucta, caput fœtus fortiter descendens ipso instrumento vulnerari potest?"

But Nægele's method of procedure is clearly inapplicable, where the interposed cellular membrane, shutting up the os, has become thoroughly organised and firm; so much so, indeed, as effectually to have resisted twelve, twenty, or thirty hours of most urgent uterine effort: although I am quite aware, that neither the wedge like dilating property of the membranous pouch containing the liquor amnii, nor the head of the child, supposing it to present, can be brought, owing to the occlusion, fairly to bear upon the closed os.

Nor must it be foregotten, if the finger or catheter be forcibly used to make an artificial os, that the parts would be contused, and that there would probably ensue, after such contusion, local, if not general uterine inflammation. If this be the result, the chances of recovery are greatly diminished.

It may too, perhaps, be fairly assumed, that the risk of unlimited laceration of the uterus and adjacent parts is much less, where incisions of tolerable extent have been discreetly made, than where merely a diminutive central aperture has been formed by a blunt instrument. In Mrs. Purcell's case, after both operations—and in others, where incision was practised—the subsequent lacerations were confined to the cervix; they were restrained within the limits of the reflection of the mucous membrane over the neck, and did not involve the peritoneum, the body, or fundus of the womb. As of additional weight in Mrs. Purcell's case, it may be stated, that the structure into which the incision was made, was not the structure of the cervix; for it was clearly ascertained, afterwards, that a cervix did not exist; and yet, although, in both instances, the incisions by the knife were followed by rent, yet in neither did those lacerations extend beyond the lower segment of the uterus, included within the reflection of the vaginal mucous membrane.

I proceed now to the second part of my subject;—in treating of which, I shall attempt to prove, from the similarity of cases of excessively rigid and undilatable os uteri to those of occlusion, as well as from the experience of the operation itself, that, in many such cases, incision may be safely and advantageously practised. It will not be supposed that I recommend the knife to be at once employed in these more complicated maladies; but I am confident—so far, at least, as it is possible to be confident, in cases where a high probability must be our only guide—that where fatal results have occurred, they might often have been prevented by timely incision of the parts. But it has too often happened, as the appended cases show, either that the operation has been performed too late, or that a too powerful dilatation by the finger, and an unwise reliance on the natural efforts, have altogether superseded its employment. Examples of entire occlusion without disease, like those to which I have already alluded, are much more rare than extreme rigidity of the cervix and a diminished os: nor will it be found quite so easy in the latter, as in the former class of cases, to determine the precise moment when bleeding, diaphoretics, fomentation, and delay, are to yield to the use of the bistoury; still the general safety of incision, and the known and imminent danger of protracted and severe uterine effort and contusion, ought to induce an *earlier*, rather than a *deferred* operation. A careful perusal of the cases and authorities appended to this Essay, especially Smellie's, can scarcely fail to impress this conviction. In every instance, or nearly so, where the division of the morbid structure has been made, prior to the occurrence of inflammation and sinking, it has succeeded; and, generally, with the fewest possible bad symptoms. Where, on the contrary, violent uterine action, contrary to the sagacious directions of the experienced Dr. Hamilton, has been allowed to go on for a great number of hours—say, twelve, fifteen, twenty-four, or even a longer period—the result has been generally unfavourable, often fatal; and still more certainly so, where, during a portion of this time, powerful dilatation has been long and forcibly employed. Dilatation by the fingers is not the same operation here, as to its safety, which it is found to be in examples of rigidity not dependent on, or associated with, local or structural malady. It is true, that, in transverse and placental presentations, artificial dilatation is often practised with safety and advantage. Neither the mouth nor neck of the womb, both being healthy, suffer from the process: prevention of hemorrhage, and a freedom from useless and exhausting pain, are the results of the process: but where the cervix is rigid, contracted, and diseased, and the os so small as scarcely to be recognised, powerful and long-continued artificial dilatation *must be a dangerous remedy.* It is scarcely to be expected that it should relax the parts and lead to dilatation: it is much more likely that it should irritate, and thus induce inflammation, gangrene, and death. I have said, that cases of entire occlusion and excessive rigidity have points of resemblance: but it must also be acknowledged, that they present important and marked differences.

The simplest, perhaps, of the examples of rigid os uteri is where a very contracted orifice is surrounded by a structure almost entirely undilatable. In such a case, although there may be little if any indication of organic change, still, if there be a total absence of the power of dilatation, after the use of free venesection and antimony—time having been allowed for their beneficial effects—such a case cannot be long trusted with safety, either to the natural efforts or artificial dilatation. Other examples are not so simple as this. Many, probably the majority, are the consequence of some previous morbid occurrence. The os and cervix may have been injured in a former labour: abscesses, ulcerated surfaces, and cicatrisations, may have taken place: thus the uterine orifice may have become nearly, if not entirely closed; and the relative situation of the urethra, bladder, and vagina, so altered, as to render the division of parts much more difficult and hazardous: or it may be, that a hard tumour, or a more malignant and active deposit, has imbedded itself in these parts, totally altering the os and the natural structure of the cervix. In one essential particular, all these varieties will be found to agree; viz. in the difficulty with which the os and cervix are dilated; while in some, and not a few of them, the susceptibility of dilatation will have been entirely destroyed.

Supposing, then, that the incapability of dilatation is satisfactorily established—what is to be done? We are presuming that the disease is well understood pathologically;—that bleeding and every adjuvant remedy have been fairly tried, but without success.

The case may then be treated by *artificial dilatation, or by incison; or it may be left to nature.* To adopt the last course, would be to consign the woman, most probably, to unlimited laceration, if the womb continued to act; or to death, without laceration, if, worn out by protracted yet fruitless uterine pain, inflammation should be set up.

Of artificial dilatation enough, perhaps, has been already said, to indicate how little confidence in such rigidities can be placed in the utility of a moderate stretching of the uterine orifice: and certainly no impression can be derived from the appended cases favourable to protracted and powerful dilatation by the fingers or hand.

It may then be assumed, that we are not justified in protracting the employment of the knife till the patient is well nigh exhausted by the continuance and severity of the expulsatory efforts; the dications of approaching collapse being apparent, in a quick and feeble pulse, a cooling surface, hurried and short respiration, a subdued tone of voice, a tender and tympanitic abdomen, and a gradually diminishing uterine pain. Many instances are on record precisely of this kind; and the event, in nearly all, was fatal. Nor ought we to hesitate about incising the cervix, where the violence and frequent return of the uterine effort threatens rupture of the womb. If there be distressing and constant pain about the neck or body of the uterus, or in any other part; if the countenance becomes turgid and dark; if perspiration issues at every pore, and the pulse is full, strong, quick, and incompressible: and if these symptoms continue, although perhaps somewhat lessened by bleeding and antimony; there can be no doubt that recourse should be had to the incision. It is impossible to fix a precise limit during which a patient may be safely left to her own unaided efforts; time cannot be the sole ingredient, although an essential part of every rule, regulating interference in obstetric cases.

There can be no doubt, that, in many instances of rigidity, a free abstraction of blood, the exhibition of $\frac{1}{6}$th, $\frac{1}{4}$th, or $\frac{1}{2}$ gr., every hour, of tartarised antimony, with or without opium, till it produce nausea, will accomplish the dilatation. No sensible practitioner would feel himself warranted at once to propose incision; nor would such an individual consider himself justified in not performing it when other means had failed. While, on the one hand, I am anxious to avoid the imputation of rashness, I am, on the other, if possible, more desirous to avoid the imputation of timidly shrinking from a procedure absolutely essential to a patient's welfare.

The operation, in any of the cases, whether it be on an os firmly closed, yet without organic change—or on an os very diminutive and contracted, with or without surrounding disease, but entirely undilatable—is, generally, easily performed. A probe-pointed knife or bistoury is the instrument most safely used;—the woman lying, either on her left side or on her back, close to the edge of the bed. The fore-finger of the left hand is to be carried to that spot of the cervix intended to be cut: afterwards, the knife or bistoury is to be cautiously conveyed, along the finger in the vagina, to the spot already mentioned; and if its point be gently pushed against the uterine structure, it will completely incise the parietes. In Mrs. Purcell's case, I carried the knife, first of all, forwards, toward the neck of the bladder, (which was empty,) carefully avoiding it; afterwards towards the sacrum, making an incision about two inches long. The liquor amnii will necessarily escape as soon as the first incision is made. The instrument may now be carefully withdrawn, and the further dilatation left to nature. It is scarcely to be expected that all rending should be avoided; but the extent of the tearing is, as has been already stated, generally confined within the limits of the vagina. I have no experience of the better effect of a crucial incision, in preventing extensive laceration; but I am favourably inclined to it. It is not probable that much blood will be lost during or after the operation: in my own cases, only a few drams escaped. If there should be fainting and collapse, after the incision of the parts, brandy and ammonia may be freely exhibited. It is a necessary preliminary step that the bladder and rectum be emptied of their contents. In Mrs. Purcell's case, the birth of the child was accomplished, in both instances, without instrumental aid; but the forceps is not unfrequently necessary safely to terminate the labour.

The remaining part of the paper will be occupied by a brief summary of the most important circumstances of some of the various recorded examples of occluson and rigidity, in which incision was or ought to have been practised.

CASES OF ENTIRE OCCLUSION.

Case 1.—Mrs. Purcell's (see Guy's Hospital Reports, Vol. II. p. 258.) Here the patient, prior to the incision of the neck of the uterus, had been in strong labour for twenty-nine or thirty hours.

The division was made by a sharp-pointed bistoury (Dr. Ashwell not having a blunt-pointed instrument at hand.) There was scarcely any pain complained of; and not more than a few drams of blood were lost. Although there were two or three lacerations after the incision, and rather alarming collapse, the natural efforts were sufficient for the delivery; and the patient recovered quickly and well. The child, although somewhat asphyxiated at birth, rallied.—Length of incision, about two inches.—In this case, it was satisfactorily ascertained that there was no cervix; and the left mamma had no nipple.

Cases. 2 and 3—are examples taken from the Thesis of Dr. Nægele, jun., page 19 (published 1835.)

In both, the os uteri was, normally, exceedingly small; and the occlusion was produced by cellular membrane filling up the orifices. The lower part of the uterus was rendered very tense and hard, and greatly pushed down by the uterine efforts; so that, in one of the cases, it might with some excuse have been mistaken for the bag or membranes containing the liquor amnii.—In Case 2, the patient was fat and plethoric; and so violent were the pains, that, although she had been bled four times, no pain occurred without hemorrhage from the mouth and nose. It appears that she was more or less in labour for eight days (matrona quædam plethorica et satis obesa per *octo dies* vehementissimis ad partum doloribus agitabatur, ita ut sanguis ei e naribus et ore erumperet, quanquam jam quarta vice ei vena secata erat.)—In Case 3, the patient had been in labour two days and nights. A female catheter was used in both these cases, to accomplish the puncture. In both, the uterine orifice dilated (confirming the opinion I have expressed in another part of the paper,) not only without laceration, but with only a moderate amount of delay. The forceps was not required in either; and in both, the children were born alive and healthy.

These are instances, not of very firm and organised closure of the os, but of conglutination effected by a slight cellular membrane —"ope telæ filamentosæ"; the finger or the catheter, would therefore do remarkably well.

Case 4. (also taken from Dr Nægele's Thesis, p. 27.)

On the 17th of August 1822, Dr. Meissner, of Leipsic, was called to a patient, thirty-five years of age, in her second labour. The pains were first felt on the 14th of August, and they had increased on the succeeding day. The midwife, on examination, detected the head of the child, but could not discover an os uteri. A surgeon was then called; and although he urged the patient to bear down when the pains occurred, by which the lower segment of the uterus was pushed very low in the vagina, still he could not discover any uterine orifice.

At noon, on the 16th of August, the woman was so exhausted, that she was unable to make any further voluntary efforts, although she still complained of the urgency of the pains. In the evening, the pains were less frequent and strong; and during the night she was delirious. In this state Dr. Meissner first saw her, on the morning of the 17th of August. The pulse was small, quick, and intermittent; and the patient was exhausted and worn out. The head of the child was entirely covered by the inferior portion of the uterus, much stretched and attenuated; and although the globular mass was pushed almost to the lower orifice of the vagina, there was to be found no vestige of an os uteri. Dr. Meissner, convinced that the uterine orifice was occluded, determined on the propriety of making an artificial opening. He did this with a scalpel; and, by the forceps, brought into the world a dead child. At nine o'clock in the evening the patient died.

It is scarcely possible that any case should more entirely verify the opinions advanced in the former part of this essay. The occlusion here seems to have been as firm as in Mrs. Purcell's case: and we must deeply regret that the operation was not performed at the expiration of twenty-four hours, instead of at the end of nearly three days.

Cases 5 and 6 (also from Nægele, p. 28) are examples of occlusion of the os uteri produced by membranes filling up the orifice, and uniting the margins of the aperture. In one, the pressure of the finger was sufficient to rupture the membrane. In the second, the point of the female catheter was used. In both, parturition was accomplished without instruments. The children were living at the time of birth, and both the mothers did well.

Case 7 (also from Nægele, p. 32) was managed by Dr. Rummel.— The labour commenced on the 25th of August 1822. The patient was pregnant for the first time, and had suffered from leucorrhœa during the whole period.

There was no os uteri; and on the 27th of August, Dr. Rummel made one, by incision. Six hours afterwards, he applied the forceps, and brought into the world a living child. The patient recovered well. The orifice retained afterwards the form it had received from the incision; and in the next confinement there was no necessity for further interference.

CASE 8 (also from Nægele, p. 34.)—Here the patient was forty-two years old, and in her first pregnancy. The labour commenced May 2; and Dr. Solera, after repeated examination, was unable to find an os. On the 4th, in the presence of other medical men, an incision was made into the neck of the womb; and twenty-two hours afterwards the child was brought away by the forceps.

CASE 9—An example of complete occlusion at the time of labour, the patient having previously borne several children. Dr. Waller, of Bartholomew Close, furnished the case to Mr. Tweedie; and for a full account of it, see the present number of Guy's Hospital Reports.

CASE 18, is reported in Dr. Gooch's published lectures.—After miscarriage, extensive sloughing took place, comprehending the os uteri; in place of which there was only a hard contracted circle, as if formed by a cicatrix. This woman was attended in her labour by three surgeons; all of whom agreed in the fact, that the os uteri was lost. The labour-pains were not sufficient to force the head through this unyielding portion of the passage: the head had descended low into the pelvis, pushing the lower part of the uterus before it. After waiting a considerable time, and the strength of the patient being almost exhausted, it was determined by the professional attendants, to cut an os uteri. The patient was taken out of bed, and placed in the position for lithotomy; so that the light fell on the vulva. By dilating as much as possible the external orifice, the cervical portion of the uterus was apparent, as well as the cicatrix in the situation of the os uteri. This part was first punctured with a sharp-pointed bistoury; and an incision of considerable extent was then made, with Pott's bistoury. The patient was replaced in bed: the labour pains returned; and the head was forced through the opening, rending it right and left. Some alarming symptoms now occurred; and as the head descended slowly, it was perforated, and she was speedily delivered. In forty-eight hours after her delivery, this woman had no bad symptoms. There was a purulent discharge from the vagina for about a fortnight; after which, she recovered perfectly, and is now pregnant again.

Dr. Gooch adds:—"Many similar cases, which were treated in the same manner, have been recorded: some of them terminated successfully; and others fatally, in consequence of the operation having been too long delayed."

It would be superfluous to add more such cases as these. They abundantly verify the opinions advocated, and the treatment recommended in this essay: and any one may easily increase his information on this interesting subject, by a careful examination of the authorities which support these views.

CASES OF CONTRACTED OS UTERI,

Co-existing with extreme Rigidity of the Cervix, demanding Incision.

Case 1.—A continuation of Mrs. Purcell's;—the complete history being given in the present number of the reports by Mr. Tweedie. Incision was practised: there was some rending of parts, and collapse. The mother and child both did perfectly well.

Case 2.—The following history demonstrates the inexpediency of strong artificial dilatation and delay. There can be scarcely any doubt but that recovery would have followed an early incision. It is however very instructive.

To-day, August 6, 1831, I visited Mrs. R——, residing in Spitalfields. She is thirty-one years of age; has been confined only two days; and is dying from peritoneal inflammation. I ordered ammonia and wine, together with a mustard poultice over the hypogastric region. The slightest pressure on the abdomen produced exquisite pain, pulse 148: weak, fluttering, and intermittent. Two days afterwards I inspected the body; Mrs. R—— having died shortly after my visit.

I was informed by the medical attendant, that the os was extremely rigid; and that having waited nearly twenty-six hours for its dilatation, he had stretched it artificially, by the finger; and although he had done it gently, she complained severely of pain, both at the time and afterwards. The atttempt at dilatation occupied upwards of two hours.

An examination after death showed the peritoneum to be generally inflamed, but especially the portion of it investing the uterus: there was a considerable quantity of dark-looking serum, tinged with streaks of blood, in the pelvic cavity; and floating in this serum there were many shreds and patches of coagulable lymph. On dividing the uterus from the fundus, downwards, the whole of the cervix, and much of the lower portion of the general cavity of the uterus, was found to be in a gangrenous state. The upper part of the vagina was inflamed and also gangrenous.

Case 3.—Vide "Smellie's Cases," Vol. III. p. 43.—As this case is very long, although interesting, I must refer the reader to the work in which it is contained, giving only the leading particulars.

It was under the care of Dr. Simpson, Professor of Medicine in the University of St. Andrew's.

The patient was observably narrow between the ossa pubis and the os sacrum; and the growing together of the sides of the os uteri, leaving no vestige of a passage, was the result of mischief occurring in a former labour, which lasted four days, and was eventually completed by the perforator. A plentiful suppuration from the internal parts continued for a time after the first labour.

Dr. Haddow confirmed Dr. Simpson's opinion of the case. Two days having now elapsed, it was determined to cut an os uteri; but it was thought necessary, in order that the incision might be more securely made, that the vagina should be first dilated. This being completed, the cicatrix of the united parts was distinctly seen; and it was divided by an incision, at least half an inch deep. The child's head was then touched; and the whole circumference of the passage was found to be hard, like a cartilage, not at all yielding to several throes she had after the incision;—"so that I was obliged," says Dr. Simpson, "to guide a narrow bladed scalpel with my finger, and to make several incisions into this cartilaginous ring. The labour continuing, the passage dilated a little, but not so much as to give any hopes of its allowing the child's head to pass, notwithstanding the bones of the cranium were overlapped; and therefore I was obliged to bring away the child by perforation."

"My patient," says Dr. Simpson, "immediately after being put to bed, was seized with a pleuritic pain, very high fever, and difficult breathing: which coming on so soon after her being fatigued several days with hard labour—during which she slept none, but drank much—appeared to me rather the cause of her death in twenty-four hours after, than any consequence of the incision I had made; for she never complained of uneasiness in those parts, nor had she any hemorrhage."

There can be little doubt, that the contusion of the parts, and the collapse of the system consequent on the two days of hard labour, prior to the incision, induced the fatal result. Nor does it appear that bleeding, so likely to have been highly beneficial, was practised; at least, there is no allusion to it in the narrative of the case.

Case 4. (also from "Smellie's Cases," Vol. III. p. 205.)

This is a painfully instructive history. First of all, repeated and powerful attempts were made to dilate the os, not alone by Dr. Smellie, but by others also. Instruments were passed into the mouth of the child, with the same intention; and although considerable efforts were thus made, the dilatation could not be accomplished. Flooding and faintness were the consequence of these measures. "But," says Dr. Smellie, "after she was recruited, I tried again to dilate the os uteri; having found, in other cases, that it dilated easily when the patients were faint and weak;—but I found the same difficulty as before.

"I was apprehensive," says Dr. Smellie, "of using any greater force by pushing up lest I should tear the uterus from the vagina: but finding that I could not fix the crotchet to advantage, I again withdrew it. All this time the os uteri felt as if it was two inches thick.—Mr. Burnet, who had first seen the case, again attempted to dilate, even after this period, but without any success.

She died soon afterwards, in a convulsion, undelivered. Here, again, it does not appear that bleeding was practised. The case requires no comment;—venesection, and the incision, would probably have saved the patient.

Case 5.—Vide "Smellie's Cases," Vol. III. p. 211.

This is another instance of the same unfortunate kind; although here Smellie approached to the right treatment. The os uteri was open to about the size of half a crown, but rigid and very thin: it was a first labour, and that occurred two months before the full time.

After continued and unsuccessful efforts to dilate the rigid orifice, Smellie incised the neck of the womb by a pair of scissors: the parts afterwards gave way: the hand was introduced; and a dead child was brought away, by turning.

There was much flooding; and the patient died the fourth day.

Case 6.—From Dr. Nægele's Thesis, p. 17.

Here the patient was a healthy country woman, of 35 years of age. On examination, a very small aperture or orifice was found, from which there issued a brown mucous fluid. Various attempts were made at dilatation and delivery, but without success; and after two days of useless and protracted uterine suffering, the patient died. After death, there was discovered a very large rupture of the uterus.

I might increase the number of these cases; but I decline to do so: nor am I willing to increase the length of the paper by an addition of examples where timely and discreet incisions have been successfully practised. This treatment has received the sanction of some of the best obstetric writers and practitioners; and, I am persuaded, renewed trials will only confirm the value and safety of the procedure.

As references to some of these examples of successful incision in rigidity may be useful, I append them.—In the volume of the Medical Gazette for 1837, p. 585, I have detailed an instance where, in two succeeding labours, it was necessary to incise the os. Crucial incisions were made in both operations. In the first, perforation was resorted to. In the second, the forceps only was employed; but the child died. This patient has subsequently borne three living children: no further division of the uterus having been required.

In Professor Davies's work on operative midwifery, some valuable observations on rigidity will be found. He is fully aware of the unquestionable value of bleeding, as a remedy for, or corrective of, an actually existing rigidity: nor does he deprecate artificial dilatation, in some cases, if employed with tenderness and caution.

Several very interesting cases are recorded of the success attendant on timely incision; and one is quoted from Tretzelio, where fatal rupture of the uterus occurred, from non-dilatation of its orifice; in which, although severe labour lasted for nearly three days, no attempt of an efficient or decisive character was made to avert the calamnity. In another example, the patient was forty years old, and pregnant with her first child: she had been in strong labour for three days, and suffered convulsions during the second. Her person could not be known, she was so frightfully pale: her pulse was weak, and almost extinct, as well as her voice, yet the ridge of the orifice of the uterus, open to the diameter of a crown piece, was hard, tight, and, in a manner, callous. Delivery was performed spontaneously in three or four minutes after the section of the part: the child was dead: but the mother immediately grew calm, and the subsequent symptoms were mild.

Heath's translation of Baudelocque, Campbell's Midwifery, and various other journals, may be consulted for further information.

Dr. Davies very properly refers to the forceps and turning, as important remedies, where the incision may have been unfortunately succeeded by a profuse hemorrhage, or having been too long delayed by an inability on the part of the uterus to effect its own delivery. If the head has advanced far into the cavity of the pelvis, the forceps must be resorted to: if, on the contrary, it be still at or above the pelvic brim, the hand, being of softer texture, and itself endowed with feeling, would be the more gentle instrument.

My friend Mr. Godfrey, formerly a student of Guy's, informs me, that recently, in Paris, M. Paul Dubois incised successfully in a case of occlusion of the os, after the employment of opium.

OBSERVATIONS

ON

FIBRINOUS CONCRETIONS IN THE HEART.

BY H. M. HUGHES, M. D., F. L. S.[1]

The notice attracted, and the interest excited, by the bodies which form the subject of the succeeding observations, appear to me to have varied according to the current opinion of the time, respecting changes in the blood as the cause of disease. While humoralism prevailed, they were, after their nature was understood, elevated to a rank of importance which at the present time appears ridiculous. The wonderful cases related by some old authors, in which snakes, worms, &c. were found in the heart and large vessels, without doubt, owed whatever they possessed of the marvellous to the presence of these concretions. According to Morgagni, they were first observed, or rather first regarded, as masses of coagulated fibrin in the early part of the sixteenth century; and continued to attract attention during the seventeenth and the beginning of the eighteenth century. If indeed, at this period, a firm concretion was found in the heart, it was often considered as sufficient to account for death; and further examination was deemed unnecessary. They thus probably for a time formed a serious obstacle to the progress of morbid anatomy, and, it is stated, were sometimes the cause of the escape of criminals guilty of the murder of the persons in whom they were found. These extravagant opinions were successfully opposed by Pasta and Morgagni, who employed arguments very similar to those now urged by physiologists who still entertain doubts of their formation prior to death. Since obvious structural lesions have been found, by the investigations of morbid anatomists, very generally to accompany disease, and have been commonly considered its cause rather than its consequence—or, in other words since solidism has reigned almost exclusively—these concretions have been usually looked upon as cadaveric formations. In consequence, however, of the more frequent examination of the fluids in disease, and the increased means for such examination afforded

[1] Guy's Hospital Reports, No. viii. April, 1839, p. 146.

by the advances of animal chemistry, the blood and its secretions have been proved to undergo considerable changes in the progress of many complaints; and it is not improbable that we may revert and are now slowly reverting, to a modified humoral pathology. In some degree, perhaps, in consequence of this commencing change of theory, several practical authors have, during the present century, deemed these bodies worthy of a brief notice; and Corvisart, Laennec, Andral, Kreysig, Testa, Hope, Legroux, Bouillaud, &c. have stated that they sometimes present characters which cannot possibly be regarded as cadaveric. Though I have noticed the objections of a modern author, the object of the following remarks is not to prove that these bodies are sometimes formed before death, but to describe them as they have been presented to my own observation. Their prior formation I have assumed; as, though the fact may be incapable of direct proof, and though the mode of their formation may be difficult of explanation, I am perfectly convinced that the appearances they exhibit, and the circumstances which attend them, are frequently such as are utterly inexplicable, independently of the continuance of life and motion, and are entirely distinct from any presented by, or accompanying fibrin, after its removal from the body.

That coagulation of the blood may occur in the vessels of the living body, is a fact clearly proved by the results of disease, and by experiments on the lower animals. That this coagulation generally depends upon one of two causes—viz. inflammation or other disease of the vessels themselves, or considerable retardation of the motion of the blood—will also, I presume, be generally admitted. Examples of both are familiar to the surgeon and the pathologist. Phlebitis and senile gangrene at once present themselves as apt illustrations of the one; and the clots found in varicose veins, the vessels of a stump, and arteries around which ligatures have been passed, may be advanced as instances of the other cause of coagulation; while the coagula found in aneurismal sacs, in veins passing through or near inflamed or malignant tumours, and in the vessels crossing phthisical cavities, may be perhaps dependent upon both causes combined. To these may be added the admixture with the blood of certain acrid or poisonous substances: though I think it doubtful if they are ever of sufficient power, or in sufficient quantity, to produce this effect, unless they have been designedly introduced, for the purpose of experiment.

By inflammation, the smooth polish of the lining membrane of the vessels is destroyed; and a layer of adhesive matter is effused, which favours coagulation of the blood, both by retarding its progress, and by separating it from the organised parietes, upon the vital influence of which its fluidity in some degree depends. A clot is formed, which becomes adherent, and is afterwards absorbed, or organised by union with the inflammatory product of the vessel.

Rest, perfect rest, is not necessary to coagulation of the blood, either in the vessels, or when removed from the body. For it is, I conceive, impossible to suppose that perfect rest can exist in the fluid contents of an aneurismal sac, when coagulation first occurs, or when each successive fibrinous layer is deposited. The passage of the blood into the sac, and the alternate contraction and dilatation at each stroke of the ventricle, must, I think, cause the particles in some degree to move upon each other. The same may be safely asserted with regard to coagulation occurring in an ossified or tied artery, and the vessels of a stump; some motion must exist, some circulation must be carried on by means of small anastomosing branches, at the period when the process of coagulation commences. Indeed, I believe it is now generally acknowledged, that comparative rest, or a considerable retardation of the onward current of the blood, is sufficient to induce coagulation; and that upon this circumstance the operation for aneurism, particularly when performed on the distal side, is dependent for success. The fact is further proved by spiculæ of bone, when projecting into the cavity of arteries having appended to them (as noticed by Dr. Carswell[1]) pediculated masses of fibrin; and by coagula forming around meshes of fine thread introduced into and allowed to remain within them. A needle armed with several fine threads, was passed obliquely through the axillary artery of a dog; and the threads pulled till the extremity dropped into the cavity of the vessel, in the blood in which it was left floating. The next day the circulation through it had ceased; and on the third day the animal was killed. That portion of the vessel submitted to the experiment was externally red, swollen, and firm; and contained a fusiform coagulum, an inch and a half in length; though the lining membrane of the artery was not inflamed, and there was not the slightest trace of plastic or other effusion.[2]

Now, reasoning from analogy, we might, *à priori*, expect, that what occurs in two portions of the circulating system, the arteries and veins, would under similar circumstances, likewise occur in the third portion, the heart; and we might therefore be induced to believe, that fibrinous concretions, or, as they are usually called, polypi, when formed before death, depend upon the same causes as those giving rise to coagulation in the vessels. This opinion is, I think, entirely confirmed by observation. But as in some cases of retarded circulation, this coagulation does, and in others, in which the obstruction is equally great and the general debility is equally decided, it does not occur—and as, in some cases of diseased heart, in which the delay of the blood is as great as, or probably even greater than in those in which fibrinous concretions are found, such formations are not discovered after death—it may be fairly presumed that a peculiar condition of the circulating fluid considerably favours the process, though that condition may not, in the present state of our knowledge, be really demonstrable. Leaving this

[1] 11th Fasciculus. [2] Ibid. Plate III. fig. 3.

point, then, as at present, doubtful,—probable, but not proved,—I shall proceed to consider the circumstances usually preceding, or coincident with this coagulation of fibrin in the heart of the living body; and to enquire if they are such as would probably lead to the formation of concretions.

I am induced here to enter upon this question, in consequence of Dr. Babington, the writer of an excellent article "On the morbid conditions of the blood," in the "Cyclopædia of Anatomy and Physiology," having expressed considerable doubt whether that fluid is ever coagulated in the heart during life, and stated his conviction that such coagulation is, to say the least, very unfrequent. I have already observed that, in the arteries and veins, coagulation takes place from inflammation or disease of their lining membrane —from retardation of the flow of blood, or from a combination of the two—probably assisted by a peculiar, but at present unascertained, condition of the fluid itself. I have also stated, that it is impossible to suppose but that some motion must exist between the particles of the fluid contents of an aneurismal sac, or a diseased or tied vessel, when the process of coagulation commences.—I now proceed to enquire, What are the circumstances, what is the state of the fluid, what the condition of the heart, at the period when fibrinous concretions are supposed to take place within its cavities?

The cases in which they occur are almost universally either chronic disease of the heart, extensive disease of the lungs or pleura, or endocarditis. For the present, passing over the two latter, I select for consideration a heart on the valves of which considerable deposition has taken place: the apertures which they close are thereby contracted, and the regular transit of the blood is impeded. Dilatation of one or more of the cavities is sooner or later the result; and, as a necessary consequence, the blood accumulates, and the difficulty of propelling it increases: together with dilatation, usually occur thickening, opacity, and sometimes a certain degree of roughness of the lining membrane. The organ, oppressed by the increase of fluid, contracts feebly, and is capable of expelling only a comparatively small portion of its contents; the vital energy is often considerably diminished;—and "fibrin coagulates," as Dr. Babington states, "the more speedily in proportion as the circulating and nervous systems become more feeble." Syncope is not unfrequent; than which nothing, perhaps, excepting dissolution, is more conducive to coagulation. If, then, to all this we add, that, in a majority of these cases, a considerable quantity of the more fluid part of the blood is removed from the circulation by effusion into the serous cavities and cellular membrane, and that the blood is therefore probably richer in fibrin (as indeed is indicated by the thick glutinous, tar-like characrer it presents, and the speedy coagulation it undergoes, when taken from the arm by venesection,) and that, as will afterwards be shown, these concretions usually occur posteriorly to some obvious obstruction or in largely dilated cavities, there will, I think, be ample grounds for assuming, at least, the probability of their formation previous to death.

"That the firmness of a polypus affords no proof that it existed during life," I am quite willing to admit; and, "that a colourless clot left in the larger cavities and vessels, and moulded into their exact shape, may be formed after death," I am by no means prepared, or disposed, to deny. But Dr. Babington will, I trust, excuse me for differing from him, when he states his conviction that "rest is absolutely necessary to the formation of a firm clot;" and when I express my belief, that it is not always the firmest clots which bear the most decided indications of being formed during life; and that it is precisely when they are not "moulded into the exact shape of the cavities in which they are lodged," that the evidence of their existence prior to death is most complete. I may also, perhaps, be permitted to observe, that the examples referred to by him, in the works of Hewson and Andral, in which collections of fluid were found in the crassamentum of blood abstracted from the arm—and in which "a homogeneous purulent fluid, of a deep-brown or dirty gray colour, was formed at the bottom of the basin"—are entirely distinct from the globular cyst-like bodies, containing fluid, occasionally found in the cavities of the heart.

I have only further to remark hereupon, that if the possibility of these concretions occurring in the living body be granted, the *frequency* of the fact will be differently estimated, according to individual experience, attention to the subject, and the notion entertained of the applicability of a term which is purely comparative. Having now referred to, and in some degree, at least, deprived of their force the objections of the most recent of modern opponents of the opinions I entertain, I proceed to the description of the bodies themselves:—and in the first place,

Of fibrinous concretions resulting from retardation of the blood.

That coagula are very frequently found in the heart, after death, is a fact familiar to the merest tyro in pathological anatomy. Large or small, soft or firm, white or purple, they are seen in almost all cases which are examined; and their absence may be certainly considered the exception to a general rule. They usually exist either in the form of a large blackish purple mass, of the colour and consistence of black currant jelly, like the under surface of the crassamentum of blood taken from the arm; or, like it, they sometimes consist of two portions—one, dark, soft, and friable; the other, either tremulous, yellow and transparent from the admixture of serum, or of a dead-white or pale fawn colour, and perfectly opaque; or, finally, they are entirely destitute of red particles, which, as described by Dr. Babington, may have separated from the liquor sanguinis, in consequence of the slow coagulation of the fibrin, and either passed into the large vessels from gravitation, or entered the tissues by imbibition.

To Corvisart is usually attributed the merit of first attempting, in modern times, to distinguish these genuine post-mortem coagula from polypi, or fibrinous concretions formed previous to death. The principal characteristics of the latter, in his opinion, are a fibrous texture—a firm consistence—adhesion to the parietes—and a pinkish white colour. Laennec adopts nearly the same view of the subject; adding, however, that there occasionally exists in the centre an isolated clot of blood; and, on the surface, red spots, which are not removable by frequent ablutions, which penetrate the mass a quarter of a line or more, and which he considers to be the rudiments of future vessels.

If the whole of these characters were present in any individual case, I should certainly have no doubt that the concretions in which they occurred had a date anterior to death; but I think that the majority may exist in cadaveric clots, and also that tolerably decided presumptive evidence of prior existence may be found when most of them are absent.

What, then, are the physical characters, or attendant circumstances, from which we may derive a positive opinion upon this matter? I conceive we may speak decidedly of concretions being formed anteriorly to death: 1st, When strict adhesion exists between them and the plain surfaces of the heart; and particularly when the membrane, from which they are detached, is found rough, vascular, and sprinkled with bloody points. 2dly, When a firm white fibrinous mass is found in one of the cavities, entirely separate, and detached from a dark-purple or mixed coagulum filling up the remaining portion of the same cavity. 3dly, When, after the removal of the easily separable coagulated blood, we leave behind a smooth unbroken layer or coating of fibrin, attached to a portion or the whole of the cavity in which that coagulated blood was previously lodged; though the layer or coating may be adherent simply by passing behind and mixing with the musculi pectinati of that part of the organ to which it is attached. 4thly, When any changes, vital or chemical, the result of organisation or degeneration, are observed in the concretion, which are not to be discovered in any other coagula existing in the same heart. I wish it to be distinctly understood, that I by no means deny the anterior formation of concretions not possessing the characters referred to, but simply, that, when they are present, I consider the evidence of the fact decided and incontrovertible.

I have adopted this opinion from the following considerations.—Adhesion is a vital process, and is never found to exist between the lining membrane of the vessels and the cadaveric clots. Defined, detached, smooth portions of fibrin (judging from what is observed to take place in coagulation of the blood and the separation of that substance when removed from the body) must, whether in the form of solid masses or extended layers, be formed at a period distinct from coagula, differing in density, colour, and other physical characters with which they co-exist, with which they are in contact, but to which they are not connected; and as there is no reason, with which I am acquainted, to suppose that two separate processes of solidification can or do take place in the blood of the same cavity after death—and we are well assured that the large soft coagula are genuine post-mortem productions—the inference is clear, that the small attached fibrinous concretions are formed during life. The same, with some slight modifications, may be said of those examples in which chemical or other changes are observed in these bodies; unless it can be supposed probable that poisonous or morbific matter can act upon a very small portion of the blood, and, at the same time, leave unaffected the general mass of the circulating fluid.

On the physical characters of fibrinous concretions, the result of retardation of the blood.

These may, I think, be arranged under four varieties; which I have, for the sake of distinction, named the ***Polypoid***, the ***Massive***, the ***Parietal***, and the ***Globular***.

The early state of the first, or ***Polypoid*** variety, I have never witnessed, nor do I recollect to have seen it described. It is usually presented to notice in the form of a solid mass of fibrin, of an irregularly rounded form, varying in size from a filbert to a pullet's egg—is generally of a dull opake or dead white colour, with a smooth even surface, which, however, is sometimes marked with wrinkles or irregular depressions, arising, apparently, from the varying degrees of contraction of different parts; it is sometimes attached by a broad base; at others connected by a small narrow pedicle to the surface of the cavity in which it is lodged; and is often covered with a delicate membrane, which appears to have been occasionally injected from the coronary arteries. Internally, it varies according to its age, and the degree of softening or decomposition which it has undergone. It may be firm, uniform, and lamellated—may be (in appearance at least) supplied with blood-vessels, and interspersed with specks of bone—or may consist of loosely cohering portions of fibrin, varying in colour and in size, and easily reduced by pressure to a soft pulpy mass.

2. The ***Massive*** is that variety, the date of which there exists the greatest difficulty in determining. Its figure is exceedingly irregular; as various processes or prolongations arise from its surfaces or edges, and pass into the depressions, or through the outlets of the cavity in which it is situated. When most decidedly anti-cadaveric, it is thin and expanded, of a pinkish white colour; firm in texture; easily separable into layers; and attached to some of the plain surfaces of the organ by simple adhesion. Though this adhesion is generally easily broken down, the separation of the parts requires, notwithstanding, continued traction, like a recently effused false membrane, or a piece of paper moistened with gum-water; and sometimes leaves the surface of the membrane deficient in its natural smooth glistening appearance. The adhesion, however, is principally dependent on processes passing behind and

around the musculi pectinati or tendinous cords; or on prolongations entering other cavities, or the commencement of the large vessels through which it leaves a free but considerably narrowed channel for the passage of the blood. The large, firm, white masses of fibrin, so frequently found in the heart after death, evidently very nearly resemble the variety now under consideration, and differ from it simply in the period of their formation.

It is often difficult to decide whether they have been formed during life, or are simply post-mortem coagula. However probable it may appear that certain coagula may have been produced during the last moments of life, I think it impossible to determine the point, unless there co-exist appearances or circumstances which cannot be explained by any cadaveric process. I do not therefore consider their existence previous to death decidedly proved, unless they adhere to plain surfaces of some of the parts with which they are connected; or unless in the same cavity with them and perfectly detached, or easily separable from them, there exists a clot possessing different physical characters, and evidently of more recent formation.

3. Of the *Parietal*.—I recollect to have seen but one example in a recent state. The concretion consisted of a general fibrinous lining of the cavity in which it was formed; and presented an irregular sort of net-work of fibrous bands, about a line thick and two lines broad, of a yellowish white colour, firm in consistence, and with a smooth glistening surface. As each band was connected with one or more in its vicinity, the whole presented the general appearance of the interior of the ventricle in which it was situated; the parietes of which it nearly covered, but to which it was only mechanically attached by intermingling with the musculi pectinati. It contained a large blackish clot, with which it was not even slightly connected.

4. The *Globular*, the "végétations globuleuses" of Laennec, vary considerably in size and figure; sometimes not larger than a small pea: they not unfrequently attain the dimensions of a pigeon's, and more rarely of a pullet's egg. When situated in the ventricles, they are usually of a globular, but sometimes, and particularly if large, of an oval figure. Their colour is either an opake white, a light dirty brown, or a brownish red. Their external surface is generally smooth and even. When large and of considerable standing, they are usually cystiform, and contain fluid. The parietes of the cyst are seldom more than a line in thickness, but are nevertheless often separable into concentric layers, of which the external is the most firm, and which gradually decrease in density as they are more internal; so that the loose and uneven lining scarcely exceeds the consistence of paste.

The fluid they contain is very variable: sometimes it resembles thin and impure venous blood; sometimes it is a thick violet-coloured compound of red particles and fibrin, not unaptly compared to wine lees; at others it is of a dirty brownish-yellow colour, not unlike the inflammatory effusion of the serous cavities in persons of bad constitutions or low power: and, lastly, it has been stated that it is sometimes pure pus; but this I have never myself observed and it is a circumstance of which I entertain considerable doubt. When small, these concretions are often pyriform in shape, and nearly or quite solid; the centre being occupied by either a small clot or a little black blood. They are ordinarily connected to the parietes of the heart by thick short pedicles, which are said to be generally of more recent formation than the concretions themselves, and which are fixed simply by passing behind the muscular bands of the organ. I have however observed, not unfrequently, that when of considerable magnitude they have no pedicles; but that they adhere, by their general surface, to the lining of some natural or abnormal cavity or depression; or that they are only very slightly connected to the parietes of the ventricle by a portion of their external covering.

When situated in the appendices of the auricles, they vary, in some important particulars, from those I have heretofore referred to. Thus, instead of assuming a form more or less approaching the spheroidal, they usually partake of the general shape of cavity in which they are lodged, and which they nearly fill. Their extremities, however, towards the apex of the appendix and the sinuses of the auricle are frequently rounded off; and the latter often presents a mammillary projection into the general cavity. They are also not unfrequently differently coloured; some portions being of a deep purple or a purplish-brown, and others of a dirty or tawny white. Again, they vary from those found in the ventricles, in being sometimes composed of small granular portions of fibrin, resembling the contents of scrofulous tumours; and in sometimes containing two or more cavities, which are of an irregular form, and do not communicate with each other.

On the situation of fibrinous concretions arising from retardation of the blood.

Most authors appear to suppose that these bodies occur most frequently on the right side of the heart: but from the following table, marking their position in several instances, this opinion seems not to be altogether correct. In reference to the table, I may observe, that it has been prepared, with considerable care, from the cases published by the modern authors whom I have consulted—from the preparations contained in the museums of this city, which I have inspected—and from examples witnessed by myself; and that apparent evidence of a date anterior to death has alone influenced me in the selection. With one or two doubtful exceptions, at most, they may be all considered to belong to the species now under consideration.

No.	Authority.	Situation of Concretion.				Cause of obstruction or retardation of the blood; and observations.
		Right		Left		
		Auric.	Vent.	Auric.	Vent.	
1.	Crewell.	. .	—	. .	. .	ossification of auricle and ventricle.
2.	Corvisart.	. .	—	. .	. .	dilatation of the right side.
3.	Id.	. .	. .	. .	—	diseased heart, (probably ulceration of the lining membrane also.
4.	Burns.	. .	. .	. .	—	excrescences on the aortic valves.
5.	Id.	. .	. .	—	. .	diseased mitral valve, and ossification of auricle.
6.	Id.	—	. .	. .	. .	great dilatation of the right side of the heart.
7.	Hodgson.	. .	. .	—	. .	disease of the mitral valve.
8.	Id.	. .	. .	. .	—	extreme thinning of the left ventricle.
9.	Laennec.	. .	—	. .	. .	yellow softening of the heart, combined with phthisis.
10.	Id.	. .	—	. .	. .	pulmonary apoplexy, and diseased mitral valve.
11.	Rigacci.	. .	. .	. .	—	extreme thinning of the left ventricle.
12.	Dr. Bright.	. .	—	. .	. .	great dilatation and thinning of right side; emphysema of lungs.
13.	Id.	—	. .	. .	. .	emphysema of the lungs.
14.	Uncertain.	—	—	—	—	none mentioned: paient died of renal dropsy.
15.	Dr. Hope.	. .	. .	. .	—	great dilatation of the ventricle.
16.	Id.	. .	. .	—	. .	diseased mitral valve.
17.	Bouillaud.	—	—	. .	. .	none mentioned: patient suffered from hæmoptysis.
18.	Id.	—	. .	. .	. .	none mentioned.
19.	Id.	. .	. .	—	. .	diseased mitral valve.
20.	Id.	—	—	. .	. .	dilatation of right side: diseased tricuspid and mitral valve.
21.	Id.	. .	—	. .	. .	rupture of tendinous cords.
22.	Id.	. .	—	. .	. .	diseased mitral valve.
23.	Dr. Watson, quoted by Dr. G. Burrows.	—	—	. .	—	dilatation and hydro-pericardium.
24.	Legroux.	—	—	. .	. .	dilatation and adhesion of heart to sternum.
25.	Id.	. .	. .	—	—	diseased mitral valve.
26.	Id.	. .	. .	—	. .	diseased, mitral, tricuspid and aortic valves.
27.	Id.	. .	. .	—	. .	diseased mitral valve.
28.	Id.	. .	. .	. .	—	general ossification of the arteries.
29.	Id.	. .	—	. .	. .	phthisis: none other mentioned.
30.	Id.	. .	—	. .	—	dilatation and softening of muscular parietes.
31.	Id.	. .	—	. .	. .	thinning of the ventricle; age 86.
32.	Museum of Guy's Hospital.	—	. .	. .	. .	dilatation of auricle and open foramen ovale.
33.	Id.	. .	. .	. .	—	none visible.
34.	Id.	. .	—	. .	. .	hepatisation of the lung, age advanced.
35.	Id.	—	. .	. .	—	great dilatation.

No.	Authority.	Situation of Concretion. Right Auric.	Right Vent.	Left Auric.	Left ent.	Cause of obstruction, or retardation of the blood; and observations.
36.	Museum of Guy's Hospital.	..	..	..	—	aneurismal dilatation of the apex of ventricle.
37.	Id.	..	..	..	..	disease of mitral valve.
38.	Id.	..	..	—	—	dilatation; diseased mitral and aortic valves.
39.	Id.	..	..	..	—	open foramen ovale.
40.	Id.	..	..	..	—	dilatation and rupture of the apex of ventricle.
41.	Insp. Book, Ditto,	..	..	—	—	pericarditis and hydro-pericardium.
42.	Museum of St. Thomas's Hosp.	..	..	..	—	disease of aortic valves.
43.	Id.	—	..	..	..	tricuspid and aortic valves diseased.
44.	Id.	..	..	—	..	disease of mitral valve, and dilatation.
45.	Museum of Bartholomew's Hosp.	..	..	..	—	dilatation.
46.	Id.	..	..	..	—	dilatation and ulceration of the apex of the ventricle.
47.	Id.	..	..	..	—	none observed: parietes of ventricle rather thin.
48.	Id.	..	..	—	..	diseased mitral valve. and dilatation.
49.	Mr. Key.	—	..	..	..	opening between the auricles.
50.	Museum of College of Surgeons.	..	—	..	..	dilatation.
51.	..	..	—	..	..	dilatation.
52.	..	..	—	..	—	aneurismal dilatation.
53.	..	..	..	..	—	diseased aortic valves, and aneurismal dilatation.
54.	..	..	..	—	..	dilatation of the left ventricle.
55.	..	—	..	..	..	none visible.
56.	..	..	..	..	—	large carotid aneurism.
57.	Dr. Hughes.	..	..	..	—	small aorta: disease of aortic and mitral valves.
58.	Id.	..	..	..	—	dilatation of the ventricle; diseased mitral and aortic valves.
59.	Id.	—	..	—	..	diseased mitral and aortic valves.
60.	Id.	..	—	..	..	pulmonary apoplexy, and dilatation of auricle.
61.	Id.	—	..	..	..	pulmonary apoplexy: hydrothorax; coagulum in one of the aortic valves.
62.	Id.	..	—	..	—	consolidation of the right lung, and aneurisms of the aorta.

From this table it will be seen, that out of 62 examples, concretions have existed in

32 on the right side of the heart.
38 on the left.
15 in the right auricle.
21 in the right ventricle.
14 in the left auricle.
27 in the left ventricle.

7 in the right and left side at the same time.
4 in the right auricle and ventricle.
3 in the left auricle and ventricle.
2 in both auricles.
6 in both ventricles.
1 in all the cavities.
1 in the right auricle and ventricle, and left ventricle.
1 in the right auricle and left ventricle.

The preceding table refers to all the varieties of fibrinous concretions resulting from retardation. The different varieties, however, appear to me to affect particular situations, which require a very few words. According to my own observation, the first, or polypoid, is generally attached to the septum of the auricles (usually the right), but occasionally, also, to the septum of the ventricles.

The second, or massive, is occasionally found in each and all of the cavities.

The third, or parietal, appears to be most common in the ventricles; as, of the three examples with which I am acquainted, two existed in the right, and one in the left ventricle.

The fourth, or globular, are always, I believe, situated in the ventricles or the appendices of the auricles.

On the mode of formation, age, and changes of these concretions.

When a considerable obstruction exists to the passage of the blood through the heart, whether arising from disease of the valves, aneurism of the aorta, or other causes, one of two conditions usually results. Either an increased thickness of the muscular parietes, constituting hypertrophy, is produced by undue nutrition of the organ—by which it is enabled to overcome that obstruction of which the hypertrophy is the indirect consequence, and to propel the blood into the extreme vessels of the distant parts of the body; or, if the increased nutrition of the organ be unequal to the undue obstruction of the circulation, a state of distention necessarily occurs in one or more of the cavities, from an accumulation of blood. This state of distention is as persistent as its cause; and produces ultimately, a gradual yielding of the parietes; and thereby leads, in a longer or shorter period, to dilatation of the organ. These effects of obstruction may be either single, or combined in different degrees in different individuals. The particular form of the disease is probably, in a great measure, influenced by the relative constitutional vigour of the person in whom it occurs. In proportion as one or more of the cavities becomes dilated, especially if unaccompanied with hypertrophy, the heart experiences a greater difficulty in propelling the blood, and a larger quantity of this fluid is left behind at each contraction of the ventricles. The disease therefore advances, both by the increase of the obstruction, and by the decrease of the ability to surmount it. A portion of blood farthest removed from the direct current of the circulation, after the expiration of a certain time, is, I suppose, left in a state of comparative rest, at least equal to that existing in the fluid contents of a small aneurism, or of a diseased vessel when they first assume the solid form.

Independently of this state of comparative rest, however, the blood, in long-standing diseases of the heart, is, as I have previously observed, often peculiarly prone to coagulation; as is proved by the short time required for its solidification, when taken from the arm. A diseased, inflamed, or roughened state of the lining membrane of the organ also frequently exists; and the general condition of the patient is usually such as materially to favour the process. If, then, under such circumstances, the circulation be more than usually disturbed, and the contractions of the heart become irregular, unequal, and intermitting, as well as feeble—or especially if the patient is suddenly attacked with syncope—that portion of the blood which is farthest removed from the direct current, and which, during the scarcely more than tremulous movements of the organ, may remain, not only almost motionless, but unmixed with the general stream gently undulating through it, coagulates, and afterwards forms a concretion, varying in colour and consistence according to the celerity or tardiness with which it becomes solid, the degree of contraction it undergoes, and the subsequent condition of the individual in whom it occurs.

The preceding view of the mode of formation of these concretions derives, I think, considerable support from the preceding table: from which it may be observed, that these masses of fibrin have, in a great majority of cases, existed in that portion of the heart, in, or immediately anterior to which there has been some obvious cause of retardation. In some of those in which this condition has not been satisfactorily established, I think it more than probable that the deficiency has arisen from the brevity of the narrator, or the too free use of the scalpel of the morbid anatomist. To what circumstances is attributable the form assumed by these concretions, in any particular case, I must confess my inability to determine. I may, however, observe, that the variety which I have named the polypoid has appeared to me, generally, to co-exist with either an open foramen ovale, or a diseased condition of the parietes of the cavity in which it was lodged. The mode of formation of, and the particular figure assumed by, the globular variety, is very difficult to explain. After some consideration of all the attendant circumstances, I am induced to believe, that when they occur in the ventricles, coagulation of the blood first takes place in one of the enlarged depressions, between the musculi pectinati, or in the dilated apex of the cavity; that the coagula remain for a time stationary; but that they are dislodged from their moulds, either on the subsidence of the aggravated attack of dyspnœa or syncope which contributed to their occurrence, and the consequent return of the ordinary power of contraction of the heart; or by one of those violent propulsive efforts, frequently observed by the auscultator, when the action of the organ is irregular and unequal. The concretions, thus formed, remain attached by portions of fibrin coagulated at the same time, but incapable of being moved from their situation in consequence of passing behind and around the musculi pectinati, and acquire a globular figure by the uniform pressure of the fluid by which they are surrounded. The fibrin is sometimes arranged in concentric layers, in consequence of coagulation occurring, subsequently to their formation, on the external surface of these concretions; as the coagulum in an aneurism increases by successive depositions upon its internal surface. I am induced to adopt this view of the process, from having observed, that, when small, they are attached close to a depression capable, or nearly capable, of containing them; that, when large, they usually co-exist with a notable thinning, or aneurismal dilatation of the ventricle; that their rounded surfaces are sometimes seen peeping out between the muscular bands;[1] and that, when situated in the appendix of the auricle, they generally pretty nearly fill the cavity, and assume its form, with the exception of a mammillary projection towards the current of blood. Mr. Thurnham, in an otherwise very valuable paper on Aneurism of the Heart, published in vol. xxi. of the Med. Chirurg. Transactions, gives the following explanation of the formation of the dilated apex of a ventricle which contains one of these bodies, and of which the preparation is in the College of Surgeons:—"The thinnest part of the walls of the ventricle was the seat of a foreign body, by which it must have been compressed during the contractions of the heart. As a consequence of this, atrophy of the heart ensued; then fibro-cellular degeneration; and, lastly, the dilatation of the part."[2] From these opinions I need scarcely say I entirely dissent.

As the symptoms attending the formation of these concretions are generally obscure, and the time at which coagulation commenced is therefore frequently a matter of conjecture, and always incapable of direct proof, the exact age of a particular example is generally undeterminable. There are some instances, however, in which the condition of a patient, some time before death, is so extremely favourable to their production, and the symptoms following that condition are so precisely those which would probably result from their presence in one of the cavities of the heart, that no doubt could, I think, exist in the mind of an unprejudiced observer, on seeing the concretion after death, that it and the previous symptoms had been related as cause and effect. A remarkable case, in reference to the age of these bodies, has been related by M. Legroux:[3]—A woman, suffering from symptoms of diseased heart, was suddenly seized with paralysis, and loss of pulsation in the left arm, terminating in dry gangrene of the part. She died suddenly, eighteen days after; and, on examination, there was found a very diseased

[1] See plate i. fig. 3; also plate iii. fig. 2: in the Medico-Chirurgical Transactions, vol. xxi.

[2] P. 214.

[3] Recherches sur les concrétions sanguines, p. 13.

mitral valve. The brachial and ulnar arteries were filled by fibrin of a yellowish red colour, granular in texture, easily reduced to pulp by pressure, and adherent to their lining membrane. A concretion of exactly the same colour, texture, and consistence, was discovered in the left auricle, slightly adherent to its parietes, but connected principally by mixing with its muscular columns. The fair and natural presumption is, that both masses of fibrin assumed the solid form about the same time.

Other cases are, however, on record, which bear presumptive evidence of much longer standing. Thus, in a case related by Burns, a mass of fibrin in the left auricle was not only covered with a distinct membrane, but contained specks of bone, and was permeated by air, by inflation of the coronary vessels. In another case by the same author, a concretion was separated with difficulty from its attachment; and when it had been forcibly removed, the membrane was left rough, and painted with red vessels. In a concretion found in the right auricle of a girl, Bouillaud saw vessels filled with bright and dark blood. Rigacci, quoted by Andral, distinctly saw vessels injected with mercury passing along the pedicle, and distributed through the mass of a fibrinous concretion in the left ventricle. In the Museum of Guy's Hospital, is a preparation in which a large fibrinous mass attached to the septum of the auricles has been injected with sise, and in which distinct vessels are now visible.

Case 1.—A woman, aged 55, suffered from the ordinary symptoms of diseased heart, with ascites, anasarca of the legs and left arm, great dyspnœa, and uneasiness of the left side. On examination after death, the heart was found rather dilated. At the margin of the fossa ovalis, which was remarkably distinct, there existed a valvular opening, capable of admitting a crow-quill; close to which was the attachment of a solid concretion, as large as a pullet's egg. Though dark and discoloured at some parts, it was generally of a light yellow colour, and transparent, with some opaque white spots, having a general concentric arrangement distributed through it. Fine injection thrown into the coronary artery passed into minute vessels, ramifying beautifully through the transparent substance: it was covered by thin membrane, which appeared to be continuous with the lining of the auricle. The edges of the auriculo-ventricular valves, particularly the left, were slightly thickened.—(See Inspection Book in Guy's Museum, prep. 1388.

This preparation has lost some of its characteristic features by long maceration in spirit. However accurately it may now resemble a fungous growth from the parietes, and whatever doubt may be felt as to the presence of true vessels by persons now examining it, there was no hesitation on either of these points in the mind of those who saw it in a recent state. I must however acknowledge, that in a preparation in Bartholomew's Museum is a similar mass attached to the septum in the left auricle, which is considered by Mr. Stanley to have been secreted by the lining membrane of the heart.

It appears, then, by the statements of authors of credit, and by existing preparations, that these concretions may be covered with membrane, supplied with vessels, interspersed with specks of bone, or changed into granular pultaceous masses, according to the degree in which they have been organised, and the action of the vessels of the part with which they are in contact, or the amount of degenerative softening they have undergone; and it is evident that these changes could not have been effected in a very short space of time.

The correctness of the preceding statements may, I am aware, be considered questionable; as there are some who still doubt if a fibrinous clot is capable of organisation under any circumstances; and there are many, who, though conceding the possibility of the occurrence, yet hesitate to admit that it can take place in fibrinous concretions of the heart when the membrane is entire and the powers of life are almost exhausted. As to the general objection, I think it necessary only to state, that branches have been distinctly traced from the parietes of vessels to clots contained within them.[1] As to that which refers particularly to the subject under consideration, I willingly admit that I have no reason to believe that organisation ever exists in fibrinous concretions without some lesion of the lining membrane of the heart; but, at the same time, I must be allowed to express my conviction, that observation by no means justifies the conclusion that these concretions are, in all cases, formed "*in extremis*." The preceding remarks refer solely to the polypoid variety.

The massive and parietal I have never seen present any other characters than those of ordinary fibrin; though some of the cases of Bouillaud and Legroux, in which vital or spontaneous changes had taken place, appear to me to have belonged to the former of these varietes.

On the changes occurring in the globular, much has been written, and different and conflicting opinions expressed. The formation of the fluid resembling pus, occasionally contained within them, has been variously explained by the different authors who have noticed the subject: thus Laennec thinks that it is probably secreted by the parietes of the cyst. Andral expresses different and contrary opinions at different parts of his works. At one part he says: "We must admit they possess an independent vitality, by means of organs they have themselves secreted":—at another he compares them to zoophytes:—again, he states, that if pus exists in other parts of the body, it has been transferred to the coagula by absorption; if not, he is unable to form a rational conjecture as to its origin: and, finally, he appears to consider the fluid merely broken

[1] Vide Carswell, 11th Fasciculus.

down fibrin. Legroux believes that it is the product of inflammation in the cyst;—Bouillaud, that it is either secreted by the heart, or absorbed from other parts of the body; and that, in either case, it forms a sort of nucleus, around which the fibrin coagulates. Dupuytren considered it produced by decomposition, the result of vital heat. Dr. George Burrows thinks it most probably dependent on degeneration of fibrin:—an opinion not materially differing from that last mentioned, and one in which I entirely concur.

I am not aware that the fluid has ever been proved, by microscopic observation, to be true pus: and since my attention has been directed to the subject, I have not had an opportunity of examining it with minute attention. I believe that true pus never exists in these concretions: I have certainly never seen any fluid in them which could be properly so represented. M. Magendie, in one of his lectures, states, that he had examined the fluid contents of a globular mass of *tubercular* matter, which was discovered, after death, entangled between the tendinous cords of one of the valves; and found the particles to differ from those of true pus. This "globular mass of tubercular mattter" I suppose was, in reality, a globular fibrinous concretion:—if so, its examination rather curiously confirms the opinion I have advanced. The formation of the variously coloured fluid may be simply explained in a few words, as follows: A concretion originally produced in the mode I have previously described, and containing many, few, or no red particles, according to the celerity or tardiness with which it originally assumed exteriorly a solid form, and more or less serum in proportion to the amount of subsequent contraction, may not merely not become adherent to the parietes by vascular connection, but may, like tubercular matter, and some inflammatory products, be incapable of organisation. Subject, therefore, to the laws of unorganised or unorganisable matter, that portion containing the most serum or first coagulated, like the fibrin effused in slow forms of pneumonia, gradually softens, and breaks down, or degenerates into a fluid, the physical characters of which depend on the materials of which the concretion was originally composed.

At the same time that the interior softens, the exterior may acquire fresh layers of fibrin, which thus produce the concentrically laminated parietes which these globular concretions not unfrequently possess. It will be seen, then, that I consider the presence of fluid within these globular cysts a proof, not of their advanced organisation, but of their incapability of being organised.

The very few words that I have to say on the subjects of the symptoms and treatment, I shall, to avoid repetition, reserve till I have made some observations.

On fibrinous concretions, the result of inflammation.

These occur in two forms, the warty and the amorphous. T warty fibrinous concretions, or, as they are usually termed " ve tations of the valves," have been so often and so accurately described, that a few words will here suffice. They differ, in shape, consistence, colour, and firmness of adherence, not only in different hearts, but in the same heart, and on the same valve. They are sometimes seen of a rounded form, with a broad base and a wrinkled surface, like a wood strawberry; or they more nearly resemble venereal warts; they may be conical, like the papillæ on the interior of the cheeks of some ruminant animals, globular, and attached by a small pedicle, oval and flattened; or may present the general appearance of small beads, or grains of wheat. Their colour varies from a dead white or whitish brown, to a semi-transparent pink, or deep violet or purple; and their consistence, from boiled white of egg and tubercular matter, to that of fibro-cartilage. When white externally, they sometimes contain a dark purple clot in the centre, or a drop of dark fluid blood. They are said, occasionally, to be purple externally, and white in the centre, and to be variously coloured on the surface; but of these conditons I cannot speak from observation. Occasionally, and particularly when large, and friable, like a mass of scrofulous matter, they are covered with a delicate membrane; but more generally they are naked, and in immediate contact with the blood. They adhere sometimes so firmly, as not to be detached without removing a portion of the membrane on which they are situated; at others, they may be scraped off with very slight pressure of the nail, or handle of the scalpel.

Of the amorphous concretions I recollect to have seen only a single recent instance; and the heart in which they occurred had been removed from the body, and macerated for some hours. They then appeared in the form of irregularly shaped masses, detached from each other, of a dirty white colour, capable of being separated into layers, but uniform throughout; at one part extended on a broad surface of the ventricle or valve to which they closely adhered, without vascular connection, varying from a line to a line and a half in thickness, and exceeding an inch in their longest transverse measurement; at another, projecting from the surface to which they were attached in a solid mass of the shape and size of the first joint of the little finger.

The situations in which the warty concretions most frequently occur, are upon the mitral and aortic valves: they are found more rarely on the lining of the left auricle, and the tendinous cords attached to the mitral valves, and still less frequently on the tricuspid and pulmonary valves. When on the mitral valves, they are usually placed along its free margin, among the attachments of the tendinous cords, or upon the upper surface of the broad curtain; and when in the situation last mentioned, it is not very uncommon, also, to find them on that portion of the left auricle immediately opposed to it. When upon the aortic valves, they are generally attached—as observed by Dr. Hodgkin and Dr. Watson—to the double festoon, extending from the extremities of the valves to the corpora sesamoidea; but sometimes to the natural free margin, or the diseased, ruptured, or ulcerated edges. When on the tendinous cords, they are almost always attached to a ruptured extremity, or an inflamed or ulcerated surface. These observations, *mutatis mutandis*, are applicable to the corresponding parts on the right side of the heart. It is, however, a curious fact—to which I have hitherto found not a single exception, which I think has not hitherto been noticed, and as to the cause of which I cannot form even a plausible conjecture—that when attached to the surfaces of the valves, they are uniformly on that side opposed to the direct current of the blood, *i. e.* upon the ventricular side of the sigmoid, and the auricular side of the mitral and tricuspid valves.

The parts to which the amorphous concretions were attached, in the case to which I have referred, were the mitral and tricuspid valves, and the parietes of all the cavities, but particularly those of the left ventricle.

The formation of warty concretions or vegetations has been ascribed to three distinct causes. Laennec regarded them as simple polypiform concretions, resulting from coagulation of the blood; and Andral thinks his opinion is probably correct. Bouillaud considers them, if not the direct, at least the indirect, product of inflammation; and Dr. Hope supposes that they originate in some peculiar condition of the blood, or particular constitution of the individual in whom they exist. My own opinion is, that they are always the direct or indirect result of inflammation, or other disease of the endocardium. It has been customary to regard the thickening of, or deposit in the valves, as the effect of endocarditis; which must, under such circumstances, be regarded as a very common disease. I am, however, disposed to think that it is, in truth, a comparatively rare affection of the heart; and that whereas thickening, puckering, and ossification are produced in the valves of the heart, as in the arteries, by inflammation or altered action of the vessels in the subserous tissues, or cellular layer below the lining membrane, warty concretions or vegetations arise, though sometimes indirectly, from inflammation of the membrane itself. That inflammation is the first step in the process of their formation, I cannot doubt, when I observe the thickened endocardium, to which they are attached, covered with a membrane which may be frequently peeled off, together with the concretions;—that they occur most frequently on the left side of the heart, and on parts most liable to inflammation;—that they are occasionally found upon parts which, from some local cause, have been attacked by, but are not ordinarily obnoxious to, inflammation; and that they often exist without more important disease than thickening, or roughness of the lining membrane. But though inflammation may be the first link in the chain of their formation, it does not therefore follow that they are always its direct product—that they are secretions, or, strictly speaking, vegetations—any more than, because phlebitis is the cause of the formation of a coagulum, it therefore follows that the inflamed vein has secreted the coagulum. I believe, then, that these vegetations or warty concretions are, at least, sometimes produced by coagulation of the blood upon the inflamed membrane. It is indeed true, that it may be difficult to account for their arrangement and form, but I conceive equally so, whether arising from coagulation or secretion. My reasons for adopting the opinion I have mentioned are the following:—

In endocarditis, the false membrane, as in serous cavities, is generally spread over the affected surfaces in a uniform regular layer; varying in thickness and texture according to the duration and intensity of the disease, and assuming the form (if of long standing) of the lining membrane of the heart itself. This membrane, if carefully sought after, may sometimes (perhaps universally) be found below the vegetations, and peeled off the endocardium, together with them. The inflamed surface is equally covered with this membrane; yet the vegetations are distributed irregularly over it; some portions being perfectly free, and no ulceration being discoverable on those spots to which they are attached, and by the vessels of which they are supposed to be secreted. Though they are certainly found upon the ruptured extremities of the tendinous cords and the ulcerated edges of the valves, yet they generally extend far beyond the ruptured extremities, and often occupy only a small portion of the ulcerated edges; neither of which circumstances would probably occur, if simple exudation was the only source from which they were derived.

What I have hitherto stated, however, is, I must allow, in a great degree conjectural, and cannot be fairly considered as proof of the truth of my position. Of a different character is, I conceive, the fact, that not unfrequently, if examined with attention, one or more of these so called vegetations will be found to be globular, attached by a pedicle to the inflamed surface, white and smooth on the exterior, soft in texture, and to contain in the centre either a little fluid blood, or a minute purple clot; to present, in fact, all the characters of globular fibrinous concretions of small size, which I cannot conceive to be secretions from an inflamed surface.

The formation of what I have termed the amorphous fibrinous concretions appears to be much more simple. Thus, I suppose, it may be easily understood, and will be generally conceded, that inflammation of the endocardium, covering either the valves or the parietes, by destroying its smooth glistening surface, may so impede the motion of the blood, or so change or modify its properties, as to induce its coagulation upon the parts affected, as upon the membrane of an inflamed vein; and that the fibrin, thus separated, may increase in extent and thickness, according to the severity and duration of the disease, the activity of the circulation, and constitutional vigour of the patient.

On the symptoms of fibrinous concretions &c.

I think it unnecessary to state the opinions of authors upon the nature of the symptoms resulting from concretions induced by retardation of the blood; as they, for the most part, agree that these bodies sometimes exist without any indications of their presence, and as they do not materially differ, as far as I have been able to ascertain, in their accounts of the sufferings to which they occasionally give rise. I may, however, remark, that M. Legroux observed, in several instances, violent symptoms of gastric irritation, without any indication of lesion of the stomach being found after death: and that he fancies, that if a sudden and notable diminution of the ordinary sounds of the heart occurs over one or more of the cavities, particularly if, coincidentally with this diminution of sound, appear the more commonly recognised symptoms of their formation, fibrinous concretions may be confidently predicted.—Dr. Hope has given, as it appears to me, a more correct account of the symptoms than any author with whom I am acquainted. He says, that if their formation is gradual—as in those concretions existing a long time before death—their presence is not easily detected; that concretions of the globular variety are often present without any symptoms; and that they are usually found in those who have been moribund for days, or even weeks, before their end;—but that if, in conjunction with an increasedly irregular and confused action of the heart, there be a sudden and excessive aggravation of dyspnœa, without any obvious cause, the patient being in agony from an intolerable sense of suffocation, remaining restless and distressed till death, with cool surface and extremities, and a livid countenance, occasionally accompanied with nausea and vomiting, the presence of a fibrinous concretion in the heart may be almost certainly predicted.—From what I have been able to collect from the records of cases I have examined, I am induced to believe that the variety I have termed polypoid may exist withot any symptoms distinguishable from those of dilatation of the cavity in which it is lodged, while it remains adherent to the parietes; but that it is sometimes the cause of instant death, by blocking up one of the apertures of the organ.

The following case, for which I am indebted to Mr. Key, may be quoted as an illustration :—

Case 2.—An odd-looking boy, aged about 11, in the London Orphan Asylum, had been rather unwell, and placed, in consequence, in the infirmary for three days, when he suddenly expired in the act of passing his fæces. A large opening was found to exist between the auricles; but the cause of death was an old and firm fibrinous concretion, the size of a pigeon's egg, which was attached to the parietes of the auricle, and had blocked up three fourths of the right auriculo-ventricular opening. It had become entangled in the cords of the tricuspid valve, and prevented the blood passing into the lungs.—There is a preparation in the Museum of the

College of Surgeons, in which a round, and apparently lamellated, concretion, as large as a pullet's egg, has been forced into the same opening of a very large heart. Death in this case was probably equally sudden, as there appears to be scarcely any opening for the passage of the blood.[1]

I can even conceive, that, in a largely dilated cavity, a body of this kind may, like the coagula in an aneurismal sac, be rather advantageous to the patient; not simply, or principally, by preventing a rupture of the cavity, but by decreasing its fluid contents, and thereby facilitating the circulation. Of the symptoms of the massive variety, I have nothing to add to the statements of Dr. Hope; excepting, that it is to this variety that I believe those symptoms more particularly belong.

The following case is so interesting, independently of the concretions, that I am induced to relate it more at length:—

Case 3—James Restall, aged 40, a man of small stature, and of melancholic temperament, came under my care in June 1836. He had formerly been, by trade, a hatter; and at that time fared badly, and drank intemperately: but for eleven years, since his marriage, he had lived more regularly; and for the last five years had been employed as a common labourer. For the whole of this latter period, he had been the subject of cough during the winter; and for about six months had observed a pulsating on the right side of the neck. A month before I saw him, he for the first time experienced pain of the chest: the tumour increased in size, and the cough in severity. When first seen, there existed a soft pulsating tumour above the right clavicle, to the outer side of the sterno-clavicular articulation: he had no disphagia, nor was the tumour materially affected by the act of swallowing: there was no tenderness about the part, or redness of the skin, which moved freely over it. He was himself sensible of the pulsation; was unable to assume a perfectly recumbent position; and was often obliged quickly to get up, from a sense of impending suffocation; his cough was frequent and short, with muco-purulent expectoration: dyspnœa, when quiet, was not considerable; and he walked slowly, without much inconvenience: but he frequently suffered from palpitation, with pain between the scapulæ, or of the right shoulder; the complexion was sallow and muddy; the countenance expressive of distress: the features shrunk: the tongue natural; and the pulse 120, regular, but extremely feeble.

Physical symptoms.—The chest was tolerably resonant on percussion, excepting at the upper part of the sternum, below the clavicle, and over the right scapulæ, where considerable dulness existed. The respiratory murmur was feeble, but natural on the left side; but upon the right side was quite obscured by a loud, harsh bronchial rhoncus, arising apparently from pressure. The voice was hollow and sepulchral, and below the right clavicle was

[1] It is among the unarranged preparations, and has no number attached to it.

considerably louder than natural. There was no unusual dulness in the præcordial region: the sounds of the heart were feeble, but pure: the rhythm natural, and the impulse was exceedingly small. There was no bruit or impulse on the right side, or over the first bone of the sternum, but the sounds of the heart were here heard with unnatural distinctness. These symptoms led me to form the following diagnosis:—"Aneurism of the arteria innominata—enlarged arch of aorta—tubercular consolidation of apex of right lung—a weak, feeble heart, with little or no valvular disease." Rest and abstinence, with mild sedatives and diuretics, occasional aperients, and a belladonna plaster, were prescribed.

About a fortnight after, on awaking one morning, he found the tumour had entirely disappeared. On diligent examination, no tumour could be found, nor was ever after discovered, either behind the clavicles or sternum; and the only apparent remains of it existed in the evidently larger size and fuller pulsation of the right than the left subclavian artery, as it passed over the first rib. At the same time, however, the dyspnœa became troublesome; the act of swallowing impeded and difficult; the expectoration considerably more abundant, and more decidedly purulent; and, a few days after, was, for two or three days, streaked with blood. He now began to waste rapidly; his features became pointed; his countenance more anxious; and his general appearance was that of a person in advanced phthisis. Sulphuric acid during the day—hydrochlorate of morphia at night—frequently repeated blisters below the right clavicle, in consequence of the pain, now pretty constantly experienced, afforded him considerable relief;—and no particular change occurred till Sept. 28th, when his dyspnœa became distressing, and orthopnœa occurred in more frequent paroxysms; and he was frequently convulsed during his sleep, till he was relieved by expectorating, with several violent fits of coughing, about six ounces of a thick viscid muco-purulent matter of a dingy-red or rust colour, from the admixture and thorough incorporation of blood. It was observed, that this did not consist of one perfectly cohering mass, but that the different portions remained partially separate, like the rounded pellets expectorated in some cases of phthisis, and appeared, in fact, to be the sputa of a chronic pneumonia. The chest was still resonant on percussion, except at the parts formerly noticed. Under the right clavicle, a loud harsh rhoncus was still heard, and bronchophony, but no pectoriloquism, was discernible. The diagnosis was now somewhat modified, chronic pneumonia being considered the cause of the consolidation of the lung. He was now ordered mild expectorants; and the little digitalis, which he had previously taken in a diuretic mixture, was withdrawn in consequence of his increasing debility.

Oct. 4. The expectoration was now, and for a day or two had been, muco-purulent, without the slightest trace of blood: still, by the slight examination practicable in his debilitated condition, together with the quickness of his respiration, and the consequent weakness of his voice, no pectoriloquism could be discovered.

Oct. 5. He was seized with increased distress of respiration, gasping, and constant sense of suffocation; he could not speak, and could scarcely swallow: his aspect was wild: his eyelids widely separated: his countenance anxious in the extreme, and the pulse scarcely perceptible. Stimulants were freely administered, but without effect, as, after lying in a state of extreme distress and constant restlessness for twenty-four hours he expired.

SECTIO CADAVERIS, twenty-four hours after death.—The body was much emaciated, and without any appearance of œdema. The chest alone was examined. On the right side, the pleura was not adherent, and contained but little fluid. The whole of the upper lobe of the lung was consolidated, and scarcely permeable by air. It was soft, pulpy, easily lacerable by slight pressure of the finger, of a dark-olive reddish-brown colour, with a few just-softening tubercles sprinkled throughout its whole extent. Nearly in the centre was an irregular cavity, almost capable, if distended, of containing a pullet's egg. It was without lining membrane, its surface being flocculent, its parietes loose and soft, and of a dirty olive colour, but without any fetor. It contained a little dark brown fluid, similar to that which escaped from the cut surface of the lung on pressure. The lower lobes were very œdematous; and the bronchial tubes yielded, by pressure, an abundant supply of muco-purulent fluid. These portions of lung were not consolidated at any part; and contained no tubercles, in any stage. The pleura on the left side was not adherent, and contained about half a pint of dark-coloured serum: the lungs posteriorly were in a state of congestion and softening, arising probably from gravitation; the lower lobe was partly emphysematous, and in part distended by œdema: the bronchial tubes here also contained much puriform mucus; and their lining membrane was thickened, and dark from injection; no tubercles were discovered. In the front of the trachea, the lining membrane of which was otherwise tolerably healthy, was an ulcerated opening, about the size of a goose quill, filled up by fibrin, and communicating with an aneurism of the aorta. The pericardium was healthy; the heart natural in size and colour, but soft in texture, and easily broken down by pressure. The pulmonary valves were healthy, excepting the presence of the rudiment of a fourth curtain; the tricuspid and aortic were also free from disease; but the mitral was rather thicker, and less transparent, than in the normal condition. In both ventricles, independently of and unattached to, the common soft coagula constantly found in the heart was a thin and flat fibrinous concretion, quite opaque, firm, and of a pinkish-white colour, easily separable into fibrous bands like muscle, and presenting, on the transverse section, a spotted surface, somewhat resembling a divided nerve. They were both adherent, not simply by entering into the depressions and anfractuosities of the muscular parietes, and mixing with the tendons, of the valves, but also to plain surfaces, from which they separated like false membrane, or paper moistened with thin gum and water: they passed only a short way into the auricles, and were quite distinct from the coagulated blood which distended all the cavities. The ascending portion and arch of the aorta were much dilated and diseased; their lining membrane being wrinkled and puckered, and having beneath it patches of soft opaque yellow matter at some parts, and, at others, spots of bony deposit. The arteria innominata was dilated to the size of a mould candle, and the right subclavian was as large as the little finger of an adult; the right carotid appeared natural. From within the opening of the innominata proceeded two aneurismal pouches; one turning to the right from the lower part of the artery, about the size of a chestnut; the other partly arising from the arch of the aorta, passing to the left, and as large as a hen's egg, pressing upon and opening into the trachea. Passing on in the course of the aorta, the left carotid was found to have no opening communicating with its parent trunk: a puckered depression alone marking the situation where it formerly existed; the artery, in other respects, though small, appeared healthy. Close to the origin and to the left of the left subclavian was a third aneurism the size of a walnut; the coagulum contained within which had so pressed upon the root of the subclavian, as completely to close its communication with the aorta. The artery itself was about the size of a goose-quill. All the aneurismal sacs contained a firm pale pink coagulum adherent to their parietes.

This case is interesting in many particulars. When first presented to my notice, I had little hesitation in putting it down as aneurism of the innominata, with diseased aorta; for though no impulse or bruit could be discovered at the upper part of the chest —which may, I conceive, be satisfactorily accounted for by the feeble contractile power of the heart—independently of the evident pulsation of the tumour itself, the dingy complexion so frequently observed in diseases of the primitive vessels, the increased sound of the heart in the track of the aorta, and the general symptoms, appeared sufficiently to characterise the complaint. The sudden disappearance of the tumour, however, seemed at first to throw some doubt upon the accuracy of this diagnosis; for though such swellings occasionally subside by a gradual process of natural cure, it is, I believe, rare for them suddenly to disperse, at least without the simultaneous appearance of severe and even dangerous symptoms. Two explanations occurred to me at the time; first, it was possible that no aneurism had ever existed, but that an abscess of the anterior mediastinum had been for some time formed:—that, from its increase in size, a portion of its contents had passed above the clavicle; and that it had there received an impulse from the large arteries upon which it rested;—that this abscess had burst into the right bronchus, a portion of its contents had been expectorated, and the subsidence of the tumour had been the result:—with this explanation coincided the simultaneous increase and puriform character of the sputa. The other, and the more probable explanation was, that another and a larger sac had been formed in the course of the aorta; by the distention of which with blood, in consequence of the feeble state of the circulation, the smaller sac had been emptied, and had, in consequence, collapsed and contracted. This, I say, appeared the more probable explanation: but was again rendered doubtful by the streaks of blood in the expectoration, two or three days after; and still more so by the sudden expectoration of a large quantity of viscid sanguineous puriform mucus; which, though quite compatible with both views, was more consonant with that of abscess.—The perfect occlusion of the mouth of a large artery, though far from unprecedented in cases of aneurism, is by no means very common. An instance of the same kind in which the mouth of the same artery was very nearly closed, occurred, several years ago, in a woman operated on by Mr. Key for aneurism of the innominata. Since the occurrence of this, I have been informed, by a justly celebrated morbid anatomist, that a similar state of parts is not very unfrequent. The explanation of the circumstance is not, I think, very easy; and the only one I have heard advanced is the following:—The mouth of the artery is not dilated to an extent corresponding to that of the trunk from which it opens: when, therefore, a portion of the trunk yields, and a sac is formed, and the trunk itself consequently contracts, a puckering and narrowing of the mouth is produced, which favours if it does not cause its absolute occlusion. In the case related, however, the left sub-clavian, as well as the carotid, had been recently—though, I think, perfectly and permanently—closed; the consequence of which, had the man lived, would probably have been gangrene of the arm; as the carotid, from which it must have received its principal supply, was itself furnished with blood by anastomosis.

I have only to observe, in reference to the fibrinous concretions, that they belong to that variety which I have termed the Massive; and that I conceive there can be little doubt, from the circumstances I have mentioned, connected with them, that they were formed before death. Whether they were the cause or the consequence of the extremely distressing condition to which the poor man was reduced, in the last twenty-four hours of his existence, I am, of course, unable to determine: but, from the exceedingly feeble circulation, the great obstruction to the flow of blood, the consistence of the heart itself, and the sudden appearance of the aggravated severity of his symptoms, or, more properly, of the indications of approaching death, I have no hesitation in expressing my opinion, that they were really the cause of that condition.

The particulars of the only instance I have seen of the Parietal variety are related in the following case:—

Case 4.—A short stout man, aged 28, suffering from catarrh, was observed, about a week before his death, to have a very irregular pulse—his countenance was slightly suffused and anxious—he complained of oppression at the scrobiculus cordis, and severe pain across the loins. There was not extensive dulness of the pericordial region; but the impulse of the heart was felt over a larger space than usual, and was considerably increased below the ensiform cartilage: the sounds were soft and indistinct. The day before his death he complained of severe pain in the præcordial region, and suffered from paroxysms of intense dyspnœa; during which he moaned piteously, and was purple in the face. During the intermissions of these paroxysms, he lay on his back, rather inclined to the right side; breathed freely, and filled his chest without distress; the face was pale, with a slight purple tinge. He expired in the evening, in one of the paroxysms. On examination after death the left pleura was found to contain about half a pint of clear serum—a little emphysema existed at the edges of the right lung—the bronchial membrane was generally inflamed, and the left bronchus flattened by compression—the pericardium was universally adherent by loose cellular membrane. The heart was enlarged; and between the muscular parietes and pericardium was a layer, varying from one and a half to two lines in thickness, of a reddish-yellow adipose substance. All the cavities of the organ were dilated; and the left ventricle was also hypertrophied. They were all filled with soft purple, easily separable coagula; but the left ventricle was also lined with a firm, yellow, fibrinous coating, which mingled with, and was slightly adherent to the columnæ carnæ; and composed of bands, which by their arrangement presented the general appearance of the interior of the ventricle: the mitral and aortic valves were thickened, and the aorta about one third less in size than the pulmonary artery.

Concretions belonging to the Globular variety are generally productive of few or no symptoms, and occur only in those who are moribund for a considerable time:—

Case 5.—A man aged about 50, with considerable deformity of the chest, suffered from dyspnœa and anasarca; but the exhausted state in which he lay for some days before his death prohibited any examination by auscultation. After death, the lungs were found very generally consolidated by pulmonary apoplexy; the heart was much dilated; and the cavities, particularly the right auricle and left ventricle, contained several cystiform coagula, the exterior of which was membranous and reticulated, and the interior soft and grumous; they were particularly abundant in the dilated apex of the ventricle, and adhered slightly to the lining membrane. Some of the natural depressions also of the heart were filled with small rounded masses of fibrin of the same general character.

Case 6.—A mountebank, aged 48, was admitted into the hospital, in an exceedingly feeble condition. He rallied a little by the use of stimulants, but afterwards sank from exhaustion. On examination, the heart was found to be slightly dilated; the left ventricle contained defined rounded coagula, of a light colour, soft and grumous internally, and firmly attached to the surface; one of them was situated quite in the apex of the cavity.

Case 7.—An old man with disease of the chest lay for a long time before death in a sinking state; the lungs were found to be generally consolidated from gray hepatisation and tubercular deposit; the heart was dilated. After the recent coagulum had been removed from the right ventricle, a grumous lilac-coloured fluid was observed to escape from the apex; and was found to have proceeded from a round cystiform coagulum of the same colour, and about the size of a large marble, lodged in the extremity of the cavity.

Case 8.—A woman, aged 41, suffered from the ordinary symptoms of diseased heart, and considerable accumulation of fluid in the abdomen. She was tapped; had hæmoptysis, and was exceedingly exhausted, after the operation; and died in about a week. On examination, both pleuræ were found to contain a considerable quantity of serum; and in the lungs were several consolidated masses, the result of pulmonary apoplexy. The pericardium contained about half a pint of serum; and was much thickened, and opaque. The muscular structure of the heart was paler and firmer than natural, and between its fibres contained a dense white deposit, which gave it a mottled appearance: the lining membrane was mottled with white spots: the left ventricle was immensely dilated, being at least three times its ordinary size: the mitral and aortic valves were opaque and thickened, and the aorta itself was small: portions of fibrin, of a rounded form, adhered to the parietes, and were lodged in the depressions of the left ventricle; some of which were solid; others cystiform, and contained a thick dirty-white turbid fluid.

In the following case, the severe and sudden paroxysms of dyspnœa may possibly have been connected with the concretion found in the left auricle:—

Case 9.—A man, aged 42, had suffered for six years from symptoms of diseased heart, following rheumatism, to which he had been subject from childhood. A few days before his death he was attacked with paroxysms of fainting, cold perspiration, and severe dyspnœa, with feeling of imminent suffocation; during which his attendants thought him dying; but after which he regained his usual comparatively quiet condition. He was temporarily relieved by sinapisms and stimulants; but the fits afterwards returned with greater frequency and severity, and in one of them he threw himself out of his chair and expired on the floor. The lungs were not much diseased. The pericardium was universally adherent. Between it and the muscular parietes of the heart were several plates of cartilage, interspersed with specks of bone; and at other parts, a layer, half a line thick, of an opaque dense yellow substance. The heart was much dilated, and its cavities distended with soft purple coagula. The appendix of the left auricle was filled with a firm, brownish concretion, which was adherent only at the very extremity, and presented a rounded projection towards the general cavity. A section presented a party coloured surface, not unlike some specimens of fungus; and exposed three or four irregular cavities, some of which were filled with a purple, and others with a cream coloured fluid. The mitral and aortic valves were very much ossified.

I am not acquainted with any symptoms by which concretions of long standing, resulting from inflammation, can be certainly distinguished from the more common diseases of the valves. But if, in the course of endocarditis, the natural sounds of the heart were suddenly decreased, and a soft bellows murmur, which had not previously existed, supplied their place, and there were indications of unusual obstruction to the circulation and consequent general distress, I should be induced to suspect their formation. I may also state, that, even in chronic cases, I have sometimes been enabled to predict their existence, if large or extensively deposited, by an unusual coldness and blueness of the nose and extremities supervening more quickly upon the original attack, and being more marked and decided than could be otherwise explained by the physical signs afforded by the heart, and by the abnormal sounds being less harsh and strong than in ordinary disease of the valves. I think this may be, perhaps, understood, when it is recollected that this condition of the valves is probably produced in a much shorter time than is required for extensive cartilaginous or ossific deposit in the parts affected; and, consequently, that the parietes of the ventricle have not become thickened, nor the vessels dilated, to a degree proportionable to the amount of obstruction, as in diseases of slower progress and longer duration. Of the two following cases, the former illustrates the history of amorphous concretions; and the latter is introduced for the purpose of supporting the statements I have made in reference to the symptoms resulting from warty concretions.

Case 10.—A thin, delicate girl, aged 17, came under my notice, as a patient of the late Dr. Cholmeley, in Guy's Hospital; when her face was pale; her feet, hands, and nose cold, and of a purplish leaden hue. The respiration was not particularly laborious, though very frequent—46 in the minute. Dyspnœa and palpitation occurred on the slightest exertion or excitement; and she was unable to lie down in her bed, or to turn on the right side. She had much soreness, on motion, at the scrobiculus cordis, and tenderness on pressure there, in the intercostal spaces of the præcordial region, and over the inferior part of the right side of the chest. The tongue was clean and moist; the bowels open, without medicine; the urine scanty; and there existed slight œdema of the feet: the pulse was 120, small, and very feeble; and the skin, except at the parts previously mentioned, warm and dry. The resonance of the chest, generally, was tolerably good; but considerable dulness on percussion, existed over the inferior part of the right side. Here, also, the respiration, which at other parts was tolerably natural, was deficient, and accompanied by a sibilous rattle; and there existed increased resonance, and unnatural shrillness of the voice. The impulse of the heart was feeble; the rhythm natural; the first sound was clear, but not loud; the second was indistinct.—She was ordered stimulant diuretics, and small doses of mercury; and to be cupped to four ounces, in the region of the heart. She was much relieved by the cupping; which was performed two days after her admission, and was succeeded by a blister. For about ten days she was much better; was able to lie down in her bed; and was but rarely attacked with paroxysms of dyspnœa. After the expiration of that time she became troubled with a feeling of suffocation, which prevented sleep and recumbency; and though she could then turn to either side, the tenderness in the left reappeared; the skin was hot; the impulse of the heart stronger, and jerking; the pulse frequent, and weak; and the extremities were still cold. She was again cupped, with relief; and afterwards ordered digitalis, but was soon after removed by her friends. During the three weeks she afterwards lived, I saw her only occasionally; but I am not aware that any fresh symptoms appeared, excepting that evidence of effusion in the right pleura became more decided, and that her back became sore from lying in bed. It is remarkable, that while she was capable of bearing an examination of the chest no morbid sounds were observed in the heart during the whole of her illness.

The body was examined by Dr. Barlow; who favoured me with a view of the heart, and some of the following particulars:—Chest: on both sides, the pleura were partially united by old cellular adhesions, and by some recently effused plastic lymph; and on both, but particularly on the right side, there was a considerable quantity of serum. The lungs were healthy. The pericardium was universally adherent, through the medium of firm solid lymph, which allowed of the easy separation of the two folds of the membrane. The heart was of natural size; and its muscular walls not much changed, but rather pale and flabby. The lining membrane was thick, rough, opaque, and injected; and attached to it, in both the auricles, and ventricles, particularly on the left side, were flat irregularly-shaped masses of firm opaque fibrin, some of them of considerable size. They were particularly abundant among the tendons of the auriculo-ventricular valve. To the mitral was attached a portion, of the shape and size of the first joint of the little finger, which projected into the ventricle; and which, like most of the other masses, was fairly adherent to the lining membrane itself, and possessed many of the physical characters of muscular fibre. With the exceptions already mentioned, the valves on the right side appeared pretty healthy; those of the aorta were slightly thickened and opaque; the mitral was thickened, contracted, and corrugated near its free margin, but yet appeared large enough to close the opening to which it was attached, which would scarcely allow of the passage of the little finger. The aorta was exceedingly small, but not diseased.

Case 11.—A large and muscular woman, aged 25, after two attacks of rheumatism, was troubled with dyspnœa and palpitation on exertion or excitement. When she was admitted into Guy's Hospital, independently of the general symptoms of diseased heart, the extremities were cool; the lips and tip of the nose purple and cold; the respiration was laborious, and the pulse scarcely perceptible; the resonance of the chest on percussion generally deficient, but there was no unusual dulness of the præcordial region. The impulse of the heart was rather great, the rhythm natural, and the sounds indistinct; the first being followed by a soft bellows murmur. She died suddenly on the following morning.—On examination, the pleuræ were found adherent, and the lungs much congested, and interspersed with consolidated masses from pulmonary apoplexy. The pericardium was healthy. The heart was rather larger than natural; the right ventricle being rather dilated, and the left slightly hypertrophied. The pulmonary and tricuspid valve were rather thickened; and upon the upper surface of the latter were some warty concretions. The mitral valve was thick, rigid, and contracted; and the aortic valves were opaque, and less flexible than natural. Upon all of these, attached to the surface opposed to the direct current of the blood, were scattered warty concretions; some with a smooth, others with an uneven surface, varying in consistence from that of boiled albumen to fibro-cartilage. Some were not merely soft, but friable; and composed of small granules, of a dead-white and tawny colour; one of these, as large as half an almond, appeared to be covered with a membrane, and depended from one of the aortic valves into the ventricle. The aorta itself was not healthy.

Of the treatment very little need be said; as it is obvious that, in the forms of concretion dependent on retardation, when the symptoms are decided in their character, little can be effected by medicine; and that sinapisms externally and stimulants internally, are the remedies imperatively demanded by the condition of the patient. Should any amount of reaction occur, it may become a question if a small abstraction of blood may not be desirable; and whether, together with stimulants, the salts of potass and soda may be advantageously administered; as, according to Magendie and others, they not only possess the power of dissolving fibrin, but of decreasing its coagulability. Dupuytren is stated to have caused the absorption of coagula in aneurismal sacs, by the internal and external use of acetate of lead. Should this be confirmed by the experience of others, it might possibly be employed with benefit in the cases now under consideration.

In the inflammatory species, the remedies adapted to the cure of endocarditis, particularly the free but careful employment of mercury, are clearly indicated as long as any evidence of inflammatory action exists. When it has been subdued, it is doubtful if much can be effected to produce absorption or solution; but mercury should still be carefully administered; and liq. potass. or the salts of potass and soda, may certainly here be prescribed, not only with safety, but advantage; as, if they have no effect in dissolving the fibrin already coagulated, or in preventing its further coagulation, they will act beneficially, by increasing the secretion of urine, which is generally deficient, and removing disorders of the stomach which are commonly present in all diseases of the heart.

Note.—Since this paper has been to the press, I have seen in the Medical Gazette of March 9th, a brief account of some experiments made by Mr. Gulliver, which amply confirm the opinion I have expressed above. Justice, however, demands that I should state, that Dr. Addison has for some years strongly insisted upon this softening of fibrin giving rise to the puriform fluid found in the veins of persons affected with phlegmasia dolens; and that Dr. George Burrows, in his Croonian Lectures, published in the 15th volume of the Medical Gazette, mentions some experiments which he had made, and which he adduced iu support of his opinions.

PRIZE THESIS.

DISSERTATION

ON THE

PHYSIOLOGICAL INFERENCES

TO BE DEDUCED FROM THE

STRUCTURE OF THE NERVOUS SYSTEM IN THE INVERTEBRATED CLASSES OF ANIMALS.

BY WILLIAM B. CARPENTER, M. D., M. R. C. S.[1]

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To JOHN BISHOP ESTLIN, Esq.

M. R. C. S., F. L. S.

TO WHOSE KINDNESS THE AUTHOR IS INDEBTED FOR HIS ENTRANCE INTO THE PROFESSION OF WHICH IT IS HIS PRIVILEGE TO BE A MEMBER, TO WHOSE JUDICIOUS GUIDANCE HE OWES MUCH OF HIS SUBSEQUENT SUCCESS, AND ON WHOSE TRIED FRIENDSHIP HE RELIES WITH CONFIDENCE FOR THE FUTURE, THIS THESIS IS DEDICATED BY HIS GRATEFUL AND ATTACHED PUPIL.

INTRODUCTORY REMARKS.

THE department of physiology, which embraces the phenomena of the nervous system, is universally confessed to be so difficult, that it needs all the light which can be brought to bear upon it from any quarter, for its perfect elucidation. Amongst the sources of information which lie open to the enquirer, comparative anatomy is certainly among the chief; and it is perhaps to be wondered at, that more use has not been made of the data which it supplies. It has been with the view of bringing together the results of the investigations of various recent labourers in this extensive field, in such a form as to admit of comparison and generalisation, that the present essay has been undertaken. One of the principal objects which the author has kept in view, has been to ascertain how far Dr. M. Hall's doctrine, regarding the distinctness of the *excito-motor* from the *sensori-volitional* system of nerves, accords with the data furnished by comparative anatomy. It will be seen from

[1] Published as a separate work. 8vo, pp. 83. Edinb., 1839.

the concluding summary, that the author has thus been led to an affirmative opinion on this question; and he gladly avails himself of this opportunity of giving publicity to the result of his enquiries. That he formerly withheld his assent from this part of Dr. M. Hall's doctrines, was solely because he did not consider them substantiated by the evidence adduced by that gentleman in their support; and his opinion on this point remains unchanged.

In the following essay is embodied the principal part of the dissertation read by the author before the Royal Medical Society, on the evening of March 15th. With regard to the anatomical details which occur in it, the author can lay no claim to originality, (with the exception of the description of the structure of the ganglia in the articulata, § 76); since they are selected from recent systematic works, and from the memoirs on the subject, with which the extended spirit of enquiry that is now so prevalent has caused the transactions of various societies, both British and foreign, to abound. These memoirs, however, usually concern but a single class of animals, and sometimes but a single species; and the details given have reference, more to the particular functions of the beings described, than to the general physiology of the nervous system. In many instances, therefore, the author has given a very different form to the descriptions, (still, he hopes, preserving their accuracy,) for the purpose of bringing them into comparison; and whatever merit this essay may possess, must be looked for, therefore, in the comprehensiveness of the survey which has been taken, and the probability of the inferences drawn from the facts brought under consideration.

The following are the chief sources from which the author has derived his information:—

General Treatises.

Grant's Outlines of Comparative Anatomy.

Leuret, sur l'Anatomie Comparée du Système Nerveux.

Rymer Jones's Outline of the Animal Kingdom.

Dugès, Traité de Physiologie Comparée.

Müller's Physiology, translated by Baly.

Memoirs on Special Departments.

Echinodermata. Sharpey in Cyclop. of Anat. and Phys.

Mollusca. Cuvier, Mémoires sur les Mollusques, Garner in Linnæan Transactions, Vol. XVII.

Deshayes on Conchifera, in Cycl. of Anat.

Rymer Jones on Gasteropoda, in do.

Owen on Cephalopoda, in do.

Owen's Memoir on Nautilus Pompilius.

Articulata. Newport in Phil. Trans. 1832, 1834, 1836.

Burmeister on Entomology (translated by Shuckhard.)

Lacordaire, introduction à l'Entomologie.

Milne-Edwards on Crustacea.
Owen on Entozoa.
Audouin on Arachnida.
Milne-Edwards on Annelida. } Cyclopædia of Anatomy and Physiology.

On the *Sympathetic* and *Stomato-gastric* System.
Müller in Nova Acta Curios. Nat. Vol. XIV.
Brandt in Ann. des Sci. Nat. NS. Zool. tom. v.

ON THE PHYSIOLOGICAL INFERENCES, &c.

I. ON THE SUPPOSED NERVOUS SYSTEM OF PLANTS.

1. Few physiologists who have given such attention to the subject as to be competent judges of the question, now maintain the existence of a nervous system in vegetables. No traces of such a structure can be detected by the anatomist, who is able to analyse the tissues of plants, in the higher orders at least, with much greater certainty than those of the lowest tribes of animals. Nor is there any thing in the phenomena of life presented by them which need induce the philosophic physiologist to infer the presence of a structure which cannot be demonstrated to the senses. The belief that *vitality*, or the capability of exhibiting those actions which collectively form life, is dependent upon a nervous structure must be regarded as a remnant of the exploded system of the vitalists, which was scarcely less erroneous, as a general theory, than the hypothesis of the chemical and mechanical philosophers, in opposition to which it was first erected. We observe a seed, which consists but of an aggregation of vesicles, appropriating to itself, when placed in circumstances favourable to its growth, the nutrient materials supplied by the surrounding elements, and developing itself into a perfect plant; and we watch this plant performing all the changes involved in the functions of nutrition, secretion and reproduction, by the exercise of the properties which its tissues and organs respectively possess. To suppose that these changes are *governed* by a nervous system, *because* a nervous system is found *associated* with the organs which perform them in the animal kingdom, is obviously an unphilosophical hypothesis. We have no right to assume causes whose presence we cannot discover; and we should be led rather to question the *essential* nature of their operation in the second case, from finding them absent in the first, than to argue, from their supposed operation in the second, that they must also be efficient in the first.

2. If we were to carry out this train of reasoning, we should be brought to admit that something like a "diffused nervous system" exists in every particle of matter, inorganic as well as organic; since there is no doubt that many of the actions of the living economy are of a strictly physical nature, and that many, if not all,

of the changes in its composition involve the operation of chemical laws; and if these result from "nervous agency" in one case, by parity of reasoning, they must also in every other. This would bring us back to the old doctrine of the "Life of the World," which has not wanted some recent advocates among those who prefer a philosophy of "cloudy vastness," to one of defined outline and complete detail.

3. The truth appears rather to be, that every particle of matter is endowed with properties of various kinds of which some manifest themselves under the simple conditions which the ordinary changes in the inorganic world supply, and thus perform the actions termed *chemical* and *physical;* whilst others can only be called into play under conditions of a more complex nature, which are only supplied by a living organised system, where many particles being combined by a previously existing life into one structure, exhibit actions of a peculiar character, dissimilar to any they have heretofore presented, which are denominated *vital*. There can be no doubt that, where a nervous system exists, the vital actions of the being are *influenced* by it; but it would require evidence of a different character from any that has yet been adduced to prove that they are dependent upon it; and the *onus probandi* certainly rests with those who maintain a doctrine so contrary to the analogy furnished by a large proportion of the animated world.

II. NERVOUS SYSTEM IN THE LOWEST ANIMALS.

4. It is obvious that just ideas on the foregoing subject should lie at the very foundation of our system of nervous physiology; and they will even influence our views of its anatomical character. For in the extensive group of acrita, in which are associated the lowest of all the types of structure presented in the higher forms of the animal kingdom, the existence of a "diffused nervous system" is commonly regarded by naturalists as the necessary alternative resulting from the want of any definite indications of its presence. Many well-informed physiologists even have fallen into this error for such we must regard it; and it may be worth while to enquire into the basis upon which it rests.

5. Is a nervous system essential to endow the tissues of these beings with *contractility?* We cannot so regard it, since we find that property possessed in a high degree by the tissues of many plants, to which these beings bear a much greater *general* resemblance than they do to the higher animals; and we have also reason to regard this property as independent of nervous agency, although generally called into exercise by it, even in the highest of the latter group. Nevertheless, a physiologist of some reputation has recently spoken of the tissue of the acrita as consisting of a union of the nervous and muscular structures in a "diffused form," denominating it *tissu neuro-myaire*.[1] That a nervous system is not required by

[1] Dugès, Physiologie Comparée, tom. i. p. 72.

them for the performance of the functions of nutrition and reproduction, otherwise than to supply, by its locomotive actions, the conditions of those functions would appear from what has been already stated.

6. If these phenomena do not constitute any evidence for the existence of a nervous system in such beings, it may be reasonably enquired what ground we have for placing them in the animal kingdom. All our reason for attributing to them *sensibility* is derived from the movements which they execute in respondence to external stimuli; but such movements are also executed by the dionæa and sensitive plant. But some of their actions appear to show a certain degree of voluntary power, and therefore of consciousness; being independent, so far as can be ascertained, of the operation of external stimuli. Moreover, we often see an impression made upon one part (one of the tentacula of the hydra, for example,) propagated to distant parts, and exciting respondent movements in them, more rapidly than we could imagine to occur without such a channel of communication as a nervous system *only* is known to afford. These phenomena, then, would lead us to suspect the existence of a nervous system in beings that exhibit them; *not*, however, in a diffused condition, but in the form of connected filaments. For what consentaneousness of action can be looked for in a being whose nervous matter is incorporated in the state of isolated globules with its tissues? How should an impression made on one part be propagated by these to a distance? And how can that consciousness and will, which are one in each individual, exist in so many unconnected particles? The essential character of a nervous system is its capability of conducting excitor and sensory impressions *to* a centre, and motor impulses *from* it; and this cannot be effected by any such structure as the one imagined to exist in these beings. As well might we say that a "diffused" circulating system exists, where every part of the tissues is in equal contact with the surrounding medium, and equally performs the functions of absorption, assimilation, and excretion.

7. If, then, we allow any sensibility, consciousness, and voluntary power to the beings of this group—to deny which would be in effect to exclude them from the animal kingdom—we must regard these faculties as associated with *nervous filaments* of such delicacy as to elude our means of research; and, when the general softness of their textures, and the laxity of structure which characterises the nervous filaments in the lowest animals in which they *can* be traced,[1] are kept in view, little difficulty need be felt in accounting for their

[1] Thus in the conchiferous mollusca, the sheaths of the nerves are so loose and the filaments they enclose have so little tenacity, that they were mistaken by Poli for lymphatic vessels, and the ganglia for receptacula chyli. Having been injected by him with mercury, they were beautifully figured under this character in his splendid work, Testacea utriusque Siciliæ.

apparent absence.[1] The case is very different from that of plants, in which the negative evidence afforded by anatomical research is far more to be relied on.

8. The only animal among the polypifera in which a nervous system has been stated to exist, is the common *actinia,* or sea-anemone. A description of a series of ganglia and diverging filaments, connected with the muscular base, was given by Spix;[2] but it is now generally agreed by competent observers, who have searched for it in vain, that the account is erroneous, and that no nervous filaments can be detected in that situation. Very considerable muscular power is exercised, however, by the tentacula and muscular integument of the sea-anemone; and *that* with a consentaneousness which strongly indicates the combining or *internuncial* power of a nervous system. From the analogy of the radiated classes, to which this animal approaches, we should be rather led to search for nervous structure around the entrance to the digestive cavity; and professor Jones[3] has recently described a delicate filament which he suspects to be of this character, running round the roots of the tentacula, and imbedded in a strong circular band of muscle, which surrounds the orifice of the stomach, and acts the part of a powerful sphincter in closing the aperture.

9. There has been much vagueness in the comparisons frequently drawn between the springs of action in these creatures, and the agents which operate in higher animals. And this may be attributed to the tendency which is prevalent among many physiologists to grasp at a superficial resemblance, instead of seeking for a more fundamental analogy. Thus, some naturalists seem by their language to imply that the little *hydra viridis*, or green polype, possesses as much sensibility and is as completely under the guidance of volition, as man himself. But what is the character of this interesting little being? It is *a stomach*, the orifice of which is provided with tentacula, that contract when irritated by the touch of any adjacent body, and endeavour to draw it towards the entrance. To what action in the human body is this most allied? Evidently to that of the muscles of deglutition, over which we know, that *will* has no power, and whose actions probably do not even involve sensation, being of a simple *reflex* character. These like the tentacula of the hydra, contract upon whatever is brought within their sphere, and convey it to the orifice of the stomach; the only difference is that, in man and the higher

[1] An interesting fact has lately been communicated to the author by his friend Mr. Edward Forbes, in regard to this question. Having collected a number of specimens of *cydippe* (Beroe) *pileus*,—an animal in which a nervous ring has been stated by some to exist, and by others to be absent,—he was led to remark that extremely slight variations in the transparency of the individuals, and in the light in which they were viewed, would occasion the presence or absence of the filaments to be decided on by the observer.

[2] Annales du Muséum, tom. xiii.

[3] Op. cit. p. 43.

animals, another set of muscles is superadded to these, in order to prepare the aliment for the operations of the stomach and to bring it *within reach* of the pharyngeal constriction. But it may be urged, does not the inactivity of the tentacula, when the hydra is gorged with food, prove that they are excited to action by the will of the animal? We think not; and for these reasons:—The cavity of the stomach is evidently continued into the arms; and it is evident that, when the former is distended, the tissues of the latter also will be gorged with fluid. It is easy to imagine that this condition may be unfavourable to the exercise of their contractility; just as the distention of the tissues of a plant, by any check offered to the function of exhalation, speedily suspends their absorbent action. But we have a still more satisfactory explanation in the fact, that the muscles of deglutition in man are not called into action nearly so readily and energetically when the stomach is distended, as when it is empty—a fact of which any one may convince himself by observing the relative facility of swallowing at the commencement and termination of a full meal. No one will assert that *this* variation is an effect of the will; indeed, it is often opposed to it, being one of those beautiful adaptations by which the welfare of the economy is provided for, but which the indulgence of the sensual appetites opposes. Most of the movements of this animal, and of others of the class, appear to be equally the result of external stimuli with that already described; and it is only in a few instances, principally those of absolute locomotion or change of place, that any evidence of voluntary action can be discerned. There is no doubt that many of these movements are influenced by light; but it may be questioned whether the animal is conscious of its presence *as light*, or whether it may not be acted on by this stimulus somewhat in the same manner as plants are known to be, which grow towards it.

III. NERVOUS SYSTEM IN THE RADIATA.

10. The general characteristic of the radiated classes is the repetition of similar parts round a centre, which is the place of the mouth or entrance to the digestive cavity. In many of the species included in the group, however, this repetition is but obscurely traced; it is by these that the transition is effected to other classes. Wherever a nervous system has been traced, it has been found to partake of this character, presenting the form of a ring surrounding the mouth, and sending off filaments to each of the segments of the body.

11. The peculiar softness of the tissues of the animals composing the class acalephæ, renders the detection of a nervous system in them a matter of some difficulty and uncertainty.[1] No continuous

[1] A *medusa*, which, when taken out of the water, weighs fifty ounces, is reduced by drying to a few grains.

filaments have as yet been certainly traced in the larger *medusæ*, where the locomotive powers of the structure would lead us to suspect their existence. Ehrenberg, however, has recently described two nervous circles in their disks—one running along the margin of the mantle, and furnished with eight minute ganglia, from which filaments proceed to the eight red spots which he supposes to be eyes; whilst the other is disposed around the entrance to the stomach, and furnished with four ganglia, from which filaments proceed to the four tentacula. In the little Beroe, (*cydippe pileus*,) however, the nervous system can be seen without dissection, though not always with certainty (§ 7, *Note;*) and it presents the form of a double ring around the mouth, with eight minute ganglionic enlargements, from which filaments diverge to the spaces between the longitudinal ciliated bands.[1]

12. In the echinodermata, we shall find the same type of structure manifested with little variation. We may first enquire, however, into the character of the sensory and locomotive powers which the animals of this class possess. Their movements are of various kinds. Change of place is principally effected by the extension and contraction of the tubes which are protruded from the apertures in their covering. These tubes possess a fibrous contractile structure, by which they are shortened when occasion requires; and their protrusion is effected by projection of fluid into them from cavities within the body. By means of suckers at their extremities, the animal fixes upon some firm surface those which it has advanced; and then, by contracting them, draws itself forwards. It may perhaps be doubted how far this *contraction* of the tubes is effected by any stimulus communicated from the nervous system, or whether it is not rather the effect of the elasticity of the tissue coming into play when the distending force is withdrawn; just as the claws of the feline tribe are retracted by their elastic ligament, when the protruding muscle ceases to act. We can hardly avoid the belief, however, that the internal reservoirs of fluid must be influenced by the nervous system in order to produce that *consentaneousness* of action which is essential to the regular movements of the animal.

13. Besides these instruments of locomotion, the *asterias* seems to possess the power of altering the form of its whole body, by bending its rays towards either surface, or approximating them laterally, by which it can adapt itself to the passages through which it is creeping, and even assist in drawing its prey towards the mouth. This seems effected by muscular fibres, running both longitudinally and transversely along the rays. The *holothuria* has a muscular system of the same kind, but much more developed, by which the general cavity of the body may be dilated or contracted, and by its means change of place seems to be partly effected, as well as the regular inspiration and expiration of water, which is performed at definite intervals. The stem and branches of ther amifying respira-

[1] Grant, in Trans. of Zool. Soc., vol. i.

tory apparatus itself are also provided with muscular structure, and contract when irritated; they are even able to carry on the respiratory movements to a certain degree after the sac has been cut open.[1] The tegumentary covering of the *holothuridæ* is particularly susceptible of irritation from external objects—the slightest touch often causing powerful contraction. We can scarcely regard either this or the respiratory movements as of a *voluntary* character; they would rather seem to be the result of a simple reflex action; and it is a curious evidence of their being but little subject to the control of the will, that the contraction is often so powerful as to rupture the membrane of the cloaca, and to force large portions of the intestine through the aperture. The density of the integument in the *echinus* altogether prevents any such movements of contraction and expansion; and the respiratory currents in it, as in the *asterias*, are produced by the vibration of the cilia which cover the membrane lining the shell and the other aerating surfaces. But in this animal there is another series of movements (besides that of the spines), no less remarkable—those of the dental apparatus—by which it is enabled to break down the firm calcareous shells of the crustacea on which it feeds, and other bodies of equal density.

14. The echinodermata have not been usually regarded as possessing any other sense than that of touch, which seems to reside in their extensile feet, and especially in those modifications of them which are placed round the mouth, and serve especially as *tentacula.* Ehrenberg, however, is disposed to regard certain red spots, at the extremity of the rays, as rudimentary organs of vision; and he states that the nervous trunk is continued towards each, and swells into a sort of ganglion, where connected with it. The recent observations of Mr. E. Forbes seem to confirm this belief—that gentleman having pointed out a curious disposition of the spines round these spots, by which they can completely fold over and protect them; whilst he has also remarked that the animal seems by their means to take cognisance of objects of food at a little distance from them. It may be doubted, however, whether a distinct visual perception is produced through their instrumentality; or whether the impression thus excited is not rather of a more general character, analogous to that formed by the organ of smell. It may further be doubted whether the contraction of the tubular feet, in respondence to external irritation, necessarily involves *sensation.* Considering these organs as analogous in function and character with the fly-trap of the dionæa, or the tentacula of the hydra, on the one hand, and (so far as the prehension of food is concerned) with the muscles of deglutition in the higher animals, on the other, we should rather incline to a negative opinion.

15. The nervous system of the echinodermata appears to consist essentially of a filamentous ring surrounding the mouth, which presents ganglionic enlargements equal in number to that of the seg-

[1] Cycl. of Anat., vol. ii., p. 41.

ments of the body; and from these diverge the filaments which connect this central apparatus with distant organs. In the *asterias* this ring may be distinctly traced; and from each of its ganglia a large branch is transmitted to the corresponding ray, whilst two smaller ones pass downwards to be distributed to the stomach and other viscera included in the centre of the star. A similar ring is stated by Dr. Grant, (and more recently by M. Van Beneden,) to exist in the *echinus*, which sends filaments to the dental apparatus, and others along the course of the vessels to the digestive cavity. According to Dr. Grant, also, a similar ring exists in the *holothuria*, which sends nerves to the mouth and the surrounding tentacula; others to the stomach and alimentary viscera; and others, again to the muscular bands, which form part of the tegumentary apparatus. In the *siponculus*, an animal which approaches the vermiform tribes in the aspect of its elongated body, though it still retains the essential characteristics of the echinodermata, we observe two of the longitudinal filaments more developed than the rest; and these are situated on what may be termed the ventral surface of the animal, so as to indicate a transition to the double nervous cord of the articulata.

16. In this nervous apparatus then it is evident that several distinct functions are combined. The nerves, which, from their distribution on the viscera, we should regard as analogous to the sympathetic of higher animals are not isolated at their central termination from those which appear connected with the sensorial and locomotive functions. Nor are those which minister to the instinctive actions separable from those which convey the influence of the will. It is important to observe that, in the typical members of the group at least, every segment of the body is equal in its character and endowments, and that each has a ganglion appropriated to it. None of these ganglia are different from the rest, and neither, therefore, can be regarded as having any *presiding* character.

17. All the movements which take place in respondence to external[1] impressions may, therefore, be regarded with probability as originating in the ganglion of the segment upon which the impression is made, and as propagated to the rest by the connecting filaments which form the ring. These movements, it can scarcely be doubted, constitute by far the greater part of those which the animals exhibit; and the purely instinctive character of almost all the operations which they are known to perform, together with this remarkable equal subdivision of their centres, may well leave us in doubt how far they can be regarded as possessed of any thing like our reasoning powers, or as actuated by the *voluntary* impulses

[1] The term *external* is here employed in the usual metaphysical sense, to imply that which does not originate in the *mind*. The impression may arise from some state of the corporeal structure itself, such as that which occasions in man the sensation of hunger.

which result from their exercise. It is remarkable, too, that all the ganglia should participate equally (as they appear to do) in the *special* sensation of sight.

18. We shall have some ground, then, for assuming in our future enquiries, that whenever a nervous cord terminates in a ganglion,[1] that ganglion may be regarded as the centre of the functions it performs; receiving the impressions made upon it, and exciting respondent motions without any exercise of the will being necessarily concerned. We shall hereafter find, however, that this is seldom the case to its full extent; but that where a ganglion is situated upon a nervous cord, *part* only of its filaments usually enter the mass, whilst a portion of them pass over or alongside of it, towards some other ganglionic mass, which seems to have a presiding influence over the rest.

IV. NERVOUS SYSTEM OF THE MOLLUSCA.

19. Feeble as are the animal powers in a great proportion of the molluscous tribes, they would seem to be almost extinct among the members of the class tunicata or *acephala nuda*. No beings possessed of a complex internal structure, a distinct stomach and alimentary tube, a pulsating heart, and ramifying vascular apparatus, with branchial appendages for aerating the blood, and highly developed secretory and reproductive organs, can be imagined to spend the period of their existence in a mode more completely vegetative than these. The greater number of them pass the whole of their lives in one situation, attached by a pedunculate prolongation of their external tunic to submarine rocks; many of the inferior species associate together like the polypifera (the higher tribes of which they much resemble,) to form a compound structure, in which several animals are more or less closely united: and those which are not attached to fixed points have little independent locomotive power but are driven about at the mercy of the waves.

20. These animals are enveloped in a tough elastic tunic (the analogue of the *valves* of the conchifera;) and within this is found a muscular coat, consisting of fibres crossing each other in various directions, by which compression may be exercised on the contents of the cavity it surrounds. Two openings penetrate these sacs; one termed the *branchial*, admits water to the general cavity, partly for the purpose of aerating the blood, and partly to bring food to the digestive orifice; the other, termed the *anal*, gives exit to the

[1] It is necessary, however, to limit the nature of the structure to which the term *ganglion* is here applied. It is intended to include those of the *symmetrical* system of the invertebrata, and the brain and spinal cord of vertebrata, which, as will be hereafter shown, (§ 44, and 76-8,) correspond in the relation of the white and gray matter they contain. The *intervertebral* ganglia of the spinal nerves, and those of the *sympathetic* system, have a very different structure, (§ 45,) and probably also perform functions of an ntirely distinct character.

current which has passed over the respiratory surface, and also to the contents of the intestine and ovaria. These openings are bounded by distinct circular sphincters, with which radiating muscular filaments are intermixed, that extend in longitudinal bands over the surface of the sac.

21. By means of this apparatus, the animal is capable of diminishing the capacity of the branchial sac, and thus of ejecting, with considerable force, a part of the water it contains; whilst the elasticity of the external tunic spontaneously restores its usual dimensions when the contracting power is inactive. No movements of this kind, however, are commonly employed, either for the respiratory process, or for the prehension of food. A continuous and equable current of fluid enters the branchial orifice, and is propelled by the anal, without any other visible physical agency than the movement of the cilia which cover the aerating surfaces. The mouth, or entrance to the stomach, is situated at the bottom of the branchial sac, and is unprovided with any special sensory apparatus; it seems to derive its supplies from the respiratory current alone, and not to depend upon any prehensile movements: but particles unfit to enter it are probably stopped at the branchial orifice, (§ 24.) Moreover as each animal possesses within itself all the organs necessary for the propagation of its race, and as these appear contrived simply for the passive evolution of germs, no powers of active motion are called into exercise by the performance of this function.

22. So far as the regular vital operations are concerned, therefore we see no indication of *voluntary* actions in these animals or even of that kind of respondence to impressions, which would lead us to suspect the existence of a connected nervous system. But, in the simultaneous contraction of the whole muscular sac which is occasionally witnessed, we can scarcely fail to acknowledge the operation of nervous agency. If one of these animals be touched, when its cavity is full of water, a jet of fluid is thrown out to some distance; and sometimes a number "are so closely impacted together on the rocks, that the impression given to one causes it suddenly to retract, which also acts on the one next to it, and so on throughout several of them, and each in contracting throws out a quantity of water."[1]

23. We find, accordingly, on examining into the character of the nervous system, that it is most simple in its structure and distribution. We have here no repetition of parts as in the radiata, and one ganglion serves as the centre of all the actions to which this system ministers. This ganglion lies between the two orifices, and sends filaments towards each, as well as others that ramify upon the muscular sac, to which they seem almost exclusively confined. In fig. 2, are seen the position of the ganglion, and the distribution of its filaments in *ascidia mammillata*.[2] The nervous

[1] Grant's Lectures on Comp. Anat. xxxii.

[2] Cuvier, Mem. sur les Mollusques.

filaments which pass to the branchial orifice diverge to enclose it, and meet again beyond, so as to form a complete ring; and sometimes, according to Dr. Grant, a small ganglion is found at the point of their reunion. Some small ganglia have been described by Meckel and others, as occurring among the viscera; but their presence is, with much reason, doubted by Mr. Garner.[1] If such should be proved to exist, it is manifest that they are to be regarded as rudiments of a sympathetic system; which does not, however, manifest itself in so distinct a form in any of the lower molluscous classes.

24. The only organs of special sensation that this animal can be regarded as possessing, are the tentacular filaments which fringe the interior of the branchial orifice. Although nothing is absolutely known of their function, it would not seem improbable that they are susceptible of impressions from substances entering with the respiratory current; which being propagated to the ganglion, may excite the closure of the sphincter, by means of the motor nerves, and thus prevent the admission of injurious bodies. Should this be the case, we can hardly regard the action as of more than a *sympathetic* character, since the closure of the sphincters in the higher animals is, in like manner, independent of the impulse of volition, although capable of being influenced by it. It would seem probable, too, that by the same sphincter is regulated the quantity of water which shall enter for the supply of the respiratory and digestive systems, in accordance with their requirements, communicated in like manner through the ganglion; and the ciliary movements would appear to be under the same control, (although not so in higher animals,) since, in those beings which make use of them for the acquirement of food, such as the common wheel-animalcule, they stop and recommence in such a manner as to prevent the observer from assigning any other cause to their variations.

25. We next pass on to the conchifera, or *acephala testacea*, a class which, though somewhat higher in the scale than that just described, has a very close affinity with it. Instead of an elastic external tunic, we find a calcareous structure enveloping the body, formed of two valves united by a ligament, and by one or two adductor muscles. In this case, as in the former one, the elasticity of the ligament maintains the natural expanded state of the cavity of the shell; whilst the contraction of the adductor muscle, which is evidently under the control of nervous influence, draws the edges of the valves in close apposition to each other when the animal is threatened with injury. The mantle which forms the cavity that contains the viscera, is less muscular than in the tunicata; and the respiratory current is maintained through its branchial and anal orifices, just as in that class, without any other apparent means of propulsion than the vibration of cilia. Sometimes these orifices are prolonged into tubes or siphons; whilst, in a great proportion of the

[1] Loc. cit.

class, the cavity of the mantle is left entirely open, by the incomplete adhesion of its lobes along the margin of the shell.

26. A good deal of variety exists among the members of this class in regard to the developement of the locomotive and sensorial powers. In some of the lowest, neither would seem to be much exalted above those possessed by the tunicata. The *oyster*, for example, attaches itself to rocks by calcareous exudation from the secreting surface of the mantle, and passes the term of its existence in a state of inactivity which is only interrupted by the occasional closure of its shell. It is entirely dependent upon the motion of the surrounding element for its supplies of food; and, as its digestive cavities are found to contain only small particles of vegetable matter, it does not require for the prehension of its aliment any complex apparatus in which active movement is essential. Here, too, each individual possesses the entire reproductive apparatus within itself; and even if, as has been recently maintained, the proximity of two individuals is requisite for the fertilisation of the ova, it is quite certain that no change of place is involved in the function.

27. A somewhat greater advance, however, is witnessed in the sensory apparatus. Late observers state that distinct, though slightly developed organs of vision may be detected at the margin of the mantle.[1] These, no doubt, may serve to indicate to the animal the approach of danger, and cause it to employ its only means of defence,—the closure of its shell,—an action evidently analogous with the contraction of the enveloping muscle of the tunicata. This accounts for the fact known to fishermen, that the shadow of a boat passing over a bed of oysters, causes the animals beneath to close their shells. An important change also here takes place in the position of the sensitive tentacula which guard the entrance to the alimentary canal. These are now developed from the true mouth, which still remains within the cavity of the mantle; and the orifices of this cavity are almost destitute of them, even when prolonged into siphons. Where the cavity is left open, it is obvious that there is nothing to prevent foreign substances from immediate contact with the mouth, although the margins of the mantle still appear possessed of greater sensibility than its other parts. The two pairs of long flexible tentacula or palps, with which the mouth is furnished, seem designed to guard its orifice, by causing its closure against substances unfit to enter it, rather than to convey nutritious particles to the entrance of the tube, which is sufficiently accomplished by the respiratory current.

28. In the nervous system of the oyster, we find but a slight advance upon that of the tunicata; and this has reference more to the increased importance of the sensory organs, than to the development of locomotive powers. The principal ganglion (B, Fig. 3) is situated by the adductor muscle, between the branchiæ, and hence

[1] Garner, loc. cit.

may be called the *posterior* ganglion.[1] It obviously corresponds, both in situation and in its relation to the respiratory organs, with the single ganglion of the ascidia; though part of the functions of the latter are here performed by a seperate centre. It sends branches to the mantle (*a*), others to the branchiæ (*b*), small twigs to the adductor muscle (*c*), and two trunks (*d*, *d*,), which connect it with the *anterior* ganglia (A, A). These ganglia are very small in the oyster, and are situated considerably below the entrance to the œsophagus (ε): they are united by a transverse filament (*e*), which passes under that tube, but they also send forwards a large branch (*f*), which arches over the mouth. The principal branches from these ganglia, besides the connecting trunks, are distributed upon the tentacula and the anterior portion of the mantle. These anterior ganglia being alone connected with the special sensory organs, will obviously have a superior influence on the movements of the animal; but as they are not immediately connected with the adductor muscle, it is obvious that whatever motor impulse may result from irritation of the tentacula, must be propagated along the cords which pass to the posterior ganglia. On the other hand, the posterior ganglion may be considered, from its size and connections, as the centre of the actions performed by the organs which it supplies, when these are stimulated by impressions made on or originating in themselves. Such would probably be the case with respect to the respiratory movements, to direct which would seem to be the special function of this ganglion. Besides the branches which have been mentioned as proceeding from it, there are some minute filaments sent by it to the viscera; and it would thus seem, like the ganglia of the asterias, to unite the offices of both systems which are seperate in the higher animals.

29. The whole course of the lives of these animals shows them to be so little elevated in the scale of psychical endowment, that we can scarcely regard the motions executed by them as often possessing a voluntary character; they may rather be compared with the involuntary or sympathetic actions of the higher classes;—the closure of the shell, for example, resembling in its *protective* tendency the contraction of the pupil under the stimulus of light, or the closure of the glottis against irritating matters. It may not, perhaps, be a departure from rigid analogy to suppose that, whilst the movements connected with their vital operations result, like those having a similar *immediate* connection in the higher animals, from changes in the nervous system, in which *mind*, in its restricted sense, cannot be said to participate, these animals may experience a sense of enjoyment or well-being, arising from the fulfilment of these operations, corresponding with that which man experiences during the digestion of a sufficient but not excessive meal, and relatively higher in degree, because not subordinated to others.

30. In the higher species of this class, we find a peculiar loco-

[1] Garner, loc. cit.

motive organ developed, which serves a variety of important purposes. This organ, which is termed the *foot*, has a firm muscular structure, and is capable of very energetic action. Sometimes it is employed in burrowing in sand or mud; and sometimes in executing sudden and rapid motions—true leaps—by which the animal is enabled to change its place with great celerity. These motions are frequently executed in such a manner as to imply consciousness of the most advantageous direction for them, and therefore the operation of a guiding *will*. A curious instance of this kind has been elsewhere mentioned by the author;[1] and he has since learned that it is no uncommon thing to see animals of this kind making their way along the sea-shore in the most direct line towards the water, as if conscious of its proximity. The foot is largest and strongest in the most active species, which never form any local attachment; but, in others, its principal function seems to be to form the *byssus* which attaches them to rocks, and it is then reduced to a rudimentary condition.

31. Wherever the *foot* exists in the conchifera, we find an additional ganglion in close relation with it, being usually situated at its base, and following its changes of position, as well as corresponding with it in degree of development. As the nerves proceeding from it, with the exception of the trunks that connect it with the anterior ganglia, are almost entirely distributed on this organ, it may with propriety be called the *pedal* ganglion; or, from its position, the *inferior*. Of this we shall see a good example in the *pecten* (Fig. 4). Here the anterior and posterior ganglia have pretty nearly the same relation as in the oyster, except that the latter have partially separated, so as to form a bilobed mass, which, in other instances (*modiola*), becomes completely double. The anterior ganglia, however, are much larger in proportion; and, besides transmitting the usual branches to the posterior ganglia, they are connected by two considerable trunks with the pedal ganglion (c).

32. In considering the relative functions of these ganglia, it is important to remark that, whilst the *pedal* or inferior ganglion, and the *posterior* single or double ganglion, are always connected with the *anterior* ganglia, they are never immediately connected with each other. This would seem to indicate that their functions are distinct, though partly dependent on the influence of the anterior ganglia. With regard to the *posterior*, it has already been stated to be principally connected with the *respiratory* apparatus; and all the reflex actions of the parts which it supplies are probably effected by its instrumentality alone. The influence of the *pedal* ganglion over the foot is probably of a similar character. The general movements of the organ may be directed by the cephalic ganglia; whilst the particular actions by which it fixes itself upon a given surface, and adapts its disk to the inequalities which it encounters,

[1] Principles of Gen. and Comp. Physiology, p. 99.

may be produced simply by impressions reflected through this ganglion by its afferent and efferent nerves. Although such a view must be admitted to be hypothetical only, as regards this class of animals, it will be hereafter seen to derive remarkable confirmation from the actions of the suckers of the cephalopoda in relation to their ganglia (§ 60, 67), and from similar experiments on the independent functions of the pedal ganglia in insects and other articulata (§ 80.)

33. The cephalic ganglia, although still beneath the œsophagus, must be regarded as having a presiding influence over the others, being the residence of whatever sensibility to impressions of a *special* kind these animals may possess, and therefore, in all probability, the instruments of their psychical operations. Their immediate connection with both of the other divisions of the nervous system evidently favours this idea; and any actions which result from visual impressions, or from irritation of the tentacula, may, therefore, be regarded as originating in them. In this point of view, whilst the anterior ganglia may be compared with the upper part of the cerebro-spinal axis in vertebrata, the branchial ganglia would be analogous to the medulla oblongata,[1] which is the recipient of impressions and the originater of motions connected with the respiratory function: and the pedal ganglion would be regarded as corresponding with one of the ganglia in the double column of the articulata, and therefore (as will hereafter appear, § 79) with *one segment* of the spinal cord in vertebrata.

34. In some of the highest species of this class, as *mactra*, which show more activity than the rest, the cephalic ganglia are actually anterior to the mouth, and nearly meet over it, as shown in Fig. 5.

35. In the next class of mollusca, the gasteropoda, we recognise a type of the nervous system essentially the same with that just described, but modified to correspond with the conditions in which the animals are formed to exist, and especially with the changes in the situation and developement of their locomotive and sensory organs. Although none of this class possess very active powers of locomotion, few are entirely fixed; all are more or less dependent upon the exercise of these powers for their supply of food; and the higher tribes employ them also in the perpetuation of the race, since the connection of two individuals is in them an essential part of this function. Among the testaceous species, locomotion is principally effected by the alternate expansions and contractions of the fleshy disk termed the foot; by which the animal is enabled to crawl slowly along solid substances, whether on land or in water, with a slow but equable progression. In some of the aquatic species, this disc is convertible into a kind of boat, by the buoyancy of

[1] It will presently be seen that the *distance* of the branchial from the cephalic ganglia in the cases hitherto mentioned is no obstacle to this analogy; the position of the former being entirely regulated by that of the gills.

which the animal can suspend itself in an inverted position at the surface of the water, and then employ its tentacula and mantle as instruments of progression. Some of the naked aquatic species are still more active, moving through the water by the undulation of their whole bodies, like the leech or the vermiform fishes; and some appear materially assisted by an expansion of the mantle on the anterior part of the body, which contains muscular fibres, and probably acts as a fin. Besides these motions, all the testaceous species have others by which the place of the body is changed in reference to the shell; special muscles (obviously analogous to the *adductors* of the conchifera) being provided, by which the parts that are occasionally protruded can be immediately retracted within it.[1]

36. In every division of the animal kingdom, we find the developement of special sensory organs to bear a close relation with that of the locomotive apparatus. In the present instance, we observe an evident example of this general fact. The organs of vision, which, when existing at all among the conchifera, were very imperfect, are here almost constant and more highly developed; the tentacula are more sensitive, and sometimes increased in number to six or eight; and there is reason to suspect that some of them occasionally minister to the sense of smell. These senses, as well as the locomotive powers of the animal, have an obvious relation with the supply of the digestive system, which is not here, as in the inferior classes, dependent upon the miscellaneous aliments conveyed to the mouth by the movement of the surrounding fluid medium, but is more limited as to the character of the food to which it is adapted, and consequently requires the means of becoming acquainted with the proximity of what it can digest. This is well seen in the common snail, which, "although at rest within the shelly covering that forms its habitation, will with great quickness

[1] A very remarkable instance of the rapidity with which these muscles sometimes act is witnessed in the case of the *patella* (limpet) and *haliotis*. The former animal, as is well known, usually adheres to those levels of rocks which are occasionally exposed to the air, and again submerged by the tide. They are favourite articles of food to crows, which sometimes pick them dexterously off the rocks—placing the point of the bill beneath the edge of the shell, which, when the animal is at rest, is usually a little removed from the rock (as in the oyster from its fellow); but, if this be not done with sufficient quickness, the animal draws its shell closely down to the rock, and holds the bill of the crow so firmly that the bird is often drowned by the rise of the tide. In like manner, men have been occasionally sacrificed in the attempt to remove a large species of haliotis which inhabits the Tropical and Southern Ocean. This animal (whose shell is much valued for its brilliancy, both on the exterior and interior surfaces) usually resides at a depth of a few feet under water. If the diver be sufficiently quick in his operations to tear the animal from the rock before it can put its retractor muscles in action, the task is not difficult; but if these are once made to contract, the shell is drawn to the rock so closely as to retain the fingers beneath it too firmly for extrication. The latter fact was communicated to the author by his friend Mr. S. Stutchbury, who has known instances of its occurrence.

perceive the proximity of scented plants which are agreeable articles of food, and promptly issue from its concealment to devour them." It is not a little curious, however, that although the general surface appears highly susceptible of impressions which excite responsive movements adapted to fulfil some important office in the economy, it does not seem to be susceptible of *painful* impressions in any thing like the same degree. This, which cannot bnt be regarded as a beneficent provision for the happiness of animals so helpless and so exposed to injury, would appear from the observations of various experimenters, and especially from the testimony of M. Ferrusac, who says, "I have seen the terrestrial gasteropods allow their skin to be eaten by others, and, in spite of large wounds thus produced, show no pain." The fact has an important bearing on our general views of the operations of the nervous system; since it would seem to confirm an opinion founded upon other phenomena, that the *impressions* which produce *reflex* actions through the nervous system do not always involve the production of *sensation.*

37. We may easily recognise in the nervous system of this class the same general type which it presented in the conchifera, with an advance, however, in the higher species towards a more developed condition. The *anterior* (now become *cephalic*) ganglia are larger in proportion, and exhibit a tendency to gain a position anterior to the œsophagus, and to approximate towards each other, so as to meet and form a single ganglion on the median line. The *branchial* ganglia are constantly to be met with, but their position is extremely various. This centre always, however, bears a close relation with the gills, both in situation and degree of developement; and even where apparently conjoined, as it frequently is, with the pedal ganglion, it may be distinguished from it by the distribution of its nerves, as well as by its separate connection with the cephalic ganglia, which is always noticed in such cases (§ 38 and 42.) Sometimes the functions of this ganglion are subdivided between two, of which one is still appropriated to the branchiæ, whilst the other is connected with the general surface of the mantle and respiratory passages, and hence may be called the *palleal* ganglion. The position of the pedal ganglion (which is here generally double) also varies, but in a less degree, since it is generally in the neighbourhood of the head. Where no distinct foot exists, but the locomotive movements are executed by the action of the whole mantle (as in most of the naked species, both terrestrial and aquatic,) we still find a ganglion to which they appear equally due (§ 42.)

38. As an illustration of one of those simpler forms of the nervous system presented in this class, which connect its more complex type, (to be hereafter noticed,) with that of the inferior groups of the mollusca, we may adduce that of the *patella.* At the base of the tentacula, and rather anterior, therefore, to the œsophagus, we find a pair of ganglia (A, A, Fig. 6,) which evidently correspond with the anterior ganglia in the conchifera, and which are con-

nected by a commissural band passing over the œsophagus. These, however, not only send nerves to the tentacula, but are also connected with the eyes, which are situated at their base. Beneath the œsophagus, and connected by *two* trunks with *each* of the cephalic ganglia, we find a broad mass, which, upon examination, appears to consist of four lobes placed in a line. The two inner ones (C, C,) send nerves to the foot, and are thus evidently analogous to the *pedal* ganglia of the conchifera. These are connected with the cephalic ganglia by one of the trunks which we observe on each side. Externally to them are the *branchial* ganglia (B, B,) which also are connected with the cephalic ganglia by a separate trunk, as well as with each other by a filament that may be distinctly traced through the pedal ganglia.[1] Besides supplying the gills and mantle, these ganglia, like their analogues among the conchifera, send branches to the shell muscles, and some small ones to the viscera. That they are specially *branchial* ganglia, however, is proved by this. Mr. Garner has remarked that, in *fissurella*, (an animal generally resembling patella, but differing from it in having the branchiæ removed to the back of the neck,) in which Cuvier noticed the deficiency of the two external lobes of the subœsophageal mass, the ganglia really exist, but are removed to a different position—namely, the base of the branchiæ on the back.

39. Besides these nerves, we find in the patella, as well as among the gasteropoda in general, a separate system connected with a very important set of organs, the gustatory and mandicatory, which are but slightly shadowed out among the conchifera. In these animals we find the œsophagus dilated at its commencement into a muscular cavity, with a curious rasp-like tongue, which serves to reduce the food; often supported upon cartilages, and sometimes furnished with horny maxillæ. The nerves which supply these do not proceed directly from the cephalic ganglia; but are a part of a distinct system, which sends its ramifications along the œsophagus and stomach, and which is occasionally connected with the first by inosculating filaments. This set of ganglia and nerves, which is even more important from its relative developement in some other classes, and into the analogies of which in the nervous apparatus of vertebrata we shall hereafter inquire, (§ 92, 3,) may be called from its distribution the *stomato-gastric* system. In the *patella* we find a broad ganglionic band (D) lying beneath the œsophagus, and forming with its nerves another ring round it. This band is connected, in most gasteropoda, with the cephalic ganglia; but in the patella, it sends its connecting filaments to two small ganglia (E, E,) anterior to the cephalic, which supply the lips, and which seem intermediate between the two systems. In the cephalopoda, we find these labial or tentacular ganglia attaining considerable developement; but in the gasteropods, in general, they do not appear to be separated from the cephalic.

[1] Garner, loc. cit.

40. A higher form of the nervous system is that found in the *aplysia*, which has been minutely described and well figured by Cuvier.[1] In this animal, we find that the cephalic ganglia have become entirely supra-œsophageal, and have coalesced to form one mass (A, Fig. 7.) Beneath this are two lateral ganglia (C, C,) which are connected with it and with each other, so as to complete the œsophageal ring. These ganglia supply the foot and mantle, and are, therefore, to be considered as *pedal* or locomotive ganglia. We here find indicated, however, the separation which exists in other gasteropoda and in the cephalopoda, between the nervous centres supplying the foot and the mantle; for the commissure which unites them beneath the œsophagus is not a simple nervous cord, but consists of two filaments which diverge to embrace the aorta,—a relation which they hold when proceeding from separate ganglia; and the cords which connect them with the cephalic ganglion, consist of *three* nerves on each side, of which two apparently belong to these lateral ganglia, and the third to the posterior ganglion next to be described. This ganglion (B) is situated at some distance from the others, lying among the viscera at the posterior part of the body, among which it is partly distributed. Hence it was regarded by Cuvier as a sympathetic ganglion; but there is more justice in the view of Mr. Garner[2] that it is principally a *branchial* ganglion, a large part of its nerves being distributed to the respiratory organs. It is connected by long filaments with the lateral ganglia; and part of these cords seem to pass on to the cephalic mass, forming the third of the filaments which connect it with the lateral ganglia. Besides these nerves, we find a *pharyngeal* ganglion, partly divided into two lateral lobes, lying beneath the mouth, and sending filaments to its muscles, to the salivary glands, and to the œsophagus, as well as connecting branches which unite it with the cephalic mass.

41. These characters become more positive in the nervous system of *bullæa*, where we find the cephalic ganglia again separate (A, A, Fig. 8,) and lying at the side of the œsophagus, along with two other pairs of ganglia (C, C, and E, E,) the distribution of whose nerves to the foot and mantle determines them to be *pedal* and *palleal* ganglia respectively. The branchial ganglion (B) is situated posteriorly, as in aplysia and as in the conchifera; and its cord of communication with the cephalic ganglia passes through the palleal ganglion. Two small pharyngeal ganglia are here found in the usual situation.

42. From these complex forms, which show us the distinctness of parts that appear simple, we may advantageously pass on to one which exhibits a highly-developed nervous system in nearly the most concentrated aspect that it presents in this class—that namely of the *limax ater* (common slug.) Here we find the cephalic gan-

[1] Mem. sur les Mollusques.
[2] Loc. cit.

glia (A, A, Fig. 9) united into one large bilobed mass, lying completely above the œsophagus. Another large mass, or subœsophageal ganglion, forms the lower part of the ring, and is connected with the first by *two* trunks on each side. A little examination will show that this ganglion is composed, like the similar mass in the patella, of two pairs having distinct functions. The branches from the outer portion (B) are principally distributed to the respiratory sac; and this will, therefore, be analogous to the outer or branchial portion of the ganglionic mass in the patella, being, like it, connected immediately with the cephalic by a trunk of its own. The inner portion (C) does not send its branches to the *foot* in particular, but to the general muscular surface in which this organ is, as it were, lost, and of which the whole is concerned in the progressive movement of the body. Hence we may fairly regard this as a *locomotive* ganglion. Two small pharyngeal ganglia are found within the principal ring, connected as usual with the cephalic.

43. Without going into further detail, then, it is evident that in this class the sensory apparatus, the foot or locomotive organ, the branchiæ or respiratory organs, and the mantle with whose actions both these are concerned, are the organs which seem to require nervous centres for the reception of impressions, and the excitation of respondent motions. These centres are modified, both as to situation and developement, in accordance with the situation and developement of the organs which they supply; and it is from their connections only that we can judge of their character. For example, it was seen in *aplysia* that the *pedal* and *palleal* ganglia were united, while the respiratory ganglion was separated. In *ianthina*, on the other hand, the *pedal* ganglia are distinct, whilst the *branchial* and *palleal* are partly incorporated with the cephalic. And in *paludina*, the *pedal* ganglion being still distinct, one other pair supplies the organs of sense and muscles of the mouth, as well as the mantle, branchiæ and viscera.

44. Nothing has yet been said of the ultimate structure, and of the arrangement of the elementary portions, of the nervous apparatus in the classes in which its form has been described; because it is only among the gasteropoda, that any minute investigations have been made whose character can be relied on. It has been stated by M. Blainville, and generally believed, that the nerves of the mollusca are not composed of definite filaments, like those of higher animals, but that they consist of a semifluid *globuleuse* matter enveloped in a fibrous neurilema. More recently, however, it has been ascertained by Ehrenberg, and after him by M. Leuret,[1] that the nerves consist, in these as in other animals of definite tubular fibres, in which the granular medulla is contained. These fibres are universally cylindrical, and present no well marked variations in size. It is very difficult, if not impossible, to isolate them, however, owing to the extreme tenuity of their tubular portion; but the

[1] Op. cit. p. 24.

transparency of the neurilema enables them to be readily viewed *in situ*.

45. The structure of the ganglia presents several points of interest. They are always characterised by the presence of a central nodule of granular matter which does not seem to possess any definite arrangement. This, in the tunicata, does not differ much in colour from the other portion of the nervous structure, being of a light brownish shade. In the conchifera it is more of an orange colour: and in the gasteropoda it is of a reddish brown. It cannot be doubted that this corresponds with the gray or cortical substance of the nervous centres in vertebrata. The manner in which it is disposed in reference to the nervous fibres, at once distinguishes the ganglia of the mollusca from those of the sympathetic nerve, or of the posterior roots of the spinal nerves, in vertebrata. In the latter we observe the fibres *continuous through* the ganglia, and the gray matter interposed among them. In the former, the gray matter is confined to the centre, and is traversed by *no fibres;* and the roots of the nerves which terminate in the ganglion are observed to penetrate to it, and then to diverge,—becoming, as it were, lost in its substance.[1] This is alike the case with what are believed to be from their connections, both sensory and motor nerves. This structure obviously, therefore, resembles that of the *centres* of the cerebro-spinal system in vertebrata; the connection of the roots of the nerves with the gray matter of the spinal cord, as well as that of the fibrous with the cortical portion of the brain, being exactly the same as that just described. These ganglia, then, may be regarded as holding precisely the same relation to the nerves which issue from them, as do the corresponding parts of the centres in vertebrata. What these corresponding parts are will be the next subject of enquiry.

46. The cephalic ganglia must be regarded as analogous—not to any single portion of the encephalon in vertebrata—but in some degree to the whole. We find nerves of special sensation proceeding from them, certainly to eyes, perhaps also to olfactive organs; as well as others of common sensation supplying the tentacula and mouth. Hence we must admit, that they perform the functions of the optic ganglia of vertebrata,[2] and perhaps also of the olfactory lobes; as well as of the portion of the medulla oblongata in which the sensory portion of the fifth pair terminates. Moreover, they certainly give origin also to motor nerves; and must thus perform the functions of the portion of the medulla oblongata from which the corresponding nerves arise in vertebrata, as well as, perhaps, of the cerebellum. And, if we regard these animals as possessed of the perceptive, reasoning, and volitional faculties, in however low

[1] Leuret, loc. cit.

[2] A slight protuberance on the cephalic ganglia, analogous to the optic ganglia in the cephalopoda, may indeed be occasionally seen at the point whence the optic nerves are given off.

a degree, we must attribute to their cephalic ganglia some portion of the attributes of the cerebral hemispheres in the highest classes. This combination of functions will not appear so extraordinary, when it is recollected that *all* the central operations of the nervous system are performed in the tunicata by *one* ganglion, and in the radiata by a series, of which each is but a repetition of the rest; and it is quite conformable to the general principle of the gradual *specialisation* of function which may be observed in ascending the scale of organisation.

47. Of the *branchial* ganglion little more need be said than what has been already stated of the probable control which it exercises over the respiratory function. It will obviously be analogous to the portion of the medulla oblongata which is the centre of these actions in vertebrata; and although generally at some distance from the cephalic ganglia, the two centres are always immediately connected by a uniting trunk.

48. The *pedal* ganglion can scarcely be regarded in any other light than as analogous to the spinal cord, or rather to a single segment of it. The organ of locomotion is here single, and confined to one part of the body. Its nerves may be compared, therefore, with those supplying one of the extremities of vertebrata; and the ganglion, to the corresponding portion of the spinal cord, which generally exhibits a perceptible increase in the amount of gray matter where they enter it. It is well known that such a portion may be completely isolated without destroying the functions to which the spinal cord ministers; and we can scarcely doubt that these functions are identical in both cases. Such an isolation, however, in vertebrata, destroys the continuity of the nervous fibres with the brain, to which they seem principally connected by the white portion of the spinal cord, whose fibres may be traced into a part of their roots; and we find that, in the mollusca, the influence of the cephalic ganglia over the pedal nerves is always provided for by a communicating trunk proceeding from these centres towards the ganglion, not passing through it, however, but subdividing into branches which enter into the composition of the trunks proceeding from it; so that *a portion* of the pedal nerves terminates in the pedal ganglion, whilst another portion is derived by a continuous trunk from the cephalic. This fact is a very important one in relation to the character of the divisions of the double nervous column in the articulata, and of the spinal cord in vertebrata.

49. It is an interesting fact, stated by M. Leuret as the result of his enquiries on the subject, that, although the cephalic ganglia are generally absolutely smaller than other nervous centres, they are always larger in proportion to the nerves which proceed from them. This is worth notice in relation to the investigations of Soemmering upon the proportion which the mass of the brain in vertebrata bears to the diameter of the nerves proceeding from it.

50. It is obvious that the portion of the nervous system of mollusca, into the analogies of which we have thus enquired, cannot

be in the least compared *as a whole* with the *sympathetic* system of vertebrata, which it was formerly imagined to resemble. The distribution of some of its nerves to the viscera, however, may indicate that it partly performs the functions of that system, with which it is structurally intermixed even in vertebrata, as the late enquiries of Müller have shown.[1] But the stomato-gastric system may, perhaps, with more probability be considered as executing its offices. Into the peculiar character of that system, we shall be more competent to enquire, when we have traced it through other classes of invertebrata.

51. The nervous system of the pteropoda does not seem, from the few cases in which it has been examined, to differ much from that of the gasteropoda. In the *clio* it is described by Cuvier as consisting of three pairs of ganglia on each side, the anterior or cephalic meeting above the œsophagus, and the others being connected by filaments passing beneath it.

52. The class of cephalopoda is a most interesting one in many respects, exhibiting to us the modification of the molluscous type (which is perhaps most characteristically presented in the gasteropoda) produced by their proximity to the vertebrated division of the animal kingdom. In no organs is this modification more evident than in the nervous system; for, whilst in the lowest members of the group we find it approximating closely to the form it presents in the higher gasteropods, its whole character and relations in the most elevated species are so like those which exist in the lowest fishes, that the analogies between their several parts may be traced with little hesitation. Before passing to the consideration of these, however, it will be desirable to advert to the conformation of the sensory and locomotive apparatus in the principal groups of this class.

53. Among the lower testaceous cephalopods, of which the *nautilus pompilius* may be selected as a type, the sensory organs are but little elevated above those of the higher gasteropoda. The eyes are still imperfect; no organs of hearing can be detected; and, if there seems ground for attributing to them the possession of an organ of smell, this may with nearly equal reason be regarded as existing in some of the class below. The most remarkable difference in their sensory organs consists in the number of the tentacula which are developed from the head, and which amount to little short of a hundred. Of these some appear more expressly modified for locomotion and prehension; and others, resembling in character and situation the antennæ of crustacea and insects, may probably be regarded as instruments of sensation. The head of this animal is also furnished with a flattened disk, which has been termed the *hood*, but which evidently resembles the *foot* of gasteropods, and seems to be its principal organ of progression on a solid surface. The muscular system is, therefore, principally disposed at the an-

[1] Physiology, Book III. Chap. ii.

terior part of the animal. There are two large shell muscles, however, attaching the fleshy mass posteriorly to its testaceous envelope; and the mantle is furnished with a considerable amount of muscular substance which seems destined to dilate and contract its cavity. By this provision it would seem that currents of water are made to flow over the respiratory surfaces, on which, according to the testimony of several observers,[1] no cilia can be detected.

54. In the higher order, which principally consists of the *sepia loligo* and other naked cephalopods, both the sensory and locomotive powers attain a considerably increased developement. The eyes are larger and more perfectly organised; and distinct organs of hearing are found to exist. Instead of a number of feeble tentacula which can scarcely assist in locomotion, we find eight or ten powerful arms, adapted both for this function, and for prehension. For locomotion we find them in many species particularly modified by the membrane that connects their bases, and acts as a powerful circular fin, by means of which the animal swims through the water with great rapidity. On the other hand, the suckers with which they are enabled to take such firm hold of any object to which they are applied, admirably adapt them as prehensory organs. In other species, again, these tentacula are but slightly developed in comparison; and locomotion is effected by means of the vibrations of the long slender body, whose acting surface is assisted by the prolongation of the mantle into fin-like processes which are elevated upon cartilaginous supports. We shall now enquire into the characters which the nervous system presents in these two orders.

55. In the *nautilus* (Fig. 10.) we observe the cephalic ganglia united on the median line, and lying across the œsophagus like a cord; its two extremities are swollen into ganglionic enlargements, which are evidently analogous to the optic ganglia of vertebrata. This mass communnicates with two collars which form the sub-œsophageal portion of the ring. From the transverse cord are given off not merely the optic nerves, but also filaments to the mouth and tongue, (which are apparently of a sensory character,) as well as branches that connect it with separate labial ganglia presently to be noticed, which, as in the patella, lie at a considerable distance anteriorly. The anterior sub-œsophageal collar seems to correspond, in part, with the pharyngeal band in the same gasteropod,—here increased in size and importance on account of the increased developement of the buccal apparatus, with its powerful mandibles, firm, fleshy tongue, salivary glands, and contractile pharynx, and brought into close approximation with the cephalic ganglion. The greater number of the tentacula receive filaments proceeding directly from the anterior part of the collar; but the internal ones are supplied from a ganglionic mass which lies at their base, and which, though principally connected with the

[1] Sharpey, Owen, and Garner.

pharyngeal band also communicates with the cephalic ganglion. Besides supplying the internal labial processes, this ganglion sends twigs to what have been supposed by Mr. Owen to be *olfactory* laminæ, and, if these are so, would have to be regarded as in part an *olfactive* ganglion. Its correspondence with what has been denominated the *labial* ganglion in the patella, seems pretty evident; and perhaps the latter is also to be regarded as connected with the sense of smell.

56. From the posterior collar,—which evidently corresponds with the sub-œsophageal ganglion of the limax and other gasteropoda, in which are united the pedal palleal, and branchial ganglia,—filaments are distributed to the shell muscles, and four others arise from it which pass backwards along the course of the vena cava: of these the two internal form a plexus upon the vein; whilst the two external, which are trunks of considerable size, swell into ganglia, from which ramifications are distributed to the digestive and reproductive organs. This distribution resembles that found in many of the higher gasteropods inhabiting spiral shells; and the system of nerves may be termed *branchio-visceral.* The *external respiratory* nerves, however, that supply the muscular edges of the mantle, and the muscles of the funnel, by the movements of which the respiratory currents are produced, arise from the anterior sub-œsophageal mass, which has been spoken of as partly corresponding with the pharyngeal ganglion or medulla oblongata. There is nothing surprising in this change of situation, since we have already had to notice how constantly the position of the nervous centres is governed by that of the organs they supply; and, in this conjunction of the centres of the stomato-gastric and respiratory systems, and their approximation towards the cephalic ganglion, we recognise an evident approach towards the type of the vertebrata.

57. The supra-œsophageal or cephalic mass of the sepia, (Figs. 11, 12,) evidently possesses a much higher character than that of the nautilus. In the latter there existed, on the median line, only a sort of commissure, narrower than the rest of the band; whilst in the former we observe a distinct cordiform mass, from the lower and lateral parts of which the commissural bands proceed, that unite it with the optic ganglia, and with the sub-œsophageal mass. Although the latter is here single, it has a double connection with the cephalic ganglion; an anterior and posterior band uniting them on each side. Anterior to this, as in the nautilus, is a *labial* ganglion which is connected both with it and with the cephalic ganglion, and which supplies with branches the superior part of the mouth, especially the lips. Two branches proceed from it anteriorly, which encircle the œsophagus, and meet in a pharyngeal ganglion, of a double or bilobed form, on its under side at the base of the tongue.[1] We have here, therefore, the same separation of parts as in the patella, the *stomato-gastric* system being again insu-

[1] Brandt, loc. cit.

lated from the cephalic; the only difference is one of situation, the labial ganglion being in that instance anterior to the pharyngeal, whilst it is here posterior. Several filaments proceed from the pharyngeal ganglion, along the œsophagus, and descend to the stomach, where they reunite into a ganglion, from which branches diverge to supply the digestive system, and particularly the muscular parietes of the gizzard.[1]

58. From the anterior part of the sub-œsophageal mass arise the nerves which proceed to the tentacula; and these are evidently destined principally to the purposes of locomotion. This fact, therefore, indicates that the functions of this part are more restricted than those of the anterior collar of the nautilus, which sent off nerves to the sensory as well as to the motor tentacula, and also to the mouth, pharynx, and their muscles, which are here supplied from separate ganglia. This anterior portion also gives off, as in the nautilus, the nerves which supply the siphonic apparatus and which thus regulate the expiratory current of water.

59. From the posterior division of the sub-œsophageal mass, which is partially separated from the anterior by the aorta, are given off, first and nearest the median line, the branchio-visceral trunks, of which part form a plexus upon the vena cava, as in the nautilus, whilst the larger portion is distributed upon the viscera and branchiæ; the visceral division assisting the pharyngeal to form the gastric ganglion, and the branchial having an elongated ganglion at its points of separation. Behind and externally to these arise two large cords which have no distinct analogues in the nautilus, since they are destined to supply the posterior part of the mantle, which is here a very important muscular organ, but there was covered by the shell. Before their distribution, however, they form a large stellated ganglion, from which the nerves radiate; but where the mantle is prolonged into fin-like processes, the branches which supply these *do not* pass through the ganglia. The anterior part of the mantle is supplied by a distinct set of small nerves, corresponding with those which alone exist in the nautilus. The active motions of the posterior part of the mantle are here the great agents in producing the rapid respiratory currents, required for the complete aeration of the blood of animals whose movements are so energetic. Amongst these respiratory nerves arise, as in vertebrata, the small filaments which supply the acoustic organs. The anterior part of the mantle is supplied by a distinct set of small nerves, corresponding with those which alone exist in the nautilus.

60. Some interesting peculiarities in the distribution of the nerves supplying the arms are worth notice in this place. Just before the divergence of these members, the nervous trunks give off a

[1] Mr. Owen appears to be in error in asserting that these anterior ganglia correspond with the labial ganglia of the nautilus; since their filaments are almost entirely disposed on the lower part of the mouth, and on the œsophagus, salivary glands, &c. See Garner, loc. cit.

filament on each side, which meet corresponding filaments from the neighbouring trunks, and thus form a continuous circle uniting the nerves of all the arms.[1] It can scarcely be doubted that the purpose of this structure is to produce that *consentaneousness* of action among them, so necessary for active locomotion, especially where their movements are the only means of progression enjoyed by the animal, as in the poulp. Along each trunk is a series of ganglionic enlargements, which correspond to the suckers on the surface of the arm, and send radiating nerves to them. According to Dr. Sharpey,[2] each trunk consists of a pair of cords, of which *one* only presents ganglionic enlargements, whilst the other passes over these, without contributing to their formation. Another interesting circumstance is pointed out by Mr. Owen.[3] "In the cephalopods, whose shells are rudimentary and internal, and whose bodies are enveloped in a naked, and, as we must suppose, sensible mantle, the nerves which supply that part radiate from a ganglion, which, as in the posterior roots of the spinal nerves in the vertebrata, is interposed on the chord which brings them in communication with the central mass. In *nautilus* on the contrary, whose body is encased in an insensible calcareous covering, the analogous nerves are wholly expended on the largely developed muscles which attach the shell to the body; and these nerves, like the motor filaments of the spinal nerves, pass into the muscles directly from the brain, without the interposition of any such ganglion." If this ingenious view be correct, we should here perceive the first indication of the intervertebral ganglia of higher animals. But there is, we think with Mr. Garner, as much reason for regarding it as a *palleal* ganglion, analogous to those met with in gasteropoda, and the centre of the respiratory movements of the mantle (§ 64); whilst the trunk that passes over it, and is continuous with the œsophageal collar, would influence its movements as an organ of general locomotion.

61. In both these orders of cephalopods, the nervous centres are protected by cartilaginous supports which obviously foreshadow the *neuro-skeleton* of vertebrata. In the nautilus, the œsophageal collar rests upon a firm cartilage, which does not, however, enclose it, but gives attachment to the powerful muscles of its neighbourhood. In most of the superior order, the cephalic ganglion, with the sub-œsophageal mass, are enclosed in a cartilaginous envelope, the cavity of which, however, they do not entirely fill; the intervening space, like that within the cranium of fishes, being occupied by a gelatinous fluid disposed in cells formed by the arachnoid membrane. The expanded wings of this cartilage support and protect the eye-ball; and in its substance the organ of hearing is imbedded. The nuchal cartilage, which is placed behind it, not

[1] Cuvier, Mem. sur la Poulpe, p. 36.
[2] Müller's Physiology, i. 676.
[3] Memoir on the Nautilus, p. 57.

only gives attachment to the muscles of the mantle, but protects the great lateral nerves; and this, with the long cartilaginous plates which support the fin-like processes, where they exist, is evidently the rudiment of the osseous column, which protects the spinal cord in vertebrata, but which, in the lowest of that division, is reduced to the form of a simple cartilaginous tube, as in the cyclostome fishes.

62. The central portion of the cephalic mass in the *sepia* may perhaps be regarded as more analogous to the cerebral hemispheres of vertebrata than any thing we have as yet seen in the mollusca, since the optic ganglia are here distinctly developed in a separate form. Should the labial ganglia participate in the function of smell, their connection with the cephalic mass would evidently resemble that of the pedunculated olfactory lobes in many fishes. As this central mass contains gray matter, it is obviously something else than a mere commissure between the optic lobes, as some have represented it; but as it also gives off the lingual and maxillary nerves, we must regard it as participating in the functions of the medulla oblongata.

63. However strange it may appear to assert that the sub-œsophageal mass is a kind of concentrated spinal cord, a little consideration will show that this is really the light in which it should be viewed. In tracing the arrangement of the nervous centres in the mollusca, we have found the principle of *connections* our only safe guide; and its application here becomes of some importance. From the anterior portion of the mass are given off, as already mentioned, the nerves which supply the feet or rather tentacula; and it is therefore to be regarded as a *locomotive* ganglion, or rather as formed by the union of many such. It is only the situation of the locomotive organs around the head that occasions the giving off of these nerves from one spot, and *that* the *anterior* portion of the collar. Knowing, as we do, the varieties of position which this ganglion is capable of assuming, we cannot doubt that, if the feet had been all at the opposite extremity of the body, the ganglionic masses would have been removed to that situation; or that, if they had been disposed along the body, as in articulata, we should have had either a series of such ganglia, as in that group, or one prolonged ganglionic mass, like that presented by the spinal cord of vertebrata. That in either of these groups a concentration may take place equivalent to that which we here witness, need scarcely be pointed out; in the *crab*, for example, we have all the locomotive ganglia united into a single centre, and this only occupies the thorax, because the legs are connected with that division of the body; whilst, in the *lophius piscatorius*, and other fishes whose locomotive organs are principally disposed in the anterior part of the body, we find the *true spinal cord* or ganglionic mass soon terminating on a *cauda equina* consisting of nerves alone, like the bundle which passes backwards from the œsophageal collar of the sepia.

64. The *posterior* portion of the sub-œsophageal mass is evidently most analogous to the medulla oblongata, giving origin as it does to the auditory and respiratory nerves, as well as to those of general sense and motion. That it should be here placed *behind* the mass which we regard as analogous to the spinal cord, will not be wondered at when the relative situations of the parts supplied by these respective centres is taken into consideration. It is unnecessary, however, to draw a definite line of division between them, since they really constitute but *one* organ: and we find this part supplying, in some of the species, locomotive nerves even more important than those of the feet—those, namely, of the fin. It is an important fact, that the ganglion upon the palleal nerves formerly mentioned is constant in all the naked species; whilst the trunk that passes over the ganglion is only found in such as possess the fin-like processes of the mantle, and is distributed entirely upon those parts. We should hence be led to believe that this ganglion is connected with the respiratory functions of the mantle, which are constant in *all* of this order, and is *not* analogous to the intervertebral ganglion upon the sensory nerves, as Mr. Owen supposes. Perhaps the question might be settled by a reference to its anatomical structure—which of the two arrangements formerly mentioned (§ 45,) its white and gray portions present.

65. It can scarcely be doubted that the *branchio-visceral* nerves sent off from the posterior part of the collar, with their venous plexus, are partly of a *sympathetic* character, since we know how closely this last system of nerves is united with the sensori-motor in the classes beneath, not having yet acquired any distinct centre of its own. Such a one would here seem to exist, however, in the visceral or cœliac ganglion, to the formation of which these nerves contribute, (§ 59,) and which sends branches to the alimentary canal, generative organs, ink-bag, &c. The branchial portion of this system, however, does not enter this ganglion, but forms a small one of its own, before its distribution to the gills. This, therefore, may be regarded as principally analogous to the respiratory portion of the par vagum; and its function will evidently be to convey to the general centre those impressions from the branchiæ, the stimulus of which is necessary to keep up the respiratory movements. Such a union of the sympathetic and par vagum appears to exist, through an interlacement of their filaments, to a greater extent than has hitherto been supposed, even in man and the mammalia—but it is far greater in fishes; and it appears from the recent experiments of Dr. J. Reid, that the sympathetic is partly concerned (perhaps through the filaments of the par vagum which it contains) in conveying these impressions. The consideration of the *stomato-gastric* system we shall again defer for a time. (§ 92, 3.)

66. We shall next enquire what inferences of a general character can de deduced from the facts which have been brought together in regard to the structure and distribution of the nervous system in the mollusca and radiata. In the *first* place, we have found no

case in which nervous fibres exist without connection with a ganglionic mass, characterised by the presence of gray matter, or of something equivalent to it. We know that, in the higher animals, the separation of a nervous trunk from its centre renders it incapable of serving as the medium of reflex actions of any kind, whether sensation and volition be concerned in them or not; and we may fairly infer that the same principle extends to the lower, in which the same distinction of parts is manifest. There would seem, then, much reason to believe that ganglia are situated wherever impressions made upon the afferent nerves are destined to excite motions; and, farther, that the change by which this is effected takes place between the white and the gray matter. Thus, we have the nerves of the foot partly terminating in one ganglion, those of the respiratory apparatus in another;—and so on.

67. It may be remarked, in the *second* place, that, wherever the presence of special sensory organs confined to one part of the body gives to that part a predominance over the rest, (the entrance to the alimentary canal being always in their neighborhood,) we find the ganglia with which they are connected possessing a special relation with all the rest, which these do not possess with each other. It is obvious that, where visual organs are developed, the impressions made upon these will determine the movements of the animal, more than those of any other kind; and it would seem to be chiefly owing to the information which they communicate, that the cephalic ganglion has such an evident presiding influence over the rest, even when smaller than any one of them. This is, however, more the case in animals whose movements are rapid, and in which, therefore, the perception of *distant* objects is more important, as in the articulated classes. Except in the cephalopodo, the subservience of the nervous system to the nutritive functions of the mollusca is so great, that it might almost be regarded as an appendage to the digestive organs, destined for the selection and prehension of aliment. But in the more active members of that class, it derives a more elevated character from the developement of the organs of special sensation and of locomotion. It has been seen that filaments from the cephalic ganglia enter into the composition of all or nearly all the nerves of the mollusca; the trunks which connect them with other ganglia not terminating in those ganglia, but intermingling with the nerves which proceed from them. In the structure which Dr. Sharpey has detected in the arms of the cuttle-fish, we find a very interesting example of this general fact, (§ 60;) and it is by no means difficult to assign its use in accordance with the views here laid down. The suckers seem capable of contracting and fixing themselves, either in obedience to the will of the animal, communicated to them along the non-ganglionic cords from the central mass, or in respondence to a stimulus excited by contact, and acting through the afferent and efferent nerves of their ganglia alone. But it may be said that, in all these cases, the ganglia in the course of the trunks are equivalent to the intervertebral ganglia in

vertebrated animals, and merely distinguish the sensory from the motor portion of the trunk. Such an idea is, however, completely refuted when we apply it to the nervous system of the lower mollusca, where we find the cephalic ganglion gradually diminishing in size, until the posterior or *branchial* is obviously the *principle* centre of the actions of the animal, and cannot, therefore, be of the nature of an intervertebral ganglion. Going still lower—to the tunicata—we find this respiratory ganglion the only one remaining. The gangliated cord of the sepia, therefore, evidently repeats, on a small scale, the same characters as have been shown to exist in the larger centres of other mollusca. And this is demonstrable by experiment, as well as by structural analogy; for when the arm of a cuttle-fish is severed from its body, and the nervous cord, as a whole, has no termination in a ganglionic centre, any sucker may be stimulated to contract,—the effect being obviously produced through the nerves of its own ganglion. It is well known, that the intervertebral ganglion bestows no independent action on the spinal nerve, which is powerless when separated from its true ganglionic centre; and we cannot, therefore, but regard it as next to certain, that the ganglia in question are so many independent centres of reflex action, whose operations are controlled, directed, and combined by the cephalic ganglia, through the medium of the fibrous band that passes over them, and mixes its branches with theirs.

68. We may observe, *thirdly*, that in passing downwards to the tunicata, we find the nervous system losing one part after another, until the respiratory ganglion is all that remains. This must be regarded, however, as combining in some degree the functions of the rest (so far, at least, as the general structure of the animal allows these functions to be performed;) but the control over the movements of the respiratory sac is evidently its principal office. The mere act of respiration, or the aeration of the blood, can scarcely be regarded as dependent upon any influence derived from the nerves, for the reasons stated at the commencement of this essay, and also because it may be effected out of the body; but the working of the mechanism by which the conditions of the change are brought into play would seem an important part of the functions of the nervous system wherever such exists. Now, it has been shown by experiment that in the vertebrata the whole of the nervous centres may be removed, except that segment of the cerebro-spinal axis which connects the principal respiratory nerves—in fact, the *respiratory ganglion*,—and yet the animal may continue to exist for some time. It is curious to see how such experiments are, as Cuvier expressed it, "ready performed for us by nature," in this class of animals.

69. We may trace, in the *fourth* place, a close relation between the predominance of the cephalic ganglion, and the evidence of the operations of sensation and volition, as manifested in the movements of the animal. So long as food is within its reach, we can scarcely regard its prehension as of any higher character than that of the

infant when it applies its lips to the nipple of the mother; and this action, we know, is not dependent on the presence of the brain, and is therefore, we think, not the result of sensation or volition, although in the perfect condition accompanied by the former. But when the animal has to exercise its organs of special sensation, and to put its general locomotive apparatus into activity for the purpose of seeking its aliment, its operations must be regarded as of a higher order; yet the greater part of these may still, perhaps, be considered *instinctive*, that is to say, not involving any reasoning powers, or any notion of *purpose* on the part of the animal itself. We may take a well known case in illustration,—the ejection of the contents of the ink-bag, which takes place when the cuttle-fish is pursued. This has been regarded by some as of a *voluntary* character, and as indicating a *design* on the part of the animal to conceal itself from its pursuers. But such a supposition involves an amount of reasoning power on the part of the animal which we can scarcely attribute to it; and if the action were not performed as well the *first* time as it might be on a subsequent occasion, it would obviously be of little use. Is it not rather an involuntary or *emotional* action, analogous to the expulsion of the contents of the rectum and bladder under the influence of fear, which many of the human species know by experience to result from an impulse uncontrollable by the will? This view of its character is strengthened by the fact that the secretion of *ink* is really analogous to that of *urine*.

We shall now enquire how far these inferences are applicable to the nervous system of the articulata.

V. NERVOUS SYSTEM IN THE ARTICULATA.

70. The animals composing this group all present, in a more or less evident degree, a division into segments, which have an obvious tendency to resemble one another, as in the radiata. In the higher classes, however, this segmentation is obscured by the modifications which cause the different segments to assume dissimilar forms, and perform distinct functions. In those species, however, which may be regarded as typical of the group,—as among the myriapoda,—there is an almost perfect equality in all the segments. In such the nervous system is merely a repetition of similar parts, disposed, not in a circle, as in the radiata, but in a continuous line. The most anterior, however, has an evident predominating influence, for the reason formerly specified (§ 67); and this influence will be found to diminish with the loss, and to increase with the developement, of the faculties of special sensation which have their seat there. The locomotive powers are just as predominant in the articulated series as are the nutritive functions among the mollusca. Accordingly, we find the developement of the nervous system to bear a special reference to them; and the sensori-motor divisions of

it can be more distinctly separated from the portion which ministers to the organic functions.

71. A very brief sketch of the gradual developement of this system in the lower articulata will be here sufficient; since it is in the higher groups that its peculiarities can be best studied. In the *strongylus*, one of the entozoa, (Fig. 13,) we find a single cord running from one extremity of the body to the other, but separating into two portions to embrace the orifices of the alimentary canal, where some slight ganglionic enlargements appear; from this are given off slender filaments at short intervals, which encompass the body, whose whole surface seems equally sensitive. A similar cord has been stated by Cloquet to exist in the *ascaris lumbricoides*, divisable, however, into two filaments along its whole length; but this observer also describes another similar cord as running on the dorsal surface, and as communicating with the first by a sort of œsophageal collar. This statement has been recently controverted by Leuret,[1] who maintains that the dorsal cords are evidently vascular; and certainly their situation is not such as we could easily explain, regarding them as nervous, except upon the supposition that they are analogous to the stomato-gastric system which will be hereafter described in the higher articulata. In the *linguatula*, a single stellated ganglion is described by Mr. Owen as situated beneath the œsophagus, from which nerves diverge to supply the muscular apparatus of the mouth, and the prehensile booklets; whilst two large cords pass backwards along the edges of the abdomen to near the posterior extremity, where they gradually become expanded and blended with the muscular tissue, (Fig. 14.)

72. A somewhat similar arrangement has been traced in the rotifera, whose nervous system, notwithstanding their minuteness, is very distinct. In Fig. 15 is represented that of the *hydatina*, which consists of a circle of ganglia surrounding the entrance to the alimentary canal, and giving off filaments to the powerful muscles of the jaws, and to the ciliary apparatus of the wheels, and also a nervous cord that proceeds backwards to the posterior extremity of the body. In the species now described, this cord is single and destitute of ganglia: but in others it is evidently double, and one or two pairs of ganglia exist upon it. Here, then, we see a concentration of the ganglia at the anterior part of the body, in opposition to the general type of the group to which this class belongs, but in accordance with the disposition of the locomotive apparatus.

73. In the cirrhopoda we find another variety in the disposition of the nervous system, the same essential type, however, being retained; and it was the discovery of the double ganglionic cord in these animals that first led to the suspicion that they should be classed with the articulata, and not with the mollusca, to which their general conformation and habits apparently liken them. In

[1] Op. cit. p. 55.

Fig. 16 is shown the nervous system of the *anatifa*, which is seen to consist of a slender nervous collar surrounding the œsophgaus, and sending filaments to the neighbouring parts, but scarcely forming ganglia above it,—this creature being, in its fixed adult state, destitute of the eyes and antennæ which it possessed when in its early condition of a free-moving crustaceous animal: from this nervous ring a double column proceeds along the body, on which ganglia are found at the points that give origin to the nerves of the members.

74. In the lower annelida, such as the *earthworm*, the conformation of the nervous system is but little different from that just described in the strongylus. A nervous cord traverses the whole length of the body, forming a ring at its anterior extremity, through which the œsophagus passes. At the anterior portion of this, we find two small ganglia, from which nerves proceed to the mouth and sensitive lips; but there are as yet no eyes. Nervous trunks are given off at intervals along the ventral cord; and, according to the recent statements of M. Leuret,[1] these are given off alternately in double and single pairs; a slight ganglionic enlargement of the cord being apparent where the double pairs are given off, but not at the intermediate points. This fact is interesting, as showing, even in this low grade, the outline of a peculiar structure which will be described in the nervous system of insects. The nervous system of the *leech* bears a general resemblance to that of the earthworm; but we here find the rudiments of a separate *stomato-gastric* system also.[2] A minute ganglion exists at the base of each of the three teeth which form the mouth; these ganglia are connected together and to the cephalic by slender filaments; and they seem also to be in connection with other filaments which may be traced on the alimentary canal. In the higher annelida, such as the *aphrodita*, the same general type is witnessed in a higher grade of developement. Eyes and antennæ exist, although imperfect in their character, and the cephalic ganglia meet above the œsophagus. The ganglia of the ventral cord are much more distinct, but nearly equal along their whole length, (Fig. 17.)

75. We next arrive at the myriapoda, which present the type of the nervous system of the articulata in a sufficiently developed form to serve as a basis for our enquiries. The cephalic ganglia receive the nerves of the eyes and antennæ, and are united on the median line; but they are still of small size, in accordance with the low developement of the sensory organs. The ganglia of the longitudinal cord are well marked, and nearly equal from one end of the body to the other; each sends off nerves to its respective segment; and the branches proceeding from the different ganglia have little communication with each other. Between the ganglia we find intermediate nerves given off, as in the earthworm, (Fig. 18.) Besides these, we find a separate system of visceral or stomato-gas-

[1] Op. cit. p. 58. [2] Brandt, loc. cit.

tric nerves, of complex distribution, (Fig. 19.) A small ganglion is placed on the median line in front of the cephalic mass, with which it is connected; and from this filaments proceed to the mouth and pass down the œsophagus to the stomach. There is another set of ganglia and filaments placed laterally: the ganglia, which are sometimes two on each side, are situated behind the cephalic mass, and communicate with the anterior ganglion by filaments passing beneath it; they also communicate with each other, with the nerves passing off from the ventral cord, and with the *recurrent* trunk (as it has been termed) proceeding downwards from the anterior ganglion; and the plexus to which they give origin is distributed upon the digestive organs.

76. We shall here stop to enquire into the ultimate structure and arrangement of some of the divisions of this nervous apparatus. The nerves themselves are composed of cylindrical tubes, like those which exist in the mollusca, but more firm. The cephalic ganglia have exactly the same structure as that formerly described (§ 45); that is to say, they contain a nucleus of gray matter, in which the roots of the nerves seem to lose themselves. When we examine one of the ganglia on the ventral cord, and the nerves which seem to originate from it, we find that each nerve has three series of roots, one of which terminates, as in the other cases, in the gray matter of the ganglion; another interlaces with those of the opposite side; whilst the third is *continuous* with the fibrous portion of the cord, which may be traced uninterruptedly to the cephalic ganglia. When the structure of the cord itself is analysed, it is seen that the fibrous tract or column is throughout distinct from that which contains the ganglionic enlargements; and that it does not contribute towards the formation of these, but passes over them (as was first observed by Mr. Newport) like the analogous trunk in the arms of the cuttle-fish. This is not to be confounded with the third and narrower tract, which is still more distinct, and possesses ganglia of its own; of this, which seems connected with the respiratory function, but which is considered the motor tract by Dr. Grant, the structure and character will be described in insects, where it is more fully developed.

77. After what has been said of the offices which the ganglia seem to perform in the mollusca, and of the relation which they bear to the cephalic mass, we should have little difficulty in applying the same views to this portion of the apparatus in the articulata, had not another explanation of a very plausible character, but founded on what we deem loose and flimsy analogies, been generally received by physiologists. When we examine the actions of this cord, we at once perceive that those of all its ganglia are similar to one another, being related only to the movements of their respective segments, and of the members which belong to them. In fact, they are *so many repetitions of the pedal or locomotive ganglion of the mollusca.* It is easily proved that the movements of each pair of feet may be produced by that ganglion

alone with which it is connected; since a single segment, isolated from the rest, will continue to perform these movements for some time under favourable circumstances. Thus, if an earthworm be cut in two whilst crawling, each portion will continue to advance, though the anterior only will permanently preserve its vitality; and, if a centipede or millipede be divided into several portions under the same circumstances, each will execute movements of progression for some time. But it is evident that these must be placed, in the living animal, under some general control, by which the consentaneousness of action that is essential to regular locomotion may be produced. This is easily proved by experiment. If in a *mantis*, for example, the nervous cord be divided between the first and second thoracic ganglia, so as to isolate the ganglionic centres of the posterior legs, the limbs will continue to move energetically, but not with a combined object, and no progression will be the result. We can scarcely suppose this general control to be exercised otherwise than by the fibrous tract which connects each of the nervous trunks immediately with the cephalic ganglia, as in the mollusca; and this must, therefore, conduct to these centres the impressions which produce sensations in them, and convey downwards from them the locomotive impulse; whilst the ganglion of each segment, with the filaments proceeding from its gray matter, will form the circle necessary for the simple reflex actions of the members.

78. But, it may be asked, what advantage has this view of the character of the ventral cord over that which is current amongst physiologists? To which question a reply may be best given by asking another. Upon what evidence is that view supported? The doctrine that the ganglionic portion of the cord is *sensory*, and the fibrous or non-ganglionic *motor*, is principally based on the assumption that the ganglia are analogous to those found on the posterior roots of the spinal nerves, into which the motor fibrils do not enter. The comparison of the structure of the two, however, completely disproves this assumption. The fibres which enter the intervertebral ganglia *pass through* them to their true centre—the spinal cord; where they are partly lost in the gray matter, and partly continuous with the white. On the other hand, part of the filaments which enter *these* ganglia *terminate* in their gray substance; whilst others become continuous with the fibrous column—just as in the spinal cord of vertebrata. It is evident, then, that their true analogy is with the segments of that cord; the fibrous tract resembling its white columns, whilst the ganglionic nodules may be compared with its gray centre, which often presents similar enlargements, and which is to be regarded as a continuous chain of ganglia. Such, perhaps, we find shadowed forth in the lowest of the vermiform tribes, where the segments are so numerous that no distinct ganglia are formed, but the single longitudinal cord seems to possess the same character throughout. Moreover, the true analogues of the intervertebral ganglia are discoverable in

some crustacea, which present minute enlargements upon the nervous trunks at a little distance from the cord.[1] The argument drawn from the proximity of the so called motor column to the viscera, and its consequent analogy with the anterior columns of the spinal cord, is obviously not alone sufficient to support the doctrine in question; especially since the respiratory column still intervenes, proving that the *arrangement* of the centres is altogether different.

78. The results of experimental enquiry seem to us conclusive against the doctrine of the sensory and motor functions of the ganglionic and fibrous columns of the ventral cord of the articulata. How is it that motions may be excited in the members of a single segment by irritating them, when, the cord being divided above and below, its two tracts have no structural communication? As they may be separately traced, in many instances at least, up to the brain or cephalic mass, *that* would seem the only point through which reflex actions could be produced—which we know is very far from being the case. As no experimental proof of the correctness of this doctrine has yet been adduced, and as its chief support is an analogy which has been shown to be fallacious, it can scarcely maintain its ground against any other which is more consonant with structural analogy and with physiological phenomena.

79. Such, it may be urged, is the opinion formerly adduced—that the ganglionic portion of the cord ministers to those reflex actions which are independent of the will, and perhaps also of sensation; whilst the fibrous column is a continuation, as it were, of a portion of each nervous trunk to the cephalic ganglia. The independence of the segments, as far as their reflex actions are concerned, and their common subordination to one presiding centre of the will, are fully explained on this supposition. It is also quite conformable to the analogy both of the mollusca and of vertebrata. We have seen that, in the former, where the ganglia are more isolated from one another and from the presiding centre, each ganglion appears to be the centre of the simply reflex actions occurring in the organ with which it is connected; but that a part of the nervous fibres which seem to enter it really pass on to communicate with the central mass, where alone, it may be surmised, *sensations* can be felt, and *voluntary* impulses excited. And, on the other hand, in the vertebrata we find the ganglionic or mixed portion of the spinal cord, and the simply fibrous tracts, performing functions respectively analogous; for, when any segment is isolated from the rest, reflex actions may be excited through it, in the production of which the white columns can scarcely participate, being structurally distinct from each other and from the ganglionic portion of the cord, and continuous only with the fibrous portion of the brain; whilst pathology supplies us with instances of the converse occurrence, namely, the destruction of the ganglionic portion by disease,

[1] Leuret, Op. cit. p. 76.

without the functions of the parts below being impaired—*their* ganglionic portion being segmentally independent, and their communication with the brain being maintained by a continuity of white or fibrous structure.[1] Other pathological cases demonstrate that, when reflex actions are excited through a segment of the spinal cord unconnected with the brain, sensations are not involved in their performance; and we might, therefore, infer from analogy that the ganglia of the cord in articulata are not the seat of *sensibility*, any more than the spinal cord of vertebrata. On this point, however, we cannot arrive at any certainty; and perhaps there is some reason, on the contrary, to believe that, in these classes, sensibility is more extensively diffused through the nervous centres than in the higher, since we find the endowments of all the ganglia becoming more and more similar as we descend the scale, until in the starfish they seem identical, and each appears the seat of some amount of sensibility to visual impressions.

80. The number and variety of the reflex actions which take place in articulata after decapitation, is very remarkable; and they seem to have a consentaneousness proportioned to the closeness of the relation between the nervous centres in different species. Thus, in the *scolopendra*, we find the ganglia of each segment distinct, but connected by a commissural trunk. Here an impression made *equally* upon the afferent nerves of *all* the ganglia, will produce a consentaneous action. Thus, M. Dugès[2] relates that, if the stigmata on one side of a decapitated scolopendra be exposed to an irritating vapour, the body will be immediately flexed in the opposite direction; and that, if the stigmata of the other side be then similarly irritated, a contrary movement will occur. But different actions may be excited in different parts of the cord, by the proper disposition of the irritating cause. In the higher classes, however, where the ganglia of the locomotive organs are much concentrated, the same irritation will produce consentaneous motions in several members, similar to those which the unmutilated animal performs. Thus, the *mantis religiosa* customarily places itself in a very curious position, especially when threatened or attacked, resting upon its two posterior pairs of legs, and elevating its thorax and the anterior pair, which are armed with powerful claws; the resemblance fancied to exist between this attitude and that of prayer

[1] Mr. Mayo long ago suggested the analogy between the fibrous portion of the spinal cord, and the trunks uniting the ganglia of the articulata, (Physiology, 2d edit.) But this analogy is not altogether correct; for these trunks partly connect the ganglia themselves, (like those between the isolated centres of *bullæa* § 41,) and are partly independent of them. More recently, Dr. M. Hall has suggested that the ganglionic portion of the cord ministers to the reflex actions of the respective segments, whilst the white tract conveys the motor influence of the cephalic ganglia. We can scarcely suppose that it has this function, however, without also conveying sensory impressions *to* those ganglia, as there is no reason to believe that this is done peculiarly by the ganglionic column.

[2] Op. cit. tom. i. p. 162.

has occasioned the specific name of the animal, but it is rather an attitude of resistance. If the anterior segment of the thorax with its attached members be removed, the posterior part of the body will still remain balanced upon the four legs which belong to it, resisting any attempts to overthrow it, recovering its position when disturbed, and performing the same agitated movements of the wings and elytra as when the unmutilated animal is irritated. On the other hand, the detached portion of the thorax, which contains a ganglion, will, when separated from the head, set in motion its long arms, and impress their hooks on the fingers which hold it. These facts prove unequivocally that the instinctive movements of these parts, which are performed in direct respondence to external impressions, require only for their stimulation the ganglionic centre with which the nerves that excite them are immediately connected.

81. Another instance, related by Burmeister, is still more satisfactory in regard to the manner in which these movements are excited. A specimen of the *dytiscus sulcatus*, from which the cephalic ganglia had been removed, executed the usual swimming motions, when cast into water, with great energy and rapidity, striking all its comrades to one side by its violence, and persisting in this for half an hour; but, whilst previously lying with its abdomen on a dry surface, no such actions were excited.

82. We shall now enquire how far these views are applicable to the remainder of the articulated classes; and we shall commence by examining in detail the nervous system of insects, of which the general characters only have yet been adverted to. In their *larva* state, we find it consisting of a chain of ganglia disposed along the ventral surface, similar to each other in every respect, and one of them appertaining to each segment; with a cephalic ganglion, more or less developed, according to the perfection of the sensory organs connected with it. In this condition, therefore, the nervous system of insects perfectly repeats that which is characteristic of the annelida; and the varieties of both correspond in the most interesting manner, (fig. 20.) Besides the nervous trunks given off from the cord at its ganglionic enlargements, (and which consist, as in former instances, of two portions derived from its ganglionic and fibrous tracts,) we find, in the lower classes, a series of nerves, given off at the intermediate points, without any apparent swelling at their points of divergence. It is not easy to ascertain the true connections of these, except in the thoracic region, where the ganglionic columns usually diverge laterally, especially when the metamorphosis is taking place into the pupa state. It is then seen (fig. 21) that a third column exists on the superior or visceral aspect of the ventral cord; and that these nerves are given off from minute ganglionic enlargements upon it, which are much more distinctly seen, however, in the perfect insect.

83. Although these nerves communicate with those of the symmetrical system, they have a separate distribution, being transmitted

especially to the tracheæ, on the parietes of which they ramify minutely, and also to the muscles concerned in the respiratory movements. The latter, however, being a part of the general locomotive apparatus, are also supplied from the ganglionic column. These transverse or superadded nerves do *not* supply the muscles which open and close the stigmata or external orifices of the tracheæ; and this might be thought inconsistent with the supposition that they are especially concerned in the respiratory function, if it were not recollected that the closure of the stigmata is an action more connected with the voluntary movements of the animal than with the mechanism of its aeration, it being in this manner that it prepares itself for flight, or for any other powerful exertion. These nerves, then, would seem analogous to those of the gills and mantle in the mollusca, and may be regarded as corresponding with the pneumonic portion of the par vagum in vertebrata, which is in like manner distributed on the air passages, and with its associated motor nerves. It is to be recollected that the respiratory apparatus of insects is diffused throughout the whole body, so that its presiding system of nerves must be proportionably extended; and we here seem to have the *branchial* ganglion of the mollusca, repeated like the *pedal*, in each segment. The enlargement of the ganglionic mass during the metamorphosis, is a very interesting fact in relation to the increased activity of the respiratory function in the perfect insect.

84. The *stomato-gastric* system obtains a high degree of developement in insects, and is usually distinct in the larva as in the imago. It consists of two distinct parts. The first of these, which is situated in the median line, has been called the *recurrent* nerve. It is described by Mr. Newport in the *sphinx ligustri*, as appearing to commence by two roots from the peduncles which connect the cephalic with the first thoracic ganglion (fig. 22.) These converge and meet in a ganglion situated on the palate, which is thus anterior and inferior to the cephalic mass. From this ganglion nerves proceed to the walls of the buccal cavity, to the mandibles, &c.; whilst the principal trunk passes backwards to the pharynx, and is distributed on the œsophagus and stomach. Mr. N. regards this ganglion as analogous to the enlargement which is found on the par vagum when passing through the foramen lacerum; but *that* is evidently of the nature of an intervertebral ganglion; and we shall have reason from analogy to regard this as the ganglionic *centre* of the system of nerves proceeding from it, and the filaments which connect it with the peduncles of the cephalic ganglia as merely cords of communication. Its position and connections fully point out its analogy with the pharyngeal ganglia of the mollusca, which are undoubtedly independent centres. Besides this median system of nerves, there is another disposed laterally, which seems of a different character. In the sphinx, we find two small ganglia behind the cephalic, which are connected with these, and also with the recurrent system, as well as with the respiratory nerves. Of the

ultimate distribution of these filaments, Mr. N. does not give a very minute account: but further details will be presently given (§ 88,) in regard to the development of this system in the perfect insect.

85. Without following in minute detail the changes which occur in the nervous system during the metamorphosis, or describing the various forms which it assumes in the different orders of insects in their perfect state, such particulars will be adduced as bear upon the objects of the present essay. It will have been observed that the nervous system of the larva is constructed in exact accordance with its means and extent of locomotion. Each segment (in general at least) possesses a pair of legs; and with each is associated a *pedal* ganglion. None of the movements of the animal (in those tribes which undergo a complete metamorphosis, to which this description more particularly applies,) are very energetic; simple and slow progression is all for which its structure is adapted; and the uniformity in the actions of its legs would render it easy to combine them at the will of the animal, even though their respective centres remain so much isolated from one another.

86. But, in the perfect insect, the whole locomotive apparatus is concentrated in the thorax. The six legs (which are now all that remain) and the single or double pairs of wings, are all developed from its three segments; and a much greater variety of action is required, as well as more complete consentaneousness, on account of the increased number and velocity of the movements of the animal. We accordingly find that the ganglionic matter of the ventral cord of perfect insects is more or less concentrated in the thoracic region; whilst the ganglia of the abdomen are usually few and small (fig. 23); the nerves to its segments, however, being given off as before at regular intervals. Upon the hypothesis that the ganglionic cord corresponds with the sensory columns in vertebrata, we should be obliged to suppose that these parts of the body are destitute of sensation, whilst they retain their motor faculties. This would seem highly improbable, since these are the very parts in which the least active movements take place, whilst the ganglionic matter is carried on to those segments which give attachment to the members whose reflex actions are so remarkable (§ 80.)

87. The three tracts of which the ventral cord has been described as consisting, may be seen in most perfect insects, especially in some of the hemiptera. The ganglia of the transverse or the respiratory series are more apparent in this condition than previously to the metamorphosis. The nerves which supply the wings are found, in all the stages of the developement of these organs to have a double origin. One root arises from the fibrous tract alone, whilst the other takes its origin from both tracts at the point of enlargement. The wings are also supplied with nerves from the transverse system, of which scarcely any go to the legs; this will be readily understood when it is considered that the wings are developed, as it were out of an extension of the respiratory apparatus,[1] and that its actions

[1] See Princ. of Gen. and Comp. Phys. p. 165 and 308.

are closely connected with these movements. There is another interesting peculiarity to be noticed in regard to the distribution of the nerves of the wings. Where the ganglionic centres which supply the anterior and posterior pairs remain distinct, there is a curious plexiform arrangement of their nerves, more or less intricate. according as the wings are destined to act with greater or less consentaneous energy, and absent when the anterior pair serve only as *elytra*, and do not assist in flight.[1] This would remind us therefore, of the circular filament which was seen to connect the nerves of the arms in the naked cephalopoda.

88. As an illustration of the stomato-gastric system in perfect insects, we may advantageously select the highly developed form in which it exists in the *gryllotalpa vulgaris*,[2] (mole cricket.) The median system appears to originate in a small ganglion, (*a*, fig. 24,) situated, as in the sphinx, anteriorly and inferiorly to the cephalic mass, (A, A,) with which it communicates by a connecting branch on each side. Its principal trunk, the *recurrent* of authors, is sent backwards, beneath the pharynx; and on this a slight ganglionic enlargement is seen, where the connecting branches are given off which unite it with the lateral system. Its ramifications are distributed along the œsophageal tube and dorsal vessel; whilst the trunk passes downwards to the stomach, where its branches inosculate with those supplied by the lateral system, and seem to assist in forming a pair of small ganglia, (*d*, *d*) from which most of the visceral nerves radiate.

89. The ganglia of the lateral system are two on each side. (*b*, *b* and *c*, *c*.) The anterior pair are the largest, and meet on the median line, just behind the cephalic ganglia, with which they communicate. Posteriorly to these lie the second pair, which are in connection with them. Two cords pass backwards on each side, one derived from the anterior, the other from the posterior of these ganglia. They run along the sides of the œsophagus and dorsal vessel, and are finally distributed on the digestive viscera, where they assist in forming the ganglia already mentioned.

90. The concentration of the ganglia in the ventral cord is sometimes carried to a much greater extent than in the example already adduced. Thus, in the *melolontha vulgaris* (cockchaffer) we find all the abdominal ganglia consolidated into one, which is situated almost immediately behind the thoracic, and sends two principal trunks directly backwards, and others diverging to supply the respective segments (fig. 25.) In the *pentatoma grisea* we observe this concentration extending to the thorax as well as to the abdomen; the sensori-motor system possessing, in all, but three ganglionic masses, appertaining to the head, thorax, and abdomen respectively, (fig. 26.)

91. Upon a comparison of the nervous system of insects with

[1] All the *facts* relating to the Anatomy of Insects, detailed in the last six sections, are given on the authority of Mr. Newport. See his papers in the Philosophical Transactions for 1832, 1834, and 1836.

[2] Brandt, loc. cit.

that of the higher mollusca, it will be seen that they differ more in the relative proportions and in the management of their parts, than in their absolute character. In both, there is a cephalic division of the ganglionic centres, in which sensibility and voluntary power appear to reside more particularly, if not entirely. In both there is a division specially appropriated to the locomotive apparatus; differing only in the multiplication of the centres in insects, conformably with the arrangement of the members they supply; and sometimes, as we have just seen, consolidated even in them into two ganglionic masses. In both we find also a division appropriated to the respiratory apparatus, in which there is a corresponding multiplication of centres in the articulata, in harmony with the universal distribution of their tracheal system. And in both we find a separate system of nerves distributed to the alimentary apparatus, and supplying the organs of mastication, (with the salivary glands,) deglutition, and digestion. Into the character of this *stomato-gastric* system we shall now enquire.

92. As a preliminary to this enquiry it is to be remarked that the *par vagum* of vertebrata is distributed to *three* separate systems—the respiratory, the circulating, and the digestive. As we know that the ultimate fibrils of nerves never anastomose, there can be no doubt that these branches might be traced separately back to their origins, and would be found to have distinct connections with their ganglionic centres. There is no difficulty, then, in understanding that the respiratory system of insects and other invertebrata may be analogous with the pneumonic portion of the par vagum, although it bears no relation with the cardiac and gastric divisions of that nerve. Looking to the distribution of the *recurrent* nerve upon the dorsal vessel, œsophagus, and stomach, we can have little hesitation in pronouncing it to be the analogue of these divisions; but its commencement in the anterior ganglion, which also supplies the mouth and pharynx, might seem to place it on a different footing. With what does this anterior ganglion correspond?

93. It may be inferred from the situation and distribution of its nerves, that the *anterior ganglion* of insects is analogous both to the *labial* and *pharyngeal* ganglia of the sepia and patella (§ 57 and 38.) These would seem to form a division of the nervous system, by which the actions *immediately* concerned in the prehension of food are performed, almost as independently of the cephalic ganglia as are those of respiration. There would seem, however, a greater tendency towards the union of *these* centres with the œsophageal collar than of those presiding over the respiratory function, which is more independent of the will; and, accordingly, we find the *labial* ganglia apparently united with the cephalic in most of the gasteropoda, whilst the *pharyngeal* forms a part of the sub-œsophageal mass in the nautilus. The division of the nervous system in vertebrata, with which this stomato-gastric system corresponds, is a question of more apparent difficulty; but

if we bring into comparison not only the highest but the lowest forms of the cerebro-spinal apparatus, the chief difficulties will be removed. The analogies drawn from the distribution of the nervous branches would lead us to infer that the *third* division of the fifth pair, (including its sensory and motor origins,) glosso-pharyngeal, and the gastric portion of the par vagum, would most nearly represent it. Now, when the fifth pair is traced back to its true origin, it is found to be not a cerebral but a spinal nerve; and it is then seen to arise from the medulla oblongata in such close approximation with the par vagum and glosso-pharyngeal, as to show that, if this portion of the nervous centres were isolated from the rest, the nerves which proceed from it would form, anatomically as well as functionally, a natural group. The fifth pair, like other spinal nerves, may act in a simply reflex character; although in man it is usually under the dominion of the will. In the lower animals we find these reflex actions bearing a much larger proportion to the voluntary, than in man; and even in him we not unfrequently meet with cases in which the functions of the cerebral hemispheres seem suspended, whilst those of the spinal cord are unimpaired; so that the prehension of food by the lips may take place without any effort of the will. A remarkable instance of this kind, in which the cerebral hemispheres were entirely absent, has already been mentioned, (§ 69.) Further, the connection between the fifth pair and the par vagum is very intimate in fishes—the class which approaches nearest in the character of its nervous system to the invertebrata. We may reasonably infer, then, that the stomato-gastric ganglia are the centres of the reflex actions of the nerves which correspond to the third branch of the fifth pair, the glosso-pharyngeal, and the par vagum of vertebrata; whilst the branches which connect them with the cephalic ganglia bring them more or less under the influence of the latter, (§ 100, XIII.)

94. This view is strengthened by the connection which these nerves have with the *sympathetic* system; a connection which is much more intimate in fishes than in the higher vertebrata, though even in these, according to Müller, filaments of the sympathetic may be abundantly detected in the fifth pair and par vagum. Now, we have seen that, in the mollusca, the sympathetic does not exist as a separate system, but would seem partly connected with the stomato-gastric, and partly with the branchio-visceral nerves. In insects, the *lateral* ganglia of the stomato-gastric system appear to possess more particularly the characters of the *sympathetic;* especially in their connection with all the other systems, and in the share which their branches have in the formation of the cæliac ganglia.

95. It is scarcely necessary to extend this essay to the detailed consideration of the nervous systems of the other groups of articulata; since these will not supply us with any data which have not been already obtained from other sources. A very general outline of them will therefore suffice. The crustacea present to us a

great variety of forms of this apparatus; some resembling the type characteristic of the myriapoda, and corresponding with the equality in the segments and legs exhibited in the group; and others manifesting a degree of concentration even surpassing that of the highest insects. Of the first type, the nervous system of the *talitrus locusta* (sandhopper) is an interesting example, from its exhibiting to us the lateral divisions, which are usually in close approximation, at a considerable distance from one another, (fig. 27.) The transverse cords which unite each ganglion are evidently but prolonged forms of the fibres which have been formerly described, (§ 76,) as uniting the nerves of each side, where the ganglion appears to be single.

96. In the *astacus marinus* (lobster) we have an example of a form, which corresponds with that of insects, in which the process of concentration has taken place but to a low degree. The thoracic ganglia remain distinct, and none of the abdominal ganglia are absent, although they are much smaller than the thoracic, (fig. 28.) The stomato-gastric system here presents us, however, with an interesting variety of conformation, which shows its tendency to approximate with the cerebro-spinal. That of the *astacus fluviatilis* (cray-fish) is represented in fig. 29.[1] We here find no separate anterior ganglion existing; but it seems replaced by two small ganglionic enlargements of the cords or peduncles which unite the cephalic ganglia with the first thoracic. From these proceed the branches which supply the mouth and muscles of the jaw, as well as others that unite with a median branch proceeding from the cephalic ganglion to form the recurrent trunk, which is distributed upon the œsophagus and stomach, where it presents one or two minute ganglionic enlargements. It is evident that the small ganglia upon the peduncles of the cephalic mass correspond exactly with the division of the medulla oblongata, from which the fifth pair and the par vagum are given off; so that the analogy which has been previously drawn would seem by this structure to be fully confirmed; and we shall be less inclined to adopt the opinion of Müller, who has described this stomato-gastric system in the light of a sympathetic.[2]

97. It is in the short-bodied crabs that the concentration of the ganglionic masses is most remarkable. Thus, in the *maia squamado* we find but one large stellated ganglion in the trunk, from which the nerves radiate; a conformation which evidently conducts us towards the cephalopodus mollusca, (fig. 30.)

98. The distribution of the nervous system in the arachnida is not dissimilar to that of the crustacea—the spiders of the sea. In the long-bodied *scorpions* there is a large mass surrounding the œsophagus, formed by the union of the cephalic with the first thoracic or infra-œsophageal ganglion, from which the nerves of

[1] Brandt, loc. cit.
[2] Nova Acta, tom. xiv.

the five pairs of legs are given off; and posteriorly to this are seven small ganglia disposed at regular intervals along the trunk. In the *spiders*, (fig. 31,) on the other hand, we find the cephalic ganglia distinct but small; and these communicate with a large stellate mass in the front of the thorax, which appears to be formed by the union of at least four pairs of ganglia, and which sends off nerves to the legs; from this proceeds a double cord, which swells at its termination into an enlargement that gives off branches to other organs. The stomato-gastric system of arachnida, so far as it has been detected, seems more analogous to that of crustacea than to that of insects.

99. From the foregoing details, regarding the nervous system of the articulata, it would therefore appear that the inferences which were drawn from the examination of its character in the mollusca are fully applicable to the physiological explanation of its structure in this division of the animal kingdom, and thus derive important confirmation from its phenomena; whilst the explanation usually adopted is neither consistent in itself, nor capable of being applied to the other invertebrata. The study of the arrangement of the parts of the nervous system in mollusca may be *most* advantageously pursued before that of the articulata is entered upon; since the great variety in the disposition of the different systems in that group, the isolation of their nervous centres, and the transposition and recombination of these in so great a variety of ways, affords us the key to their real character, which may be effectually applied to the elucidation of the more complex apparatus of articulata.

VI. GENERAL CONCLUSIONS.

100. A general review of the ground over which we have passed will enable us, we think, to draw the following conclusions with a high degree of probability.

I. That a nervous system, in the form of connected filaments with ganglia on certain parts of them, exists in all animals, (that is, in all beings endowed with any degree of sensibility and voluntary power,) although its presence may not be detected by our means of observation.

II. That the actions most universally performed by a nervous system are those connected with the introduction of food into the digestive cavity.

III. That we have reason to regard this class of actions as every where independent of volition, and perhaps also of sensation;—the propulsion of food along the œsophagus in man being of this character.

IV. That, for the performance of any action of this nature, a nervous circle is requisite, consisting of an *afferent* nerve on the peripheral extremities of which an impression is made;

a ganglionic centre, where the white fibres of which that nerve consists terminate in gray matter, and those of the efferent nerve originate in like manner; and an *efferent* trunk conducting to the contractile structure the motor impulse, which originates in some change of the relation between the gray and white matter.

V. That such actions may be regarded as the simplest of those which the nervous system performs, and most resemble the examples of contraction produced by the irritation of distant organs in plants, (where an *impression* is mechanically conveyed by the circulating system,) of any which the animal kingdom affords.

VI. That in the lowest animals such actions constitute nearly the entire functions of the nervous system; the amount of those involving sensation and volition being very small.

VII. That, as we ascend the scale, the evidence of the participation of true sensation in the actions necessary for the acquirement of food, as shown by the developement of special sensory organs, is much greater; but that the movements *immediately* concerned with the introduction of food into the stomach remain under the control of a separate system of nerves and ganglia, to the action of which the influence of the cephalic ganglia,—the *special* if not the *only* seat of sensibility and volition,—is not essential.

VIII. That, in like manner, the active movements of respiration are controlled by a separate system of nerves and ganglia, and are not dependent upon that of sensation and volition, though capable of being influenced by it.

IX. That the centres of these systems are brought into closer structural relation with that of the sensori-volitional system as we ascend the scale of invertebrated animals; until they at last apparently become a part of it, as in vertebrata, where, however, they still remain separate, and may be artificially insulated.

X. That, whilst the actions of these systems are in the lower tribes almost entirely of a simply reflex character, we find them, as we ascend, gradually becoming subordinated to the will; and that this is effected by the mixture of fibres proceeding directly from the cephalic ganglia with those arising from their own centres.

XI. That the locomotive organs, in like manner, have their own centres of reflex action, which are independent of the influence of volition, perhaps also of sensation.

XII. That the influence of the will is conveyed to them by separate nervous fibres, proceeding from the cephalic ganglia; and that similar fibres probably convey to the cephalic ganglia the impressions destined to produce sensations.

XIII. That the stomato-gastric, respiratory, and locomotive centres are all united in the spinal cord of vertebrata, where they form one continuous ganglionic mass; and that the nerves connected with all these also receive fibres derived immediately from the cephalic ganglia.

XIV. That whenever peculiar consentaneousness of action is required between different organs, their ganglionic centres are united more or less closely; and that the trunks themselves are generally connected by bands of communication.

XV. That the sympathetic system does not exist in the lowest classes in a distinct form;—that the nervous system of the invertebrata, taken as a whole, bears no analogy with it;—that, as the divisions of this become more specialised, some appearance of a separate sympathetic presents itself;—but that this is never so distinct as in vertebrata.

XVI. Hence it may be inferred that, as the sympathetic system is *not* developed in proportion to the predominant activity of the functions of organic life, but in proportion to the developement of the higher division of the nervous system, its office is not to "preside over" the former, but to bring them into relation with the latter; so that the actions of the organs of vegetative life are not dependent upon it, but influenced by it in accordance with the operations of the system of animal life.

EXPLANATION OF THE FIGURES.

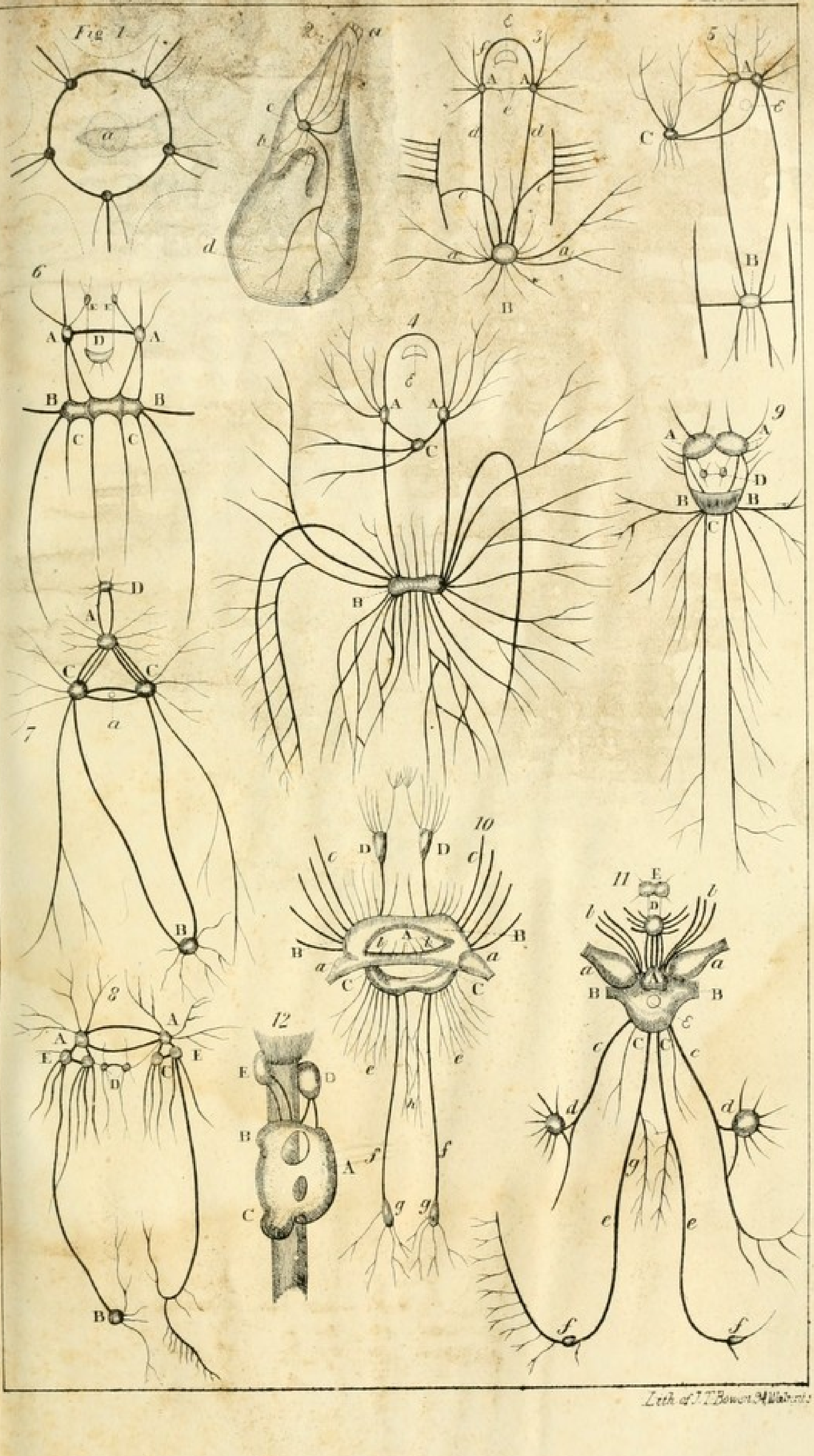
PLATE I.

Fig.
1. Nervous system of *Asterias* (after Tiedemann ;) *a*, oral orifice.
2. *Ascidia Mammillata*, with nervous system (Cuvier;) *a*, branchial orifice ; *b*, anal orifice ; *c*, ganglion with radiating filaments ; *d*, general surface of the sac.
3. Nervous system of *Oyster* (Garner ;) A, A, anterior ganglia ; B, posterior ganglia ; *a*, branches to mantle ; *c*, *c*, branches to the gills ; *d*, *d*, connecting trunks ; *e*, transverse filament uniting anterior ganglia ; *f*, arch over œsophagus, ɛ.
4. Nervous system of *Pecten* (Garner) A, A, anterior ganglia ; B, posterior or branchial ganglion, bilobed ; C, pedal ganglion.
5. Nervous system of *Mactra* (Garner ;) A, A, anterior ganglia nearly meeting over œsophagus, ɛ ; C, pedal ganglion.
6. Nervous system of *Patella* (Cuvier and Garner ;) A, A, cephalic ganglia ; B, B, branchial ganglia ; C, C, pedal ganglia ; D, pharyngeal ganglion ; E, E, labial ganglia.
7. Nervous system of *Aplysia* (Cuvier) ; A, cephalic ganglion ; B, branchial ganglion ; C, C, pedal and palleal ganglia ; D, pharyngeal ganglion ; *a*, passage of aorta.
8. Nervous system of *Bullæa* (Garner) ; A, A, cephalic ganglia ; B, branchial ganglion ; C, C, pedal ganglia ; D, D, pharyngeal ganglia ; E, E, palleal ganglia.
9. Nervous system of *Limax* (from Fig. in Baly's translation of Müller's Physiology ;) A, A, cephalic ganglia ; B, B, respiratory portion of sub-œsophageal ganglion ; C, locomotive portion ; D, pharyngeal ganglia.
10. Nervous system of *Nautilus*, (Owen) ; A, cephalic ganglion ; *a*, *a*, optic ganglia ; B, B, anterior portion of sub-œsophageal collar ; C, C, posterior portion ; *b*, *b*, filaments to mouth and tongue ; *c*, *c*, branches to tentacula ; D, D, labial ganglia ; *e*, *e*, branches from posterior collar to shell-muscles ; *f*, *f*, branchio-visceral nerves ; *g*, *g*, their ganglia ; *h*, plexus upon vena cava.
11. Nervous system of *Sepia*, (Owen and Garner) ; A, cephalic ganglion ; *a*, *a*, optic ganglia ; B, anterior portion of sub-œsophageal collar ; C, C, posterior portion ; D, labial ganglion ; E, bilobed pharyngeal ganglion ; ɛ, passage of œsophagus ; *b*, *b*, nerves to arms ; *c*, *c*, palleal nerves ; *d*, *d*, their ganglia ; *e*, *e*, branchio-visceral nerves ; *f*, *f*, their ganglia ; *g*, plexus on vena cava.
12. Lateral view of nervous centres in *Sepia*, (Garner) ; A, cephalic mass ; B, anterior portion of sub-œsophageal mass ; C, posterior portion ; D, labial ganglion ; E, pharyngeal ganglion.

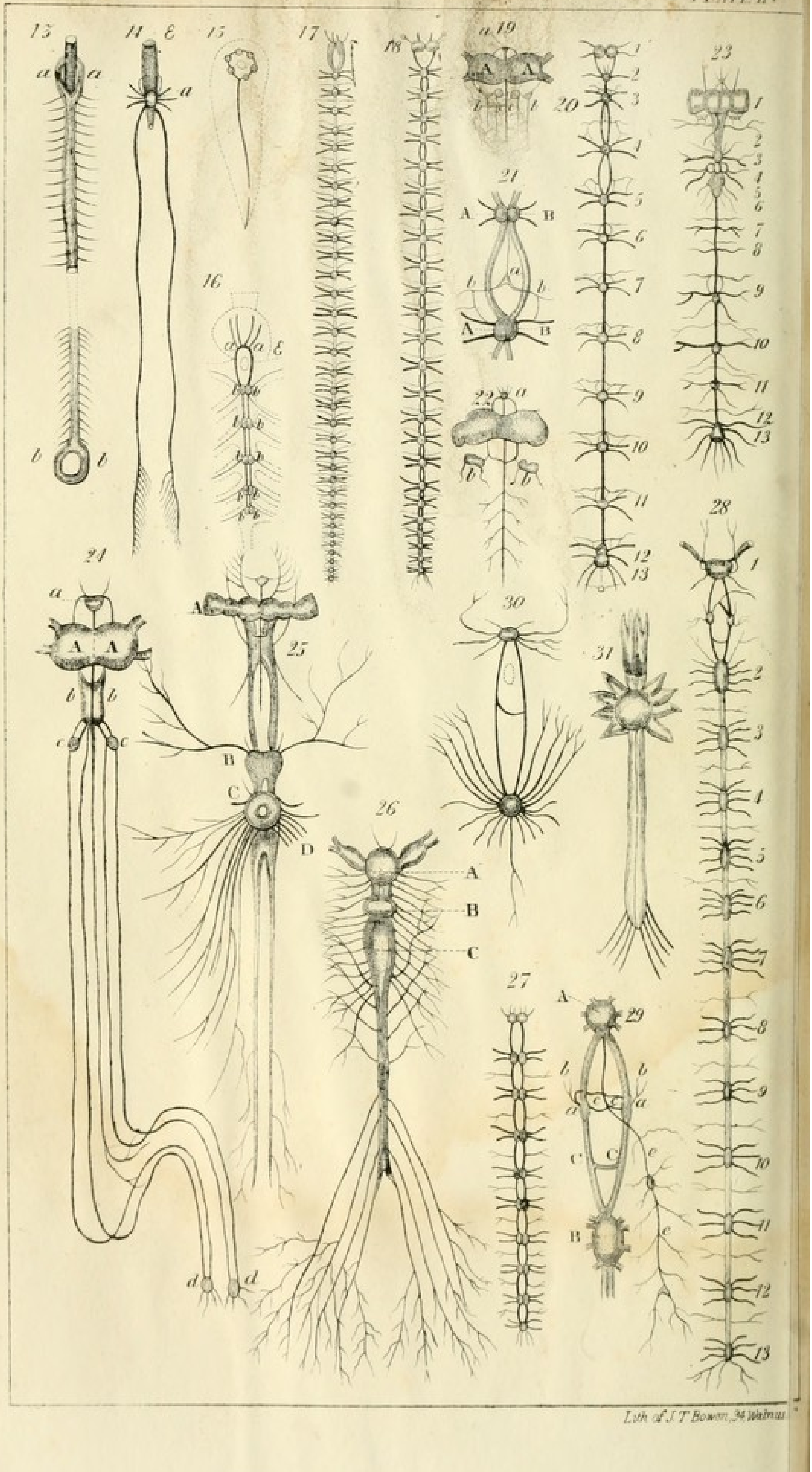
PLATE II.

Fig.

13. Nervous system of *Strongylus gigas*, (Owen); *a*, *a*, collar surrounding oral orifice; *b*, *b*, similar collar around anus.
14. Nervous system of *Linguatula tænioides*, (Owen); *a*, ganglion beneath œsophagus, *s*.
15. Nervous system of *Hydatina*, (Ehrenberg.)
16. Nervous system of *Anatifa*, (Cuvier); *a*, *a*, collar surrounding œsophagus, *s*; *b*, *b*, *b*, locomotive ganglia supplying members.
17. Nervous system of *Aphrodita*, (Milne Edwards.)
18. Nervous system of *Scolopendra*.
19. Stomato-gastric system of *Spirobolus*, (Brandt); A, A, cephalic ganglia; *a*, anterior median ganglion; *b*, *b*, and *c*, *c*, lateral ganglia.
20. Nervous system of *larva* of *Sphinx ligustri*, (Newport.)
21. Portion of cord from thoracic region of ditto, when just passing into the pupa state; A, A, ganglia of regular system; *a*, *a*, ganglia of respiratory nerves; B, B, nerves of regular system; *b*, *b*, transverse or respiratory nerves.
22. Stomato-gastric system of *Sphinx*; A, A, cephalic ganglia; *a*, anterior median ganglion; *b*, *b*, lateral ganglia.
23. Nervous system of perfect insect, (Newport.)
24. Stomato-gastric system of *Gryllotalpa*, (Brandt); A, A, cephalic ganglia; *a*, anterior median ganglion; *b*, *b*, and *c*, *c*, lateral ganglia; *d*, *d*, cœliac ganglia.
25. Nervous system of *Melolontha vulgaris*, (Strauss); A, cephalic ganglion; B, C, thoracic ganglia; D, abdominal ganglion.
26. Nervous system of *Pentatoma grisea*, (Dufour); A, cephalic ganglion; B, thoracic ganglion; C, abdominal ganglion.
27. Nervous system of *Talistrus locusta*, (Milne Edwards.)
28. Nervous system of *Astacus marinus*, (Milne Edwards.)
29. Stomato-gastric system of *Astacus fluviatilis*, (Brandt); A, cephalic ganglion; B, first thoracic do.; C, C, communicating cords; *a*, *a*, stomato-gastric ganglia on do.; *b*, *b*, branches to mouth; *c*, *c*, branches to form recurrent; *e*, *e*, recurrent passing downwards to stomach.
30. Nervous system of *Maia squamado*, (Milne Edwards.)
31. Nervous system of spider, (Audouin.)



Lith. of J. T. Bowen, Phila.



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MEMOIR

ON THE

RADICAL CURE OF CLUB-FOOT.

BY H. SCOUTETTEN, D. M. P.

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WITH SIX PLATES.[1]

TRANSLATED FROM THE FRENCH.

BY F. CAMPBELL STEWART, M. D.

OF WILLIAMSBURG, VA.

To THOMAS HARRIS, M. D.

SURGEON, U. S. N.

THE INDEFATIGABLE PROMOTER OF SURGICAL SCIENCE,

THIS TRANSLATION IS RESPECTFULLY DEDICATED BY HIS

WARM FRIEND AND FORMER PUPIL.

PREFACE.

THE great success obtained by European surgeons in the treatment of distortions of the feet, by simply dividing the tendons of such muscles as may by their contraction have occasioned an anormal deviation, has attracted the attention of some of our most eminent physicians and surgeons, and, in many instances, the operations have been repeated in this country, and so far with uniform success. Such operations, however, have as yet been principally confined to the larger cities, where every facility is afforded for the fabrication of such machines and other apparatus as are essential to the success of the after-treatment, and where able assistance is always at hand in case of accident.

The operation itself, as now practised, has been but recently introduced, and all the information on the subject, which has been afforded to members of the profession, located at a distance from the great medical emporia, has been a casual, and often incomplete re-

[1] Originally published as a separate work in 8vo., pp. 118. Paris and London, 1838.

port, generally of the result only of cases treated—furnished them through the medium of our numerous scientific periodicals.

Until the publication, during the past winter, of a very small memoir, entitled *a lecture* on "loxarthrus, or club-foot," by a surgeon of Philadelphia, who has had numerous opportunities of treating the disease, and who, from his constant success, may be regarded as one of the most experienced of our surgeons in this branch, no systematic notice had been taken in this country of the malady and its treatment. In France two works on the subject recently appeared nearly simultaneously, the one by a celebrated Parisian orthopedist, and the other by a no less distinguished surgeon of Strasburg—and thinking that there was a demand for accurate knowledge on so important a subject, I undertook the translation of the treatise of M. Scoutetten, which is now offered to the profession.

If asked why I have given the preference to this work over that of M. Duval, I should be at a loss to answer, inasmuch as both authors have done ample justice to the subject, and both works are accompanied by engravings illustrating the varieties of the disease, and by cases. Perhaps the great quantity of cases introduced into the work of Duval, which swell it out to a much larger size than that of Scoutetten, and the number of engravings (no less than seventy-eight) interspersed through its pages, the republication of which would make the book costly, have occasioned my preference of the latter memoir.

It is confidently asserted that all the information required for practical purposes is included in the following pages, and so minute has our author been in his descriptions of the surgical anatomy and *modus operandi*, that any well-informed surgeon may now, with perfect safety, undertake the task of rectifying club-feet.

One word in reference to the terms used for distinguishing the varieties of the disease. It will be perceived that our author has abandoned the expressions *varus*, *valgus*, and *pes equinus*, which he considers incorrect, and has substituted a very simple nomenclature, derived from the actual position of the parts. It is much to be regretted that so great a discrepancy should exist in our scientific vocabulary, and such a number of expressions used, as are likely to confuse.

M. Duval has added to the difficulty, by introducing terms with Greek derivations. His appellations for the varieties of the deformity are *strephendopodia*, *strephexopodia*, *strephypopodia*, *strephanopodia*, and *strephocatopodia*.[1]

This unacceptable innovation is the more to be regretted, as the author can find no better reason for relinquishing the other appellatives, which he acknowledges to be "*clear and positive*," than

[1] From στρέφω, *to turn* or *twist*,—and ποῦς, ποδος, *foot*, with the addition of ἔνδον, *inwards*, ἔξω, *outwards*, ὑπὸ, *downwards*, ἄνω, *upwards*, and κάτω, *underneath*.

"*because they are a little periphrastic, and might appear to certain persons not to be sufficiently learned.*"[1]

It is to be hoped that American surgeons will conform to one set of phrases, and not use all indiscriminately. If there are objections to those used in the following pages—and I must confess that I cannot find them—let others be substituted, and invariably conformed to.

TRANSLATOR.

WILLIAMSBURG, VA., *August*, 1839.

MEMOIR

ON

THE RADICAL CURE OF CLUB-FOOT.

HISTORY.

WHEN the foot is deformed by the contraction of one or more of the muscles of the leg, or by a primitive mal-position of the bones of the tarsus, there results a disease which has been denominated by French physicians *club-foot*, (pied-bot.)

All the muscles of the leg are liable to retraction; but it is only the more powerful ones that are capable of modifying the form of the foot. No example has as yet been presented of a simultaneous retraction of all the muscles of the leg; most commonly one or two only are affected at a time.

There are four principal varieties of the disease, viz: *inverted*, *everted*, *phalangian*, and *calcanian club-foot*.

[2] A contraction of the solei and gastrocnemii muscles, (muscles solaire et jumeaux,) contributes to the developement of *inverted club-foot*. That of the peronei, often assisted by the gastrocnemii, causes the foot to be turned *outwards*.

Phalangian club-foot is occasioned by an energetic contraction of the gastrocnemii and solei muscles, aided, in some cases, by that of the flexors of the toes; and *calcanian club-foot*, under the influ-

[1] Traité pratique du Pied-bot. Paris, 1839, p. 13.

[2] Finding no term in use to express that deformity of the foot which does not permit it to touch the ground, except by the calcaneum, I have called it *calcanian club-foot*, and, consequently, I call *phalangian club-foot* that which touches the ground only by the phalanges. I replace with these last words that of *pes equinus*,—an improper expression, and which ought long since to have been abandoned. What is there in common between our foot when thus deformed, and the foot of a horse?

ence of the contractions of the tibialis anticus, assisted most generally by that of the tendons of the extensors of the toes. There are several intermediate forms of the disease, besides those four principal ones; they are, however, all more or less closely allied to the types indicated. All the above deformities may be either *congenital* or *accidental*.

Such mal-formations of the foot as those just spoken of, were known to physicians of the most remote antiquity. The Greeks called βλαισὸς the foot turned outwards, and ῥαιβὸς, that inwards. Hippocrates, however, employed the word Κυλλὸς.[1] The Latins commonly used the words *varus* to signify the variety *inwards*, and *valgus* that *outwards*. Plautus, *in Milite*, uses occasionally the words *compernis*, *pœtus*, and *brochus*.[2] C. Hoffman, however, is of opinion that this is a mistake,—that the sense of the two expressions should be inverted, and the name of *valgus* given to that deformity commonly known as *varus*;[3] his opinion, however, has not prevailed. The Greek words were still further latinised, and the expressions *blæssus*, or *blæsus*, have been in use.

Hippocrates was not satisfied with merely indicating the evil; he also pointed out the means of combating it. Having described with great care the mode of applying the bandage, he insists that the foot must be *gradually* brought back towards its normal position: *neque magnâ vi, sed leniter cogantur*.[4] After the bandage has been applied, he (Hippocrates) recommends that the foot should be kept in its proper position by means of a leaden shoe, made in the form of those of Chio; and if that prove insufficient, he gives the model of boots which are to be applied.

This passage, from the father of medicine, presents another example of the power of his genius; for, instead of neglecting a disease, which might have seemed to him of but little importance, he describes its very forms and varieties, points out clearly the rules to be followed in the treatment, and during a period of more than two thousand years, the most expert of his successors have but reproduced his ideas and precepts. Celsus, so often remarkable for the exactitude and excellence of his descriptions, does not even mention the name of the disease under consideration, and it is not until the time of Marcus Aurelius Severinus that we find a treatise published on the subject of club-foot.[5] His description and treatment leave much to be wished for; it is, in fact, far inferior to that of Hippocrates.

Ambrose Paré,[6] after advising some tonic remedy, the formula

[1] Περι ἄρθρων.

[2] See M. A. Severinus *de gibbis, valgis, varis*, cap. 11.

[3] Castelli Lexicon, p. 106, verb. *blæsus*.

[4] Hippocratis opera; interprete Foësio: de articulis, sect. vi. p. 98, 99, editio Francofurti, 1595.

[5] De reconditâ abcessuum naturâ: lib. vi. de gibbis, valgis, varis et aliis ab internâ vi varie luxatis.

[6] Works of Amb. Paré, lib. xxiii. chap. xi.

for which is to be found in M. A. Severinus also, gives a model of boots, such as he proposes for remedying the disease. Dionis[1] appears to have been still less inspired than his predecessors, for he has the hardihood to advise, for maintaining the foot in its proper position, an iron boot, which had been previously proposed by Fabricius of Acquapendente.

Important publications, however, were made about the beginning of the eighteenth century, and men, none of whom were without merit, devoted themselves to the study of the treatment of the disease, and enriched science with useful discoveries.

Venel, a physician of Orbe, in the canton of Berne, established, about the year 1780, an hospital destined exclusively for the reception of children with deformed feet; he performed a number of fortunate cures, which quickly drew attention to him. Venel concealed his method, but it was divulged in 1790. Ehrmann, of Frankfort-on-the-Maine, learned it from a young physician of the name of Wantzel, who had been cured of a distorted foot in Venel's institution. He confided the secret to Augustus Bruckner, of Gotha, who, at a later period revealed all the details.[2] Wantzel himself, after the lapse of several years, published a dissertation on the subject. In England, many physicians also directed their attention to the rectifying of club-feet. Jackson, following the example of Venel, published a memoir, in which he describes many cures obtained by means of apparatus, which he claimed as his own invention, but the construction of which he kept a profound secret.[3] About the same time, in France, Tiphaisne and Verdier, surgeon-bandagists, boasted, through the public journals, of their success in the treatment of the malady by the aid of newly-invented machines. Until that period empiricism, and often ignorance, had experimented upon such unfortunate individuals as were affected with club-foot, for neither anatomy nor physiology had then sanctioned the theories which directed the operations of the orthopedists. Fortunately, it was not long before science obtained the victory, and ignorance no longer triumphed.

At the commencement of the nineteenth century, Scarpa published his admirable treatise on the disease.[4] The illustrious Professor of Pavia did not follow the common route; he did not seek to remedy it, before making himself familiar with the malady, but strove first to find out the cause of the deformity, and when he had been successful, showed conclusively, what no one had done

[1] Cours d'opérations de chirurg. 8vo. édition, p. 774.

[2] Ueber einwärts gedrehte Füsse, und deren Behandlung besonders nach Dr. Venel's Methode.

[3] Dissert. de talipedibus varis, in 4to. Tubingæ, 1798.

[4] Memoria chirurgica sul piedi torti congeniti dei fanciulli, et sulla maniera di corregere questa difformità: con tavol. Pavia, 1803, in 4to. This treatise exists in the French language, in the Memoirs of Physiology and Practical Surgery, by Ant. Scarpa. Translation of J. B. Léveillé. Paris, 1804.

before him, that the bones of the tarsus in such cases are never luxated, but only partially separated from their mutual contact, and turned according to their smallest axis.[1] The knowledge of this important anatomical fact ought to have led Scarpa to conceive a good apparatus for treating the disease, which in fact he did, and succeeded as well as such a plan of treatment admitted of.

At a more recent period, Boyer[2] invented a machine simpler than that of Scarpa, and he succeeded with it in restoring feet most singularly distorted inwards. It was not yet exactly known what was the process of Venel, when M. Louis d'Ivernois, a pupil of the successor to that orthopedist, published an account of it in 1817.[3]

Before doing so, however, M. d'Ivernois had submitted the machine of Venel to the Society *du Cercle Médical*, which appointed M. Capuron to report on it.[4] Useful improvements were the result of this investigation, which contributed to the success obtained by the author.

The remarkable work of Delpech, entitled *de l'orthomorphie*,[5] terminated this series of useful publications on the reducing of club-foot by means of machines. In it the author treats with much talent of the etiology of the disease, and proposes the employment of a new apparatus, of which he gives a representation in one of the last plates. Delpech by no means restricted himself in this work to indicating machines as our only resource in the treatment of the malady under consideration, for he recurred to the proposition which he had before made[6] of cutting the tendo Achillis, after all means of extension shall have been found to fail. This was the era at which an immense progress, I might almost say revolution, in the treatment of the disease commenced.

Although Delpech may not have been the first physician to whom the idea occurred of resorting to the section of the tendo Achillis for obtaining the cure of club-foot, it must nevertheless be admitted that he is the first who ventured to propose the operation as a useful and sometimes indispensable resource in certain cases—who established the method, and laid down regular precepts.[7] This much credit certainly belongs to him, and French surgeons should defend his claims to it. What if the operation was performed for the first time in 1784 in the presence of Thilenius,[8] a physician of the

[1] P. 114. Translation of Léveillé.

[2] Traité des maladies chirurgicales, t. iv. p. 613, 2e édit.

[3] Essai sur la torsion des pieds, in 8vo. Paris.

[4] Gazette de Santé, p. 178, Aug. 1814.

[5] De l'orthomorphie par rapport à l'espèce humaine, in 8vo. Paris, 1828; t. ii. p. 321.

[6] Précis élémentaire des maladies réputées chirurgicales, in 8vo. Paris, 1816, t, i. p. 669.

[7] Chirurgie clinique de Montpellier, in 4to. 1823.—Mémoire sur les pièdsbots: le malade fut opéré en 1816.

[8] Thilenius, chirurgische Bemerkungen, 1784.

environs of Francfort, and afterwards by Michaelis,[1] and Sartorius in 1812?[2] They were isolated cases, and of no value, inasmuch as they were destitute of a scientific theory. The operation as reported by Delpech, was in general received unfavourably. The editor of a journal of the day, in speaking of it, is astonished that the author *had seriously proposed such an operation.* Other editors were of opinion that it should never be performed, but they discussed the point scientifically and in a becoming manner.

Many years had elapsed without any attention being paid to the subject by operative surgeons, when suddenly there appeared in Rust's journal,[3] a memoir of Dr. Louis Stromeyer, surgeon to the King of Hanover, indicating a new process of operating the section of the tendo Achillis, in the treatment of club-foot. In this memoir, two remarkable cases, cured by means of his plan of treatment, are related. The first of the two operations was performed on the 28th of February, 1831, and the second, on the 12th of June, 1832. On the 29th April, 1834, M. Stromeyer wrote a letter to the editor of the *Archives générales*,[4] communicating the result of four new cases in which he had operated, three of which had been attended with success.

These happy results obtained by the Hanoverian surgeon, awakened promptly the attention of the Parisian orthopedists: MM. Bouvier and Duval[5] repeatedly divided the tendon, and their success soon surpassed that of Dr. Stromeyer. These, with the remarkable cures that have been obtained by myself, and which I shall presently detail, include, I think, all that has been achieved, up to the present time, in this important department of orthopedic surgery.

The section of the tendo Achillis is henceforth an established fact; it is an achievement of science destined to give new éclat to surgery, by the benefits that those unfortunate individuals affected with deformities of the feet will experience from it.

If we look back to the facts contained in the annals of medicine, we are astonished to find that this important discovery was not made at an earlier period,—a discovery reserved to adorn the nineteenth century. The fact had been established by Molinelli[6] in the

[1] Michaelis, in Hufeland's Journal; anno 1811, 6tes Heft.—This surgeon after all did not make a complete division of the tendon, but only incised it partially.

[2] Sartorius, in Siebold's Journal; 3ter Band.

[3] Rust's Magasin für die gesammte Heilkunde.--39e vol., and Gazette Médicale, Sept. 1833, p. 673. This same memoir, translated entire by Dr. Richelot, will be found in the Archives générales de Médecine, 1834, tome 1er.

[4] Arch. Gén. t. ii. p. 194,—1834.

[5] Bouvier.—Mémoire lu à l'Académie des Sciences, séance du 12 Sept. 1836, et Académie de Médecine, 26 Novem. 1836.—Voy. Bulletin de l'Académie de Médecine, 15 Décem. 1836. Duval.—Académie royale de Médecine, 17 Janvier. 1837, Bulletin, Janvier, 1837, p. 304.

[6] Comment. Academ. Scientiar: Bononiens. t. ii, par. 1. page 189—196, and memoirs to serve as a history of the 18th century, by Paul Avignon,

history of the Academy of Bologna, that contrary to the generally received opinion of that period, wounds of the tendo Achillis would heal with facility. He reports four cases in which the tendon was cut transversely, and notwithstanding the wounds were complicated, they healed kindly. Hoin,[1] an expert surgeon of Dijon, with a view of establishing the fact, instituted a series of experiments, the result of which was in perfect accordance with what had been stated by Molinelli. He divided both partially and wholly the tendo Achillis of cats and dogs, and although the animals were left entirely to themselves, and no precautions taken to exclude the air, all the wounds healed perfectly.

In order to complete our history, we may add that the division of tendons for the purpose of curing distorted members, is a fact which has been for a long time known to veterinary surgeons. I have even been assured that in Limousin[2] the operation is frequently performed, and by the most ignorant men, those wholly strangers to science. See an extract from a publication of MM. Miquel and Debeaux[3] in 1826.

"It is long since the practice of dividing the flexor tendons of the feet, in cases of vicious inclination of the members, was adopted, although no one has as yet been at the trouble of prescribing precise rules for performing the operation methodically. Probably timidity in some, and want of success in others, has heretofore prevented veterinarians from making known their operative process. We know that some practitioners succeeded by this means, and long before ourselves, in restoring limbs which had altogether lost their perpendicularity. Our object in communicating the result of our labours is to simplify and render more familiar, an operation which may prove to be as advantageous to *human surgery*, as to that of animals."

We will but remark, with regard to the above passage from the memoir cited, that human and veterinary surgery are so nearly allied in some respects, that they frequently progress hand in hand towards discovery, and that notwithstanding certain pretensions, it would be a thing almost impossible to discover to whom belongs the credit of having been the first to form the idea of dividing the tendo Achillis. But we again repeat,—this is not the most important point; the idea is essential and even indispensable, but the true founder of a method is he who lays down the rules to be followed, and points out the cases where it is applicable.

Notwithstanding the astonishing success following the division of the tendon, M. Jules Guérin is of opinion that the operation may be entirely dispensed with in the cases of very young children, and softened plaster substituted in lieu of the present containing appa-

[1] Journal de Médecine, Janv. 1769, pp. 56—78.

[2] [Lately a French province. Transl.]

[3] Observations on club-foot; Journal pratique de Médecine vétérinaire, Paris, 1826; p. 202; and same journal, 1828, p. 283, observations of M. Blanc, and 1830, p. 246, Obs. of M. Bouissy.

ratus. This is only a new application of the plaster which has been for some time in use in Germany, in the treatment of fractures.[1]

The following is M. Guérin's process. The deformed member having been previously smeared over with some oleaginous substance, and surrounded with a roller bandage of flannel, is properly placed and suspended on transverse bands in a carved splint; the foot is then subjected to an opposing lateral extension, the object and result of which is to produce torsion and reversion in an opposite direction to the existing torsion. Plaster is then poured around the member, which is kept in a fixed position until it hardens. As soon as it has become completely solidified, the limb is removed from the splint, and the envelope cut with a knife, so as to leave one layer of plaster only, of the thickness of three or four lines, around the leg and foot. This dressing is renewed every eight days.[2]

M. Jules Guérin exhibited to the Academy several young persons whom he had succeeded in curing by this plan of treatment.

We have now completed the exposition of the different modes of treatment which have been employed for combating deformities of the feet. We have done this in the character of a reciting historian, and not as a judge. This latter character we shall assume hereafter, when we have to appreciate the value of the respective methods employed for treating club-foot.

Let us now devote our attention to the pathological anatomy of the diseased organs.

ANATOMY OF CLUB-FOOT.

I reject from the historyof this complaint, every accidental deformity whether occasioned by a general disease, or the result of accident. It appears to me to be a singular error to arrange in this class, distortion of the feet brought on by rachitis, gout, rheumatism, white-swelling or a luxation badly reduced or not reduced at all.

The talent for description, as evinced in the work of Scarpa,[3] cannot be too much admired. It is truly to this illustrious professor, that we are indebted for our first precise notions with regard to the pathological alterations presented by the disease. If new researches have made known some omissions, and detected a few er-

[1] Professor Dieffenbach has often used this plaster, and one of his pupils has published a dissertation on the subject entitled, "De cruribus fractis gypso liquefacto curandis." Joan. Aug. Muttray. Berolini, Sept. 1831.

[2] Letter sent to the "Académie royale de Médecine," 19th April, 1836.—Gazette Médicale, 23d April, 1836, p. 268.

[3] Op. cit.

rors,[1] it must still be admitted that his work has served as the basis of such anatomical descriptions as have lately appeared.[2]

If in the present state of our knowledge, we cannot affirm that the causes which give rise to congenital club-foot are identically the same with those which occasion the accidental variety, we must nevertheless admit that there is the greatest analogy between their effects. I have frequently compared the limbs of children, some of whom had been deformed form birth, and others by accident; and it has always been impossible for me to detect their distinctive characters. What remarks, then, we may have to make on the one, will most generally apply to the other also.

Accidental club-foot is almost invariably occasioned by convulsions, or a chronic inflammation of the tissues, and in some rare cases by a defect of innervation in the spinal marrow. Whatever may be the exciting cause, the following is the progress of the disease.

A month or two after an attack of convulsions, the tendo Achillis becomes stiff and prominent, and the point of the foot is depressed with difficulty. This state of things may continue for a long time without becoming more aggravated. It lasted for more than a year in the case of an interesting little girl of eight years of age, who became paralytic after an attack of follicular enteritis. Finally the calf of the leg becomes atrophied, or rather, it is not developed proportionately with the other muscles of the body. The belly of the muscle being short and thin, the tendinous portion appears to be longer than it naturally should be. These appearances are very perceptible in children who are afflicted with but one club-foot. The contraction of the tendo Achillis, causes the elevation of the calcaneum in a direct manner, and if this elevation is to the extent of half an inch,—and it is sometimes several inches without lateral deviation,—it constitutes our *phalangian* variety of the disease. Most frequently, however, as the malady becomes more and more developed, the posterior edge of the calcaneum is forced to take an inward turn,[3] the inner edge of the foot scarcely touches the ground, and this is the period when, if the child is allowed to walk, the weight of the body increases the deformity.

The external ligament of the tibio-astragalian articulation becomes elongated, the astragalus and scaphoides are drawn along with the calcaneum, to which they adhere by powerful ligaments; the back of the foot becomes convex; the sole concave, and furrowed by numerous transverse and oblique wrinkles. The big toe is separated from the others, and turned towards the inner edge of the foot. The plantar aponeurosis becomes contracted, and the muscles of the foot which are inserted into it draw the toes backwards;

[1] Cruveilheir, Anatomie-pathologique du Corps humain; 2e livraison, Paris, 1830.

[2] Dissert. sur le Pied-bot, par Ch. Help. Strasb. 20 Juin, 1836.

[3] See plate ii.

at the same time the superior metatarso-phalangian ligaments become elongated, and the foot is nearly folded in two.[1] In this deplorable condition, children walk on the external edge, and sometimes on the back of the foot. The part on which they rest their weight becomes hard and callous, whilst the subjacent cellular tissue gets thickened; it still, however, preserves its softness and elasticity. It is not uncommon for mucous bursæ to form in it. The leg and thigh generally preserve their natural form, but it is not rare to find one or the other knee inclined more or less inwards or outwards, the tibiæ bent, and the malleolus internus imperfectly developed. When both feet are deformed, their points touch, and often overlap each other; the patient experiences great difficulty in walking, is obliged to raise his feet alternately, and to carry the one above, and in advance of the other, so as to be constantly describing a semicircle. Falls are consequently very frequent, and in order to avoid them, the child, when he walks, keeps his body in a constant state of agitation, he seems to be always seeking his equilibrium. Frequently the trunk is carried slightly forward, whilst the pelvis is thrown backwards. In the *calcanian* variety of the disease, this position is inevitable, and is occasionally very decided. The weight of the body, and badly designed or ill-constructed shoes, frequently occasion inflammation and ulceration of the compressed parts. These ulcerations are interminable;—the osseous tissue becomes swollen, and oftentimes carious; the leg is completely atrophied, and abscesses form in it, which eventually open and suppurate ad infinitum. Rest may remedy a portion of these evils, but they are sure promptly to reappear under the influence of locomotion.

The *phalangian* and *calcanian* variety of club-foot are attended with fewer evil consequences than the others.

Let us now see what are the changes discoverable by a dissection of the diseased parts. To commence, let us examine the pathological anatomy of inverted club-foot. On elevating the skin, we are first struck with the atrophied condition of the muscles, particularly the gastrocnemius and soleus; the fibres of the muscles will be rarely found to extend lower down than half of the tibia, whereas in a normal state they descend at least two-thirds of the way. The tendo Achillis is long, tense, and attenuated comparatively with the age of the patient; the superior aponeurotic portion is especially remarkable for its tenuity. The muscles are frequently found to have degenerated into a soft fatty state. The cellular tissue is condensed and small in quantity. No trace of adipose matter is to be found in the legs of many individuals, unless it be on the sole of the foot. The nerves are, according to my own observation, reduced in size, and the arteries are evidently so. The posterior tibial artery is nearer to the internal edge of the tendon, especially in young children, than it is in a normal state. In many

[1] See plate ii.

ing. In this instance the calcaneum was slightly elevated above the ground; the position of the astragalus remained unaltered; the articulation of the scaphoides with the three cuneiforms was not at all separated. The scaphoides in turning around from without inwards, had been drawn along by the tendon of the peroneus longus, the insertion of which is at the inferior face of the first cuneiform. The tendons of the peronei muscles, and more particularly that of the peroneus longus, were stiff and tense, and seemed evidently to be the principal cause of the deviation outwards.

The articular relations are but little deranged in the case of *phalangian club-foot*, even when very forcibly developed. I once saw a man of twenty-five years of age, in whom all the articulations of the foot, with the exception of the metatarso-phalangian, had retained their normal position. It is these last, in fact, which bear the whole weight of the body. Gradually the toes become bent, and the heads of the metatarsi are directed downwards: the luxation is now nearly complete, and the bones of the metatarsus form almost a right angle with the toes. Frequently the ligaments of the astragalo-scaphoidian articulation become elongated, and the head of the astragalus projects—or rather, all the articulations of the tarsus yield at once, and the foot becoming hollow, turns inwards, and takes an intermediate position between phalangian and inverted club-foot, and then it is, that the displacements, described in treating of this last variety of deformity, are perceptible.

Calcanian club-foot is occasioned by a powerful contraction of the anterior tibial muscles, the extensor proprius pollicis pedis, and in some instances, by that of the extensor communis digitorum pedis. The tendons form an evident protuberance under the skin; they present the appearance of cords stretched to their utmost, and resist energetically even a very forced attempt at extension. The inner edge of the foot becomes sensibly elevated above the outer, which occasions an oblique surface from before backwards, and from within outwards. The principal point where torsion takes place is at the articulation of the cuboides with the os calcis, and of the scaphoides with the astragalus. The articulations of the cuneiforms, however, are also implicated. As a consequence of these changes, all the articular surfaces of the bones of the tarsus become more or less separated from each other inferiorly; the inner tuberosity of the scaphoides has a tendency to become superior, and all the bones of the foot, with the exception of the os calcis being elevated, no longer touch the ground. In this state the dorsal surface of the foot forms an acute angle with the tibia.[1] Occasionally the point of the foot is slightly inclined outwards in consequence of a powerful contraction of the extensor communis digitorum pedis. It has appeared to me that this variety is attended with a

[1] See plate v.

greater degree of atrophy of the leg, than any of the other forms of the disease.

All the cases of calcanian club-foot that have come under my observation were congenital; at first they were trifling, but the deformity increased with the age of the patient. The knowledge of the foregoing anatomical and pathological facts will soon enable us to establish such rules as are indispensable for obtaining a radical cure of the malady.

ETIOLOGY.

What are the causes that give rise to the developement of club-foot? This is an important question, and one which has received various explanations. Ambrose Paré[1] has no hesitation in asserting that the deformity is occasioned by the mother's remaining for too long a time seated with her limbs crossed; or the nurse in carrying the child, by too long pressure from retaining it in one position, occasions the turning of the feet. Benjamin Bell[2] admits that a mal-formation of the articulations may occasionally give rise to the disease, but he considers this as a very rare cause. He is of opinion that the contraction of the muscles most frequently occasions it. But the chief cause, according to this author, is the form of the leg. "When it is curved outwards," says he, "the toes are inverted, and the side of the foot is turned under, or, if the curvature of the leg be considerable, nearly the whole sole of the foot will be turned upwards, and at every attempt at locomotion, the instep will press on the ground; when, however, on the contrary, the bones of the leg are curved inwards, the toes and sole of the foot will be thrown outwards and upwards." This is an error on the part of Mr. Bell, which is proved by every day's experience; it is quite common to meet with men having their limbs singularly distorted inwards and outwards, whose feet present none of the characters of club-foot.

Duverney[3] thought that the deformity was caused principally by an unequal degree of tension of the muscles and ligaments; "for," says he, "as these muscles and ligaments are so preternaturally stretched, they draw the foot towards them, whilst the opposing muscles and ligaments being to a certain extent in a state of relaxation can do naught, and are compelled to yield to whatever vicious direction the foot may take." This, we think, is looking at one side of the question only: it is, however, an important step towards the truth. Scarpa having congenital deformities only in view thinks

[1] Op. cit. p. 578.
[2] Cours complet de chirurgie, trad. de Bosquillon; tom. vi, page 168.
[3] Traité des maladies des os; tom. ii. chap. 3.

that Duverney is in the wrong, and that he mistakes the effect for the cause. Scarpa admits that the twisting of the bones of the tarsus is the first of the series of accidents, and that there results from it an approximation of the insertions of some muscles, and a separating of those of others from their point of attachment, and consequently a shortening of the first, and elongation of the second. He adds—"this defect of equilibrium between the two classes of muscular powers, which has just been indicated, contributes in a great measure to keep up the deformity arising from congenital-inverted club-foot, which increases proportionately as the patient advances in life. The action of the peronei muscles not being sufficient to counterbalance that of the two tibiales, the tibialis anticus especially,—these last are constantly dragging the body of the foot more and more upwards and inwards. Hence it is that the combined strength of the four above named muscles, not being sufficient to establish an equilibrium with the muscles of the calf of the leg, the tendo Achillis is necessarily kept on the stretch, and the tuberosity of the calcaneum into which it is inserted, is in the act of being constantly drawn upwards in an oblique direction, and from within outwards from the calf of the leg. Finally as the child advances in age and walks, the weight of the body presses more and more on the external edge of the foot."[1]

Thus, according to Scarpa, the primitive cause of the deformity is the peculiar conformation of the articular surfaces; the displacement and consequent contraction of the muscles being only secondary. This idea, if meant to convey a fact merely, is correct, but if adopted as a positive principle, it is certainly an error, and we are surprised at its having been committed by the expert anatomist who had just made known to the medical world the effects of the deformity in the disease, by proving from actual dissection, that displacement alone of the bones, without ever extending so far as luxation, constitutes the principal pathological derangement observable in the malady. How could he in fact account for the disease ever being accidental, by admitting, as the principal cause of the deformity, a deviation of the articular surfaces? Wrapped up in this error, it was impossible for him to account for the atrophy of the leg, an invariable condition to the complete formation of the disease! "Most generally," he says, "the leg is well formed, but thin, especially about its middle: it is not nourished proportionately with the rest of the body, and it appears to me impossible to give a plausible reason for this phenomenon. Can that condition of things which demands a reciprocity of harmony and connection between the parts as necessary to their perfect developement and growth, notwithstanding the acceleration of the circulation, and the distensible faculty possessed by the smaller vessels, be considered as sufficient? For it has been clearly proved that the want of exercise alone has no perceptible influence in inducing atrophy in

[1] Op. cit. p. 130, 131.

such cases, since experience has shown that this part (the leg) has grown, become fully developed, and strong, in children who have been kept in a perfect state of quiescence during as many months as the treatment may have continued."[1] This candid and frank confession of one of the greatest geniuses of modern surgery is greatly to be admired, and if we are not so reserved ourselves, it is because we consider that we are authorised by the increase of medical knowledge, and the desire of contributing one step to the advancement of science, to speak more decidedly. We shall soon venture to hazard our own explanation.

Delpech was better acquainted with the causes productive of the disease; he believed them to differ according as the malady was congenital or accidental. He thinks that accidental club-foot arises from muscular contractions, which are almost invariably occasioned by inflammatory action. In congenital club-foot, he considers the condition of the muscles as very different; so far from possessing that exuberance of vitality which belongs to them in the former case, they are dried up and withered—nutrition in their case is languid, and so far from assisting in the cure of the necessitous deformity, they rather contribute to its augmentation.[2]

Here is evidently a step gained—experience has been consulted, and the penetration of Delpech has discovered a part, at least, of the evil. This wise example would seem worthy of imitation, but this, I fear, will never be the case—direct observation will be abandoned, and indulgence given anew to theories which may be curious, indeed, but which will be found to be established on too weak a basis, to stand the test of a serious examination.

During the sitting of the Royal Academy of Medicine of Paris,[3] of the 26th November, 1836, M. Martin, surgeon orthopedist, recurring to an opinion often conceived, but always abandoned, and yet again renewed lately by M. Cruveilhier,[4] advanced the idea that the cause of the deformity in congenital club-foot is an absence of the liquor amnii; he brought forward, in support of his opinion, a series of curious cases. The following are the principal facts on which he relies for the support of the theory.

A child which had been born with both feet inverted, having been sent to him by Dupuytren, M. Martin was surprised to see it double itself up spontaneously, and assume the ovoidal form which it had presented in the cavity of the uterus; the thighs were flexed on the pelvis, and the legs on the thighs; the feet came voluntarily to apply themselves to the buttocks, and to cross one over the other in the form of club-foot; this spontaneous doubling was, according to M. Martin, a detection of nature, in the act of forming the disease. The mechanism of this deformity was to him as a ray of

[1] Op. cit. p. 113, 114.
[2] Orthomorphie, vol. ii. p. 322–325.
[3] Bulletin of the Academy, 15th November, 1836.
[4] Op. cit. p. 7.

light, for, evidently, it was the result of a direct pressure exercised by the uterus on the pelvic extremity of the fœtus.[1]

The author introduced this case, with sixty-one others, in defence of the theory. He proved that in every case there was a relative absence of the liquor amnii during some period or other of the pregnancy—that in consequence of such absence the womb exercised a direct pressure on the feet, and deformed them; that unvarying symptoms announced, during gestation, the existence of the deformity in question; that women uniformly experience about the fifth or sixth month, sometimes even later, a fixed and almost insupportable pain in the epigastrium, when the child occupies the vertical position; and in the hypochondriac region, when its position is transverse; which pains M. Martin refers to the pressure of the child's feet against the parietes of the womb; that constantly, also, the women complain of a troublesome weight on the perinæum and fundament; that the abdomen is generally smaller than in normal pregnancies; that if—what would appear contradictory—the birth of club-footed children is occasionally preceded by an abundant discharge of the liquor amnii, this fact is to be accounted for by the probability of the fluid's having been secreted in a large quantity only at a very late period, whereas, up to the eighth, or even ninth month, the quantity had been but small, and the reversion of the feet had already been effected prior to its increase; that, agreeably with this theory, twins should be more exposed to the accident than single-born children—a fact proven by experience.

All these theories appear to me to be incomplete and unsatisfactory, inasmuch as but one, or at most very few cases are adduced, from which general principles are drawn. If it were otherwise, why is the formation of accidental club-foot invariably overlooked? The fact is, it is neglected, because the mode of its developement is never in accordance with the system proposed; it is, however, of such frequent occurrence as to require that it should be taken into consideration.

In my opinion, it is impossible, in the present state of our knowledge, to establish any theory, which, embracing all the known facts, shall account satisfactorily for the formation of the disease. I believe that no such theory can ever be established, for the diversity in the causes which occasion deformity of the feet must, we think, ever prove an insurmountable barrier to the discovery of any single principle for the government of the whole.

Let us now proceed to examine some cases. Eugène G—— was born in the month of May, 1836, with a slight deformity of both feet; so trivial was it, that it was capable of being rectified by the least manual effort, and occasionally the contraction of the anterior muscles of the leg alone would suffice to restore them to their normal position. The child's relatives paid great attention to the

[1] Bulletin, &c., sitting of 3d June, 1838.

deformity, and took every precaution for obtaining its rectification, but all to no purpose; the feet became daily more and more distorted, and the tendo Achillis was stiff, and protruded under the skin. Although a very strong child, it was unable to walk at the age of twenty-one months:—when it stood up, the feet invariably turned on their outer edge, and the heel abandoned the ground. I divided the tendo Achillis of both feet, and they instantly assumed their normal position; in fifteen days after the operation, the cure was complete.

What does this case prove? If I am not much mistaken, it shows that here there was an inequality of force between the flexor and extensor muscles of the feet, and that the gastrocnemii, being the most powerful, drew the heels upwards. To obviate every objection to my explanation, it must be borne in mind that all the muscles of the leg were well developed—there was not the slightest appearance of atrophy. If it is argued that, in this case, the deformity was occasioned by a primitive obliquity of the articular surfaces, I should like to know how the fact of the feet having been so easily reduced can be accounted for, and how, if it was, they retained their normal position after the section of the tendon.

There can be no doubt, then, but that the deviation in the above case, is solely attributable to an inequality of strength between the extensor and flexor muscles.

A young girl, named Ida Auvert, whose case will be found reported at length further on, was born with a club-foot of the right side; so great was the deformity at the time of birth, that her relatives, deeming it incurable, disregarded it entirely. When I saw her, there was apparently no heel, the astragalus was forcibly thrown outwards, and the scaphoides also, insomuch that its inner tuberosity, which had become superior, caused a protrusion under the skin. All attempts, even the most forcible, were insufficient to reduce the foot to its normal position; even after the division of the tendon, it could not be immediately rectified. Do not these facts prove that the deformity, in this case, was principally owing to a vicious disposition of the articular surfaces?

What influence has the position of the fœtus, as asserted by M. Cruveilhier, or its compression by the uterus, as MM. Stoltz[1] and Martin think, over the formation of the congenital variety of the disease? I think it possible, and when I look at the cases brought forward by the above authors in defence of their opinions, and the figure represented in the work of M. Cruveilhier,[2] I must allow both these causes to be of the number of those capable of contributing to the production of the disease. But to admit them to be the sole causes, and attempt by them to account for the formation of every variety of the disease, would be a gross error. M. Cru-

[1] Memoir on a peculiar species of club-foot.
[2] Patholog. Anat. plate 11, fig. 1, 2d book.

veilhier[1] undertook to refute the assertions of M. Martin, and—what is worthy of notice—a part of his objections may be urged against the system which is defended by himself, and which, after all, differs but slightly from that of M. Martin. "Is it clearly proven," says M. Cruveilhier, "that in every case of club-foot, there has been a deficiency of the liquor amnii. Has it not, on the contrary, been shown that in a large number of dry accouchements, as they are termed, the children have been born perfectly formed? Whilst, on the other hand, club-footed fœtuses have been seen surrounded by a very large quantity of the fluid." Nearly all the cases adduced by M. Martin were successively examined, and discredited by M. Cruveilhier.

Notwithstanding Cruveilhier's objections, we still think that the position of the fœtus in the womb, and a diminished quantity of the liquor amnii may be admitted among the number of causes productive of the disease.

There is yet another and fourth cause which may occasion congenital club-foot, viz. convulsions of the fœtus in utero. I have, on several occasions, seen children born, having their muscles wasted away and contracted, and which still seemed (at the time of birth) to be in a state of spasm. In some instances the feet, and occasionally the hands, were found to have deviated so much as to present all the characters of the disease under consideration. In the cases of many of them, the intellectual faculties remained in a state of torpor, approaching almost to imbecility, whilst the deformity of the feet, which at birth was imperceptible, or very slight, became developed with age. The following is a remarkable example.

G——, of a village in the neighbourhood of Metz, was born with a deviation of the feet, so slight as scarcely to be noticed. The child was thin, and of a diminutive stature; its intelligence did not progress with its age. By degrees the anterior muscles of the leg became contracted, and the tendons of the tibiales antici, and of the extensors of the toes, protruded perceptibly under the skin, which was elevated by them; the toes themselves became straightened, and were raised from the ground—all the bones of the tarsus were successively lifted up, and by the time that the child had attained its tenth year, the progress of contraction had rapidly increased; the feet formed very acute angles with the tibiæ, and it ended by becoming a confirmed case of club-foot.[2] The patient experienced the greatest difficulty in controlling the motions of the thoracic and pelvic extremities, which were kept in a constant state of agitation by the involuntary contractions of the muscles.

Does not the foregoing case prove the influence of encephalic and rachidian nervous disease over the developement of club-foot? The younger brother, also, of the child above mentioned, evidently stronger and more robust, was perfectly well formed at the time of

[1] Bulletin of the Royal Academy, Nos. 18 and 19, July, 1838.
[2] See plate 5.

birth—he continued so for seven years, and retained excellent health; within the last two years, however, without any visible or appreciable cause, the gastrocnemii muscles became contracted, and the os calcis ceased to touch the ground, whilst the feet were inverted. The right foot was found to have deviated rather more than the left. I operated on this child, and he is now completely cured.

The above cases give rise to a number of reflections. Is it not very remarkable that in that of the congenital calcanian club-foot, the disease should have increased so rapidly at the age of ten years, and that in the case of the other brother, with the inverted variety, it should have appeared, and become fully confirmed after a lapse of years, and that too without any known cause? Was it a chronic irritation of the muscles of the calf of the leg which caused the pathological change? Or, was it the result of morbid innervation? These are questions difficult of resolution, and prove, in my opinion, that much yet remains unknown as to the etiology of the disease.

Accidental club-foot is frequently occasioned by infantile convulsions. At first, the deformity is slight, but it increases with the age of the patient, and may, as in the case of the congenital form, become highly aggravated. It is remarkable that convulsions seldom occasion the deformity of but one of the feet, and that if it happen in the case of children of four or five years of age, the cure will be more easily accomplished than if it had taken place at an earlier period. This difference is occasioned by many evident causes.

With these cases before us, is it not admissible to think—what we have already stated—that the fœtus experiencing convulsions *in utero*, congenital club-foot may arise under the influence of this cause? Although direct observation has not proved such to be the case, analogy would lead us to suppose that it should be so, and I have no hesitation in admitting it.

It finally remains for me to indicate a case reported by Delpech, of club-foot consecutive to a retraction of the plantar aponeurosis;[1] a remarkable, and as yet unique example.

On resuming the facts presented, we find that congenital, or accidental club-foot may be occasioned—

1st. By an inequality of force between the extensor and flexor muscles of the leg and foot.

2d. By an anormal position of the articular surfaces.

3d. By a mal-position of the fœtus *in utero.*

4th. By the pressure of that organ on the thin flexible members of the child.

5th. By convulsions *in utero.*

6th. By convulsions during early childhood.

7th. By a chronic inflammation of the muscles of the leg.

[1] Orthomorph.

8th. By defective innervation of the tibial nerves, caused by disease of the encephalon, or spinal marrow, without previous convulsions.

9th. By the contraction of the aponeurosis plantaris.

10th. By muscular contraction without any appreciable cause.

We must add to the above, the fact that club-feet often exist in monstrosities, and in some persons whose intellectual faculties are but imperfectly developed.

If we look for an explanation of the changes of nutrition brought about in limbs affected with this disease, we shall find it to be principally owing to a diminution in the caliber of the artery, which in some ancient cases has been found to have lost as much as two thirds of its diameter. This obstacle to the access of the reparative fluid accounts satisfactorily for the atrophy and diminished temperature of the diseased limb.

It has moreover been proven by M. Guérin that in all deformities of the osseous system, the arteries instead of adapting themselves—as is the case with the muscles—to the shortening of the space which they traverse, and running in a straight line along the chord of the curvature, adapt themselves to the curvatures, and follow them, or in cases where they are free, become more and more flexuous, in proportion as the distance, which they have to traverse, is more or less reduced. This fact is sensibly evident in cases of spinal deviation, and curvatures of the members. It is also worthy of remark that on the surface of the convexities of the arterial inflexions, the parietes of the vessels are almost invariably dilated.

The venous system is subject to the same laws that govern the arteries, as far as change of direction is concerned.

But M. J. Guérin has indicated a very important general fact with regard to it, which is—its marked preponderance, an increase which is general in all subjects labouring under strong and ancient spinal deviations, and local in deformities, arising from luxated members, or club-foot. The venous system is subject in all such cases to an increased developement, evinced either by a direct and general augmentation of the size and number of the venous vessels, or by the violet-like colour of the parts, where such increase has taken place. These facts with those relative to the reduction of size of the arteries, and the want of the power of hæmatosis in individuals labouring under spinal deviations, account, M. Guérin thinks, for the oily degeneration perceptible in all the tissues of such individuals, and also for the partial adipose transformation of parts suffering under partial deformities.

With regard to the muscular system, M. Guérin has been enabled, after repeated examinations, to establish as laws belonging to the diseased organism

1st. That in all deformities of long standing, the muscles instead of retaining their primitive relation with regard to the deformed portion of the skeleton, tend to contract, and hold a straight course between their points of insertion.—2d. That the transformation of the muscles is either oleaginous or fibrous; oily when they are compressed and rendered inert; and fibrous where they are subjected to powerful traction.[1]

I shall conclude this chapter with a statistical enumeration of club-feet.

M. Bouvier[2] reports eighty cases either as having occurred in his own practice, or collected from various authors, out of which number two-fifths were double; one third were of the left foot, and a quarter of the right; out of sixty of these cases three-fifths were boys, and two-fifths, only, girls. Of sixty-one cases collected by M. Martin, twenty-six were double, and thirty-five simple; of the latter, eighteen were of the right, and seventeen of the left foot; as to sex, forty-five were boys, and sixteen girls. From this fact, M. Martin concludes, in opposition to the statistics furnished by Bouvier, that the deviation of the right foot, instead of being less frequent than that of the left, is on the contrary a little more so, and that if the proportion of boys is greater than that of girls, it is because they are generally much larger, and for that reason more exposed (according to the etiology of M. Martin) *ceteris paribus*, to the pressure of the womb. Of thirty-one cases collected from various authors by M. Held, the disease was nineteen times double; twice, more decided on one leg than on the other—and in one instance there was on one leg the inverted, and on the other calcanian club-foot.

Twenty-one cases have come under my own observation, thirteen of which were boys, and eight girls; nine of them had both feet deformed; out of the twelve subjects who had but one foot diseased, seven were of the right, and five of the left foot. The disease was fifteen times congenital, and six times accidental. I have never met with a case of double club-foot that was accidental.

With such contradictory results furnished by partial statistics, it must be acknowledged that science is not as yet possessed of a sufficient number of cases, to establish general laws with regard to the forms of the disease, and its relative frequency in the two sexes, either when one or both feet are affected with the deformity.

Is the disease now under consideration capable of becoming hereditary? In the present state of the science we are not authorised in affirming such to be the fact—but the following cases may be adduced in favour of such a supposition.

At Mardigny, in Switzerland, four brothers of the name of Vaullion, whose history is given by M. d'Ivernois, were all born with the feet twisted inwards.

M. Helt, also, speaks of a family living in the environs of Lauterbourg, which numbers six children, all of whom were afflicted

[1] Extract from the report made to the Royal Academy of Sciences, by M. Double, 21st August, 1837.

[2] Dict. de Méd. et Chirg. prat. art. Pied-bot.

with a congenital torsion of the feet. Here the disease was evidently hereditary, or at least it may be supposed so, as one of the parents was afflicted with the same deformity. I have already cited the cases of the two brothers G..., one of whom presented two calcanian, and the other, two inverted club-feet; there are two sisters, however, belonging to the same family, in whom no deformity is as yet perceptible. On the other hand, however, I know many fathers of families, who have either congenital or accidental club-feet, and whose children are perfectly well formed. There is a man of fifty years of age, now living in the town of Metz, both of whose feet are horribly distorted inwards, and who has nevertheless two perfectly formed daughters.

SURGICAL ANATOMY.

The surgeon who proposes practising the section of the tendo Achillis should devote his most careful attention to the tibio-tarsal region. The most serious accidents may result from a neglect of the anatomical relations of the parts. A large artery and important veins are likely to be wounded during the operation, unless it is performed with every precaution that prudence would prescribe.

But to return to our subject. We limit the tibio-tarsal region to all those parts placed from the distance of one inch above the malleoli, to the tarso-metatarsal articulations. This region regarded as a whole, presents on the inner side—1st, the malleolus internus, and above, and in advance of its point, a hollow which separates the tendon of the tibialis posticus from that of the tibialis anticus. 2d, on the outer side, the malleolus externus, separated from the back of the foot by a hollow which corresponds to the astragalo-calcanian excavation; that part behind, and inferior to the malleolus is prolonged into an apophysis, behind which the tendons of the lateral peronei muscles play; still further back, the tuberosity formed by the external face of the calcaneum will be perceived. 3d. In front, the instep is more or less convex, and there is nothing remarkable except the ridges formed by the tendons of the extensors of the toes. 4th. Posteriorly the skin is pushed backwards by the tendo Achillis, the protrusion of which occasions two lateral grooves or gutters, varying in depth according to the age of the patient, his embonpoint, and the degree of tension of the tendon. The skin presents even in this short space, very notable changes. Fine, thin, and but slightly elastic on the malleolus internus, it becomes quite thick on the instep, and in adults presents transverse wrinkles; large veins are distributed over, and colour it; near the malleolus externus it becomes more supple and elastic; the bed of cellular tissue on which it rests, permits with great facility the immediate reunion of wounds of small extent—an important fact, and one to which we invite the most serious attention. At the posterior extremity, the skin becomes thickened and stiff, and that part about the calcaneum is often covered with callosities. The internal saphena vein and the nerve of the same name cling to the malleolus internus at a short distance from the tendon of the tibialis anticus; the vein even rests on this tendon, when it gets as high up as the articulation of the scaphoides with the first cuneiform. The malleolus has inserted on its front the extremity of the anterior annular ligament of the tarsus. The internal annular ligament arises from its posterior margin, and goes to be inserted into the inner tuberosity of the os calcis. This internal annular ligament, the continuation of the tibial aponeurosis, converts the tibio-calcanian interstice into a complete vault, and thus confines the tendons, vessels and nerves which pass from the posterior tibial region to the sole of the foot. This vault is divided by a partition which converts the posterior interosseous fossa into a canal. Its anterior portion is likewise divided into two, by a second partition very short and thick. The posterior one, the larger and much the less solid of the two, encloses the flexor proprius pollicis pedis, and the *posterior tibial vessels and nerves.* The anterior one, a very solid osteo-fibrous canal, is still further subdivided into two adjoining grooves, the one for the tendon of the flexor communis digitorum pedis, which is situated posteriorly, and the other for the tibialis posticus, which is in advance, and presents the appearance of being glued to the posterior face of the malleolus.

If it should so happen that the tibialis posticus should by its contraction offer any impediment to the foot's resuming its natural form, care must be taken not to divide it immediately at the back of the malleolus, for, at that point the tendon is enveloped in a fibrous sheath lined with synovial membrane—and a wound of these parts would almost inevitably be attended with serious inflammation which might be transmitted to the synovial capsule of the articulation. The only point, then, where it would be safe to divide this tendon, is immediately above the malleolus. This is an operation, however, which has never as yet been found necessary. The disposition of the parts is such, that it seems to me impossible that a section could be made of the flexor pollicis pedis alone, unless it should protrude so much under the skin as to render it readily accessible to the bistoury.

On the instep, the slightest contraction makes evident the tendons of the tibialis anticus, and extensores digitorum pedis. The tendon of the tibialis anticus muscle is separated from that of the extensor proprius pollicis pedis by a cellulo-adipose partition. These two tendons may be divided without danger, as they are not enclosed in a synovial sheath, and the pedal artery besides being deep-seated, is placed on the external side of the extensor proprius pollicis pedis.

The tendons of the lateral peronei muscles will be found situated *behind* the *malleolus externus;* arising from the external face of the fibula, they gradually turn around backwards; the sheath in which they are enclosed appears only to be a continuation of the aponeurotic canal, which kept them isolated on the leg. Having got behind the malleolus, they there hollow out a deep groove or canal, in which they are maintained by a resisting fibrous tissue which forms its posterior partition. Immediately above the malleolus externus, these tendons are placed directly under the skin, and this is the point to be selected in preference to every other for dividing them. It is impossible to avoid cutting the tendons of both the peroneus longus and medius at the same time, as they are too closely united for the instrument to divide one without the other also. This section, however, indispensably requisite in the case of everted club-foot, will be attended with no evil consequence, notwithstanding the presence of some of the muscular fibres which extend along with the tendon of the peroneus medius as low down as the bottom of the malleolus externus.

The vessels belonging to this region are too unimportant to render the operation at all serious. They are the external malleolar artery, some other very small branches of the anterior tibial, and (when they exist at all) the anterior and posterior branches of the fibular artery; the accompanying veins are also unimportant; one only is deserving of being mentioned, viz. the external saphena; having like the internal saphena, come from the back of the foot, it winds about in the sub-cutaneous cellular bed, and passes behind the malleolus to get into the fibulo-calcanian fossa.

The external *saphena nerve* is the only one to be seen in the vicinity of the malleolus externus, and the cutting of its small branches would have no deleterious effect on the success of the operation. The division of the external saphena vein, without being at all a serious accident would be the worst that could happen.

Let us now examine the posterior part of the leg; the tendo Achillis is there made evident by its strength, size, and the manner in which it is inserted into the os calcis—an insertion which occupies only the inferior half of the posterior face of that bone, its upper half being separated from it by a synovial bursa of considerable extent.

At that point where the tendo Achillis becomes detached from the fleshy fibres of the soleus and gastrocnemius muscles, its transverse diameter is generally about ten or twelve lines, varying in different individuals. It soon contracts, however, and presents the appearance of a large and nearly round cord. At the distance of half an inch from the os calcis, the tendon again enlarges, and the flattening of its fibres increases to such an extent as to admit of their embracing the whole of the posterior face of that bone. This is the point where the bursa mucosa is located. If the tendon be examined anteriorly, it will be found that the fleshy fibres accompany it much lower down, than they do posteriorly, the consequence is that that portion of the tendon which is completely isolated, is not more than two inches in length. The knowledge of this fact is very important to the success of the operation, for if you cut too high up, you fall necessarily on the fleshy fibres which may inflame and give rise to dreadful suppurations. If on the other hand, the bistoury be carried too low down, the bursa mucosa may be opened, and the synovia which would escape from it, would offer a serious obstacle to a speedy cure.

In order that the division may be made under the most favourable circumstances, that point must be selected which would correspond with the middle of the malleolus externus, supposing a line to be drawn transversely. The abundant supply of cellulo-adipose lining which surrounds the tendon is a fortunate circumstance, inasmuch as it facilitates a speedy cure; it forms a true sheath into which are emptied the fluids which are to serve as the medium of reunion between the divided extremities. When the tendon is cut, an interesting phenomenon occurs by an instant opposition being made to the ingress of the air, which is prevented from coming in contact with the tendon; it so happens that the moment when the instrument divides the tendon, it contracts with force, and draws along with it the adherent cellular sheath, which being pulled from below upwards, closes like a button hole after the instrument. The relation borne by the posterior tibial vessels and nerves to the tendo Achillis merits particular attention. In the adult the posterior tibial artery runs superiorly along the tendo Achillis, from which, however, it is separated by a considerable body of cellular tissue. About the height of the malleolus internus, the artery turns aside to run inwards and downwards, and finally sinks down into the tibio-calcanian fossa. This artery is accompanied by the tibial vein, which most commonly has two trunks, one situated on the external and posterior sides of the artery, and the other on its inner side. The tibial nerve is placed in front of, and on the outer edge of the arterial vessel, but it is not uncommon to find it situated on the inner side of the artery, which it pushes off towards the tendo Achillis. I have, whilst writing, an example of the kind in view.

The tibial artery furnishes a number of branches, all of which, however, are unimportant, with the exception of the one destined to anastomose with the external malleolar; it passes obliquely from above downwards in front of the tendo Achillis. This branch may be wounded, if the instrument is depressed in too upright a manner at the surface of the tissues. In young persons the position of the parts is essentially different from what we find them in adults; the abundance of adipose cellular tissue, the smallness of size of the tendo Achillis, and the slight degree of energy possessed by the muscles, cause the leg to present inferiorly a form almost exactly cylindrical; the artery is proportionately larger than at a more advanced age, and the aponeurotic fibres which cover and protect it behind the malleolus externus, scarcely exist as yet at all; the artery may also be felt, beating very superficially under the skin.

The veins large and gorged with blood surround nearly the whole circumference of the artery. The incomplete developement of the member causes an approximation of all its component parts; and from this source there arises a real difficulty and even danger, in as far as the division of the artery is dangerous, when the operation is performed imprudently, or when a departure is made from the rules which we shall presently lay down. These difficulties are still further augmented by the changes induced in the inferior portion of the leg, when the club-foot is completely formed. All these facts should be carefully noted—they are of the utmost importance to the operative surgeon.

The tendo Achillis, instead of running perpendicularly, as to the axis of the leg, deviates inwards, in order to reach the posterior extremity of the os calcis, and consequently it approximates more nearly to the artery than it otherwise would do. This, subservient to the rule so happily established by M. Guérin, becomes more and more flexuous in proportion as the distance which it has to run is more or less reduced; it follows the direction of curvature of the limb, and the artery and tendon are in almost immediate contact.

The venous system follows the same course, as to change of direction, as the arteries; it is also greatly preponderant—which circumstance, joined to the diminished size of the artery, is extremely fortunate for the protection of the latter from being wounded by cutting instruments.

These anatomical remarks lead us to conclude that, in order to avoid wounding the artery, we must necessarily attack the tendon at its inner edge, and keep as near to it as possible.

THERAPEUTIC INDICATIONS.

Treatment.

The deformity so often serious—caused by the developement of club-foot, the difficulty of walking, and the misfortunes which accompany it, promptly impress the relatives, and at a later period the patient himself, with the desire to remedy the defect. Most persons do not hesitate to make every sacrifice that such a dreadful infirmity may be removed. But, until the present day, how many anxious hopes have been disappointed! How much expense, courage, and patience have been expended for doubtful and unsatisfactory results! This was not because physicians misunderstood the indications to be fulfilled in the treatment—the object was evident—the indications are simple—they are reduced to merely *re-establishing the form and functions* of the diseased foot. The labours of many physicians have been directed towards this object alone, and some happy results attest that they were well acquainted with the nature of the disease, whilst a great number of failures also proves that they had not been so fortunate as to discover the proper mode of treatment. Let the causes of the disease be what they may, the fundamental pathological derangements are reduced to the contraction of one or more of the muscles of the leg, and to a more or less extended deviation of the articular surfaces. This is the evil. Is it always curable? Up to what age is it capable of being remedied? And what are the circumstances that may render the cure impracticable? These are important questions, which we must examine prior to the establishment of the methodus medendi. The astonishing success recently obtained in the cases of individuals whose feet were horridly deformed, and who had been afflicted for a long time with large callosities, ulcers, wasting away, atrophy, and almost an entire paralysis of the lower extremities—a success which is daily multiplied, enables us to assert that, in almost every instance, club-foot is curable. Advanced age is, however, an obstacle; the operation will probably prove unsuccessful, if the bones have acquired their full size and hardness, or if ancylosis exist, or if the articular surfaces, worn away by rubbing and pressure, have lost that bony polish which permits them to slide over one another with such facility, and the thickness which would oppose itself to the return of the foot to its natural shape. We must never despair, however, as there are instances of cures having been accomplished in the cases of individuals of forty years of age and upwards. There would be an evident *contra*-indication to undertake the treatment, should the patient be paralysed in both his lower extremities in consequence of disease of the spinal marrow, and I have met with one example of this kind; or if there should exist a congenital luxation of any one of the bones of the tarsus, as was the case in the patient spoken of by Professor Ehrmann. These occurrences are so rare, however, that it may now be considered as an established fact, confirmed by experience, that club-foot of every variety is almost always capable of being promptly cured.

The main object of the physicians of antiquity, and of Hippocrates in particular, was to oppose to the effect produced by the contracted mucles, machines, which might, by counteracting the evil tendency, restore the foot to its primitive natural shape. At a more recent period, M. A. Severinus and Ambrose Paré, had recourse to tonic remedies for the purpose of strengthening the diseased members. Benjamin Bell was of opinion that the most effectual remedy that could be opposed to the shortened and contracted muscles, was topical emollient applications kept up for a long time. But what reliance can be placed in frictions and exciting manipulations? What beneficial effect can vapour, shower, or emollient baths have on shortened and constantly contracted muscles, or a deviation of articular surfaces?

Such impotent means have always failed, or if they have occasionally appeared to succeed, the credit is due to nature alone, which has so frequently accomplished, contrary to every expectation, most remarkable cures. M. Stoltz knew a boy, the son of poor parents, who had a very decided inversion of the foot, which was totally neglected until the time when he began to walk. At this period they had made for him the simplest kind of boot, which after a time was replaced by a common shoe, made to fit his deformity; he was nevertheless spontaneously cured, about the age of ten or twelve years. Having been habituated from his earliest childhood to the carrying of heavy burdens, the exercise compelled him to apply the sole of his foot firmly to the ground, and throw its point as much outwards as possible. These exertions finally re-established the muscular equilibrium and length,—and at the age of twenty years it was impossible to discover that he had ever laboured under the disease.

Richter relates a no less remarkable case of spontaneous cure. A young man, who had been afflicted from birth with a very marked double club-foot, learned the tailor's trade at the age of fourteen years. From that time he was kept constantly seated with his legs crossed, as is requisite in exercising that profession, and he was soon astonished to find that his feet were beginning to assume their natural shape. The cure progressed insensibly, but was finally completed. This happy result must evidently be attributed to the fact of the extensor and adductor muscles having been kept in a constant state of relaxation.[1]

These fortunate cures, purely accidental, are much too rare to authorise a temporising system as a therapeutic means. I am not aware that any physician has ever proposed such a course; on the contrary, energetic action has generally been advocated, and some authors have even gone so far as to recommend the application of iron boots. Venel, Bruckner, and D'Ivernois, with a greater prospect of success, proposed the combination of tonic and emollient medicaments, with apparatus so constructed as to act at the same time on both the elongated and contracted muscles.

It was soon perceived that the emollient applications possessed the serious inconvenience of rendering the skin too supple, and of softening it so much as to give rise to excoriations, serious inconveniences which counteracted the beneficial effects of the mechanical means used, and frequently rendered it necessary that they should be suspended.

All physicians had been taught by experience that the application of mechanical force was their only resource against deformities of the feet, and, until recently, this means comprised the whole therapeutic treatment. All the machines invented, had for their object the creation of a power, which, by acting on the foot, made to perform the office of a lever, might oppose the resistance caused by muscular action. These apparatus were exceedingly diversified in

[1] Held. Dissert. cit.

form, but they may all be referred to the two systems of dead and elastic forces. The first includes a great number of machines and some bandages, and the second, every oscillating apparatus, of the merits of which very opposite opinions have been expressed by physician orthopedists. Many modifications were made in the construction of the apparatus, occasioned by the varieties of vicious conformation, the peculiar views of the inventor, or to suit certain exigences of individual position or fortune.

As all these means are destined to the same end, we shall only speak of those which, by the simplicity or the success that has been obtained by their use, are still deserving of the attention of practitioners. The *appareils immovibles* of Larrey, Seutin, and Dieffenbach, recommend themselves to our notice in preference to all others on account of their simplicity. As the two first have been long known, and are accurately described in many works, we shall only name them. The following is the bandage used by the Berlin professor :—after having rectified the position of the member, M. Dieffenbach takes two pieces of adhesive plaster about one and a half times the length of the leg, and begins by applying one end obliquely below the calf of the leg; he then passes it around the malleolus externus, the back of the foot, and its sole, and returns it on the opposite side in such a manner, that the two ends are made to cross on the external side of the leg; the object of the application of these two pieces is to prevent the foot from falling downwards and inwards. He then places along the inner face of the leg a bandage folded in the form of a loop, which is made to correspond exactly with the external edge of the sole of the foot, whilst the two upper ends united extend just above the calf.

These pieces are fixed by means of the figure of 8 bandage, wound from without inwards in such a manner as to contribute still further to maintaining the sole of the foot in an outward position, but not so as to enclose the loop, which in the mean time remains free and loose. This being done, the operator takes a strong splint about an inch and a half broad, made long enough to extend to the upper third of the leg, and having, at the distance of an inch from its inferior extremity, a double excavation, to which is attached a small flattened head,—and bringing the loose loop to the outer side of the foot, he there confines with it the neck of the splint, which is afterwards applied to the outer side of the member in such a manner that its head shall extend beyond the surface of the sole. He now fixes the whole firmly, and concludes with enveloping all the limb in a bandage. By this apparatus the foot is not only restored to a proper position, but locomotion, in place of offering any impediment to its action, rather adds to its efficacy; for, whenever the foot is allowed to rest on the ground, the little head of the splint touches first. As its point of support, however, is not sufficiently broad, and is, moreover, situated without the centre of gravity of the body, at every step that the patient takes, there results a movement of reversion outwards.

The apparatus is simple and well conceived, and it may be applicable to some cases where the deviation is but slight, and the deformity easily remedied by the action of the hand alone.

The plaster mould proposed by M. J. Guérin, the mode of applying which has already been shown, will succeed as well, under the same circumstances, as the bandage of Dieffenbach; it must be borne in mind, however, that these means, which are suited only to young subjects, are long in perfecting a cure, and that the patient, treated by them, is very apt to have a return of the disease in a short time after their removal. This is a matter of great importance, and it cannot be denied that the cures, obtained by such mechanical means alone, are uncertain, often incomplete, and always leave the patient liable to a recurrence of the deformity.

The ingenious apparatus invented by Scarpa, Boyer, Delpech, and M. Stœss, an orthopedist of Strasburg, have each been used successfully in some cases, whilst they have been very frequently found to fail in others, and it cannot be denied that many patients, having experienced from their use a very prompt but temporary amelioration of their condition, have had the misfortune to see their deformity reappear, after all their endeavours to combat it during months and even years of inconvenience, pain, and privations of every kind. All these apparatus then, are liable to objection, and the fact should not be concealed that there is occasionally danger in their use. No matter how well they may be constructed, there must always be some parts which rest on the member, which will occasion pressure, friction, pain, ulceration, and even gangrene of the skin. One of the objects of their application, is to extend the retracted organs,—and this must necessarily give rise to deep seated pains, inflammation, suppuration, and, consequently, muscular contraction. Doubtless the physician will take every precaution to prevent such evil consequences of extension and compression; he will accustom his patient gradually to the use of the apparatus, and allow him in the commencement intervals of repose. Notwithstanding every precaution, however, he will frequently witness the supervention of violent pains—a sure indication of the approach of the accidents so much to be apprehended. When they do supervene, no time should be lost in removing the apparatus altogether,—it ought to be done without a moment's hesitation,—and if, after two or three attempts, the pain is found always to recur, it should never be permanently reapplied. Experience has proved, that when constant pain is the result of extension, if such extension is not instantly arrested, instead of assisting, it will only throw new obstacles in the way of a cure.

These apparatus and bandages are much less relied on since the introduction of the practice of dividing the tendo Achillis in the treatment of the disease, and the time is not far distant when they will be almost entirely abandoned, with the exception of cases of very slight deviation, where the least traction will suffice to reduce the foot, in which plaster, the apparatus of Larrey or of Dieffenbach may be applicable, and should always be employed; for every operation, no matter how unimportant it may seem to be, is attended with more or less danger. With the exception of such cases—I repeat—the section of the tendo Achillis will soon supersede the necessity for the application of all these costly, fatiguing, and uncertain means; and the machines will be found only in museums—illustrating the history of the art.

The dividing of the tendon is a simple operation—soon over, and generally very easy of performance, whilst at the same time it is unattended with danger. It has been the means of establishing more radical cures in the space of a few years, than had before been accomplished during ages. It is worthy, then, our most serious attention, and I will endeavour to describe it with the most minute care. First, as to the division of the tendo Achillis,—and before proceeding farther, it will be well to recur to some of the most important surgical facts. It will be recollected that the posterior tibial artery is placed at the inner edge of the tendon to which it is united, and by which it is sometimes even covered superiorly; it becomes detached about the middle of the tendon, and is entirely separated from it at the inferior portion, after which it runs along the centre of the groove formed between the tibia and os calcis. The artery is accompanied in all its course by large veins, and by the posterior tibial nerve. It has already been seen that these important organs do not retain their normal relations in cases of club-foot, more especially when the disease is far advanced,—the deviation of the foot causes them to approximate more closely to the tendon; the veins, which are pathologically distended—as well as the artery, form flexuosities, which cause them to occupy a larger space than in their normal state. The tendon itself merits a moment's attention; from being very broad at its superior part, it gradually decreases in size, until it forms a large and nearly round cord, whilst at the distance of twelve or fifteen lines from the heel, it again enlarges for the purpose of being inserted into the os calcis—to obtain which insertion, it has to pass through a broad mucous bursa.

We are warned by these facts that the instrument used for dividing the tendon, may wound the artery, the veins, or even the nerves; and such accidents are the more likely to happen, if the patient be young, and the disease far advanced. If the tendon is divided too high up, the danger will be increased; and if on the contrary, the section is made too low down, there will be danger of opening the bursa mucosa, which would allow the escape of the synovial liquor into the wound, the constant presence of which would hinder the cicatrisation and hardening of the plastic lymph interposed between the ends of the divided tendon. From these considerations we have been induced to lay down the following rules, which are precise, and must not be departed from in any case, where the object is to perform with safety the section of the tendon.

1st. The point for dividing the tendon, in adults, is at the distance of fifteen lines above the os calcis. In infants it must be varied according to the child's age,—in the youngest subjects the point ought never to be less than five lines from the heel. In case these directions should be forgotten, it will be well to recollect that a line drawn transversely, so as to divide the malleolus externus, will give the exact height at which the section should be made.

2d. The tendon should invariably be divided from its inner edge, as, by so doing, the instrument will be interposed between it and the vessels and nerves.

3d. The incision should be small, and ought never to traverse the skin through and through; this precaution is necessary to prevent suppuration and exfoliation of the tendon.

What is the most suitable instrument for performing the operation? Each operator has had his own instruments, which have differed more or less from one another. Delpech made use of a bistoury, held flat, for dividing the skin, and passing behind the tendon;—and for cutting it, he used a small convex knife. M. Stromeyer employs a pointed bistoury—very narrow, and bent so as to present a convex edge.[1] M. Bouvier uses a lancet to make the opening in the skin, and then introduces a small straight knife scarcely larger than a cystitome.[2] M. Stœss also uses two instruments, a double edged bistoury—having the blade very narrow—and then a probe pointed bistoury bent to a very obtuse angle, and having only a small convex edge on the curved part.[3] In my own opinion, two instruments are not required for the performance of such a simple operation,—they serve only to increase the difficulties, and prolong the duration of the operation. Why should it be necessary to withdraw the cutting instrument at all, after it has traversed the tissues? If, by accident, any important part shall have been wounded, the necessity of having to introduce the second instrument, will prevent the surgeon from endeavouring instantly to remedy the evil.

For these reasons I have determined to make use of one instrument only in performing the operation. M. Duval also uses only one; I call the knife which I use, *Ténotome:*[4] it is a very simple instrument,[5] consisting of a blade nearly similar to that of a scalpel, inserted into a strong handle; the blade differs, however, from that of the scalpel, in its being more narrow, and having the point convex on both sides,—the curvature of the cut-

[1] Archives Méd. tome iv. page 103—104.
[2] Bulletin of the Academy, Dec. 1836, p. 200.
[3] Held, Dissert. p. 53.
[4] From τενων, tendon, and τομη, section.
[5] See plate vi.

ting edge commences near the point. I have adopted this form in order to avoid chafing the skin at its internal edge, as is apt to be the case, when the operation is performed with other knives; the back of the instrument is quite thick, and its curvature much greater than that of the point. I think it better that the back should be made thick, in order that it may be set firmly against the tendon, for in some individuals this offers very great resistance to the action of the instrument. The edge of the *ténotome* looks towards the broadest side of the handle; this disposition is made in order to afford a large surface for the fingers to rest on, and thus insure the instrument's being held firmly in the hands of the operator.

Position of the patient.—When the patient is a young child, I have him placed on his abdomen, and supported on the knees of an intelligent assistant. When an adult is to be operated on, I place him in the same position on a bed; one assistant holds firmly the lower part of the leg, whilst another seizes the foot and flexes it for the purpose of stretching the tendon, and making it prominent. If the patient is a child, I myself take charge of the foot, and move it in the manner indicated,—then holding the ténotome in my right hand, I apply its point against the tendon, whilst with the fingers of the left hand which are free, I stretch the skin by pulling it a little inwards. To execute the *first part* of the operation, I now thrust my instrument through the integuments, keeping it as near as possible to the tendon, and turn it from behind forwards, and from within outwards. When, by the depth the blade has penetrated, and sometimes by a slight external protrusion of the skin, I find that my instrument has passed beyond the tendon, I prepare to execute the *second part* of the operation. The handle of the tenotome being depressed, the edge of the blade is consequently firmly applied against the parts to be divided; I now move the instrument very slowly backwards and forwards,—a peculiar noise soon announces the separation of the tendinous fibres, and suddenly a quick, dull, crackling sound proclaims the entire division of the tendon. I immediately cease to press on the instrument, and withdraw it slowly from the wound, at the same time arranging carefully the integuments. A depression, varying in extent according to the degree of contraction of the muscular fibres, occupies the place where the tendon previously was. The operation, thus performed, is attended with but little pain, and I have frequently seen it borne by children without their uttering a single cry.

When the ténotome is withdrawn, a few drops of blood escape from the wound, scarcely ever, however, more than four and five. As soon as this is stopped I press the little wound lightly in order to expel that which may have accumulated under the integuments or in the tissues,—a precaution which I think useful, inasmuch as it prevents the formation of clots, the presence of which might give rise to irritation and suppuration. A small pledget spread with cerate being placed over the wound, a compress and bandage complete the dressing. I leave matters in this state for five or six days, at the expiration of which time, the first dressing being removed, the wound is generally found to have healed, and now is the time for reducing the foot, which by-the-by will be frequently found to have already commenced, under the influence of the active contraction of the extensor muscles.

I commence this operation by enveloping the foot in one or more long compresses of several folds, and then apply a bandage of the breadth of two fingers around it, in the form of the figure of 8, which, descending from the external side of the leg, passes under the inner edge of the foot; such a disposition of the bandage is indispensable, as it tends to depress the inner edge of the foot, and elevate the external edge. Indeed it will sometimes be found sufficient of itself to maintain in a proper position club-feet that are not highly aggravated; the bandage being applied, I next arrange the apparatus for reduction.

This machine is very simple[1]; it is composed of a wooden sole larger than the foot, and perforated by several mortices; a strong leathern heel varying in height according to the age of the patient, but which should, nevertheless, in no case exceed an inch and a half, is fixed to the posterior part of the sole; and on the inside of this heel two leathern tongues, pierced with eyelet holes, are attached, which are intended to lace on the instep, in order to keep the heel in close contact with the sole;—two steel uprights with hinges at the height of the malleoli, and two arcs of circles placed transversely for the purpose of adding to the solidity of the uprights, embrace at their inferior extremity the sole, to which they are firmly secured by means of rivets. One of these uprights has attached to its outer side, and at the height of the malleolus, a ratchet with a double spring click (*double fourchette*) to stop it. This part of the apparatus is indispensable for keeping the foot at whatever degree of flexion may have been given to it. At first I had but one click (*fourchette*) behind, but I soon saw that it was frequently bent by blows or involuntary movements. These two clicks (*fourchettes*) are capable of being simultaneously separated by means of a fixed (*clef à demure*) but movable key, placed above, and at a short distance from the ratchet. All the metallic parts of the apparatus are lined with leather, and there are two leather straps to go around the upper part of the leg. When the foot is placed in this machine, and the two leather straps, destined to fix the heel, laced, I put an end of a bandage through one of the mortices of the sole, and pass it several times around the foot and the sole, for the purpose of keeping it flat, and endeavouring to bring it back to its normal position; the remainder of the bandage is made to describe the figure eight, by passing around the foot and the sole, but without including the metallic uprights. In the commencement the foot forms a right angle with the leg, but every six days I incline it on the leg by advancing the clicks (*fourchettes*) one tooth on the ratchet.

[1] See pl. vi—the figure represents an apparatus for a child of four years.

This simple and cheap apparatus might be replaced by that of Scarpa, by adding to the latter the ratchet and double spring click (*double fourchette*) for the purpose of opposing any quick or irregular movement of flexion. The bandages soon become deranged, and it is necessary that they should be reapplied, whenever they are found relaxed. At every reapplication a new effort should be made to reduce the foot to its natural shape. It generally requires six weeks for the complete consolidation of the new tendinous tissue, and for the foot to become divested of the habit of inclining in an improper direction. But it frequently requires no more than eight or ten days, and even a shorter time in some cases, for its complete reduction. When the consolidation of the tendon is completed, half boots should be made with very thick stiffnings, and two long leather straps on the inside, for the purpose of lacing over the instep, and keeping the heel firmly applied against the sole. The patient should endeavour gradually to re-establish the functions of the leg, but never fatigue himself.

Those authors, who have preceded me, have given but incomplete directions with regard to their operative process, and such as are wholly insufficient to guide the surgeon in an operation for the division of the tendo Achillis.

Delpech, to whom, I take pleasure in repeating, we are indebted for our first exact notions with regard to the operation under review, has laid down the following rules:

1st. The tendon to be divided ought never to be laid bare,—it should be cut in a slanting manner, and not by an incision parallel with the skin, for in that case it would probably exfoliate.

2d. Immediately after the tendon shall have been divided, the two ends should be approximated and maintained in contact by means of a suitable apparatus, until they are reunited.

3d. This reunion having taken place by means of the interposition of a new formation of fibrous matter, it is necessary before that substance has become completely solidified, to elongate it by means of extension gradually increased.

4th. When a sufficient lengthening has been obtained, the parts should be immediately fixed in their proper position, until the intermediate substance shall have acquired all the firmness of which it is susceptible.

Operative process of Delpech.—In the case recorded in the *clinique chirurgicale* of Montpellier, Delpech divided the tendo Achillis of a young man nineteen years of age, in the following manner. The patient having been placed on his abdomen, he thrust a bistoury, which was held flat, behind the tendon in such a manner as to occasion on each side of it an opening of about an inch in length; he then withdrew the instrument, and introduced into the wound a convex knife, the cutting edge of which was turned towards the tendon, which was then divided transversely without implicating the skin situated above. But by this operation it was impossible to prevent the exfoliation of the tendon; the suppuration was very abundant, and extension could not be used until the twenty-sixth day, and the sides of the tendon had become adhered to the cicatrices which formed but slowly on account of the suppuration. At first, the movements of extending and flexing the foot occasioned a puckering of the skin, but this inconvenience disappeared in the course of time.

Process of Stromeyer.—The Hanoverian surgeon, from the time of his first operation on the 28th of February, 1831, modified the process of Delpech in the following manner. The patient being seated on a table in front of the operator, with the left side towards him, one assistant held the knee down firmly, and another seized the foot, and bent it, so as to stretch the tendon forcibly,—a pointed bistoury, very narrow and bent so as to make the cutting edge convex, was thrust two inches above the insertion of the tendon, between it and the tibia; the back of the instrument being turned towards the bone, and the cutting edge towards the tendon; this latter was divided by the mere introduction of the instrument; the section was accompanied with noise. The indication of making the external wounds as small as possible, in order to avoid the entrance of the air, the exfoliation of the tendon, and suppuration, was, the author says[1] perfectly fulfilled, for the point of the bistoury only passed through the opposite side, without making a bleeding wound, and the entering wound was only of the size of the blade of the instrument. In his second operation, performed on the 12th of June, 1834, the author used the same process, with the exception, however, that the tendon was divided in this case at the distance of three inches above the heel.

Although this operation is nearly analogous to that of Delpech, it nevertheless differs from it; in that the author took great care to make the incisions as small as possible, which was an important step towards improvement, and his success is owing to this circumstance. We congratulate M. Stromeyer on it, but at the same time we do not hesitate to state that there are inconveniences attending the double wound, and danger in dividing the tendon as high up as three inches above its insertion into the calcaneum.

Process of M. Bouvier.—The patient being placed on his abdomen, a small opening was made with the point of a lancet parallel to the axis of the leg, only a few lines from the tendon, and opposite to that point where it was found to be smallest and most prominent. This opening permitted the introduction under the skin of a small, straight probe-pointed knife, scarcely larger than a cystitome This ténotome was passed between the skin and the tendon, which latter was then easily cut from without inwards, without wounding the integuments on the opposite side. The foot was then placed in an apparatus constructed so as to maintain it flexed on the leg, and thus keep the ends of the tendon separated.[2]

[1] Archives générales, vol. iv. p. 103.
[2] Bulletin of the Academy, Dec. 1836, p. 200.

This process is attended with the serious inconvenience of having to cut from without inwards; the instrument—if the tendon should give way suddenly—might be carried downwards on those deep-seated parts which it is of the utmost importance not to injure. Here we also have the inconvenience of two instruments.

Process of M. Stœss. The object of this operator, as of MM. Bouvier and Duval, is to perforate the skin on one side only, and divide the tendon from as small an external wound as possible. For this purpose he introduces between the tendon and tibia, a double-edged bistoury with a very narrow blade, (it is only a line and a half broad,) held flat, with which he makes an incision two lines and a half long, taking care at the same time not to perforate the skin of the opposite side; it is then withdrawn and replaced by a probe-pointed bistoury, bent in a very obtuse angle, and having a very small convex cutting edge on the bent part. The straight part of the blade is placed in front of the heel, where the instrument is made dull to prevent its enlarging the external wound, at the moment when the bistoury being turned vertically, performs by a saw-like motion, the section of the tendon. The division being made, the instrument is immediately withdrawn, and the wound closed by the finger, to prevent the entrance of the air into the vacant space left by the retraction of the two ends.[1]

This process is likewise liable to the objection already made, of employing two instruments, when one only can be as advantageously used. This description, as well as the preceding ones—leaves something also to be desired as to the point to be selected for performing the operation, according to the age of the patient; and some directions should be given as to the precautions necessary to be taken, to avoid wounding the artery and veins.

Process of M. Duval. This expert orthopedist has not yet published an account of his process, or at least I have not met with it, although I have in one case seen him operate; in this instance he used but one instrument, of which mine is only an imitation; he took great care not to traverse the integuments on both sides, and divided the tendon with remarkable dexterity.[2]

Consecutive Treatment.—It is not enough to have overcome the principal obstacle to the reduction of the foot, the parts must be replaced in their normal position, and in order to obtain this result, it will be found indispensable that the following indications should be fulfilled:—viz. to overcome the inordinate contraction of the

[1] Held, Diss. cit. p. 53.

[2] [An account of M. Duval's method of operating, will be found in the Bulletin of the *Royal Academy of Medicine* of Paris, of the 15th March, 1837, and in his "Traité pratique du Pied-bot," Paris, 1839, in 8vo., page 117. It does not differ essentially from that of our author, and the instrument which he uses, is the acknowledged original of that of M. Scoutetten. M. Duval is, however, in the habit of employing occasionally in the cases of very young children, and under certain circumstances, straight probe-pointed scissors, with which he has in three instances operated successfully. *Transl.*]

muscles, and to restore the articular surfaces to their natural relative positions. These indications can only be accomplished by time and a suitably constructed apparatus. It can easily be conceived that a certain time is requisite for restoring to their normal position bones which have become separated, and there would be serious inconveniences attending its being greatly abridged, for this could not be done without violent pressure and traction, occasioning pain, a stretching of the ligaments, and a convulsive contraction of the muscles, which, giving rise to inflammation, might retard, and would probably hinder altogether the re-establishment of the union of the two divided ends of the tendon. Here it is that the wise precept of Hippocrates should be remembered—"*neque magnâ vi, sed leniter cogantur!*"

The reduction is nevertheless performed in some cases with won derful promptitude; I have seen many feet strongly distorted, perfectly restored in six and eight days, and it rarely requires more than fifteen.

The reduction was obtained in the thirty cases reported by M. Duval to the Academy of Medicine,[1] in from ten to twenty-five days. Agreeably to my own observation, accidental club-feet are the most easily reduced.

But at what time should the apparatus be applied? Authors do not agree on this subject; according to some, the application ought to be made immediately after the operation,—whilst others are of opinion that a period varying from five to fifteen days should be allowed to intervene. In the cases of the two persons first operated on by M. Stromeyer, the apparatus was not used until the tenth day. M. Stœss has frequently applied it on the fourth and fifth day, and I have seen M. Duval arrange it immediately after the operation was over. My practice is always to leave my patients at liberty for four or five days; the object is to avoid extension, which, if combined with the irritation caused by the division of the tendon, might induce inflammation. At the expiration of four days, then, and when the wound is healed, I apply the machine. How ought the foot to rest in the apparatus? Should it be inclined, so as to favour as much as possible the approximation of the ends of the divided tendon—as advised by Delpech and the greater number of operators who have succeeded him? And should the elongation of the intermediate substance secreted by the ends of the tendon be gradual? These are important questions which appear to me not to have been duly considered. It is generally admitted as necessary, that the two ends of the tendon should be as nearly approximated as possible, and then to cause a progressive lengthening. The newly secreted substance appears to be viewed in the light of glass rendered soft by the application of heat, which may be extended at pleasure. We instantly reply to such an assertion, that if the elongation takes place as is supposed, it can only be by diminishing the

[1] Bulletin of the Academy, Jan. 1837, p. 304.

thickness and cohesive power of the newly formed tissue, and that this tissue would thus be exposed to the possibility of being broken by violent or too long continued extension. It should still further be recollected that nature is not too bountiful or extravagant in the use of her "*vis medicatrix!*" and thus when she has caused the re-union of divided parts, the secretion of the fluids, destined to become solidified, ceases. Notice the phenomena which occur in the case of a fractured bone,—if the fragments are closely approximated, the plastic juices are secreted in small quantity, whereas if they are widely separated, the secretion is very abundant, and the callus extends to some distance around the parts.

These facts would lead us to infer that it is wrong to attempt bringing together the divided ends of the tendon, and that it would be better, within certain limits, to pursue an opposite course. At all events up to the present time, I congratulate myself on having conformed to such precepts. I place the foot, then, in the machine in such a manner that it shall stand at a right angle with the leg, and keeping it in this position for ten or twelve days, I then gradually and progressively bring it up to an acute angle of 55° or 60°, and never to 70°, as has been proposed, for there are many serious objections to keeping it so very much flexed. We must afterwards rely on the efforts of nature to make the parts supple, and restore to them their natural motions.

When I think it proper to flex the foot, I always do so slowly; I hold it firmly with my right hand, whilst with the left I raise the clicks (*fourchettes*) which rest on the ratchet, one of the teeth of which indicates the extent of inclination that I make. As long as the foot is kept in the apparatus, the position of the heel must be carefully watched,—the final success of the operation depends on the attention that is paid to its being placed and maintained in a proper position. The heel, which has a natural and decided tendency to become elevated, is still further assisted by the motions of the child, and the relaxing of certain parts of the apparatus. When any such displacement is perceived, every thing should be instantly removed, and the parts replaced in a suitable position. It is but seldom, especially in the commencement, that three days elapse without the displaced parts of the machine requiring re-application.

Although the little wound may be completely healed, I take the precaution constantly to surround the foot with several soft compresses, which are kept in their places by means of a bandage. I even take the precaution to apply a very thick piece of linen over the parts on which much pressure is likely to be exerted; it is in this manner that I protect the skin which covers the astragalus and calcaneum from pressure which might bring on inflammation and gangrenous eschars—misfortunes which many operators have had to regret.

Accidents.—Many accidents may immediately follow the section of the tendo Achillis, the most serious of which would be the division of the posterior tibial artery; very fortunately an example of the kind has as yet scarcely occurred,—at least we may infer from the silence of operators that it has never happened. It is to be feared, however, that at some future day it may occur, for the surgical anatomy has already shown us that such a thing is possible, especially when the operation is performed on young children. Under such disagreeable circumstances the first object of the operator should be to compress the femoral artery, and at the same time endeavour to arrest the hemorrhage by applying a dossil of lint over the wound, and supporting it with a tight bandage. A stop being thus put to the flow of blood, the surgeon will have to choose between tying the femoral artery at the middle of the thigh, the popliteal artery, or the vessel itself immediately above the wound. The last seems to be the most simple, but it is nevertheless by no means the easiest,—from the difficulty that would be occasioned by the extravasation of blood in the cellular tissue, and the inconvenience that would be experienced in arresting the flow of blood. Whenever it is practicable, however, this part should be chosen, as it will be found most advantageous to the patient. If the child is young, and abundantly supplied with cellular tissue—a circumstance by the way very rare in the limbs of club-footed persons, it would be more prudent and easier to tie the femoral artery at the middle of the thigh. The facility with which the anastomotic communications are made renders this operation much less dangerous in young children than adults.

In performing the section of the tendon, the little artery might also be divided, which goes from the posterior tibial to the external malleolar, and passes in front of the tendon. Such an accident would not probably be serious,—the only danger would be a small sanguineous effusion, which, by the coagulation of the liquid, would soon stop the hemorrhage.

The veins have been frequently wounded,—it has happened in my own practice in two instances.[1] The accident may be detected by the abundant flow, in a continued stream, of blood more decidedly red in proportion to the youth of the subject. This coloration of the blood may surprise and alarm the operator; he must quickly, however, regain his self-possession, in order that the assistants may not perceive the danger which he apprehends, and instead of being in a hurry to stop the blood, he should allow it to run for a short time, for the double purpose of assuring himself by the jet, of the nature of the vessel wounded, and of obtaining the disgorgement of the veins, so that the hemorrhage may be the less likely to recur.

When the jet decreases, the vein should be compressed, and a small pledget covered with cerate applied, over which a thick compress ought to be placed, and the whole firmly secured by means of a bandage. In such cases, as under more favourable circumstances, I allow the dressing to remain four or five days without touching it.

[1] See cases 1 and 4.

If the nerve should be wounded, severe pain would result, which would at once evince the nature of the accident. I know of no example of the kind having ever occurred,—if it should happen, nothing could be done, but to apply topical emollients and narcotic ointments.

After the instrument has traversed the tissues, it may, instead of passing entirely around the tendon, penetrate through its fibres, and thus leave some of them untouched. Such an accident is indicated by the incomplete retraction of the tendon, and the resistance offered by its undivided fibres,—a resistance which the operator may easily detect by the touch. A case of the kind once occurred in my own practice, in the person of a young lady twenty-one years of age; it was easily remedied by re-introducing the point of the bistoury, and dividing the fibres which remained.

Inflammation, suppuration, and exfoliation of the tendon are of rare occurrence; they however supervened in the case of the patient operated on by Delpech, and the cure, although eventually completed, was retarded by them.

It may so happen, although there be a total absence of all inflammatory action, that the two ends of the tendon will never reunite. This is a serious accident, inasmuch as it precludes all hope of cure. M. Stromeyer had a case of this kind, in a boy seven years of age;[1] the foot retained its vicious conformation.

When the section of the tendon is cured, the foot may in some cases still present a decided deviation; this accident occurred in the case of a lady of thirty years of age, who was operated on by M. Duval, and it was occasioned by the contraction of the tibialis anticus muscle. The tendon of that muscle was divided, and the cure soon after completed. Gangrenous eschars may supervene, when the precautions, which I have indicated for preventing violent compression of the skin, are not used. In the case of the first patient operated on by M. Stœss, one eschar made its appearance on the heel, and another on the first metatarsal bone,—two month's treatment was required to cure them.[2] In a patient treated by M. Duval, the formation of an eschar prevented the application of the extending machine for more than six months.[3] If it should happen that the skin is traversed on both sides, or completely divided, the wound should be closed, and an endeavour made to obtain an immediate reunion.

[1] Nouvelles Observ. in Archives générales, vol. 5, p. 194—1834.
[2] Held, Dissert. cit. p. 69.
[3] Bulletin of the Academy, Jan. 1837, p. 307.

SEQUELÆ OF THE OPERATION—PROGRESS OF CURE—CHANGES IN THE LIMB OPERATED ON.

The section of the tendon is followed by an immediate and quick retraction, varying from a few lines to an inch and more. A hollow is felt under the skin, indicating the unoccupied space; if the blood has accumulated under the skin, which ought, if possible, to be prevented, and which is moreover very rare, a slight bluish coloration will appear. There generally forms during the first three or four days, a slight sub-cutaneous swelling, which is not, however, inflammatory; the cavity is then filled with a concretable fluid, out of which is formed the new tissue destined to replace the tendon. The small external wound heals between the second and fourth day.

About the tenth day the plastic lymph becomes thickened, and begins to harden; the tissues in the immediate vicinity of the wound are swollen, and present to the touch the sensation of an unequal surface. Between the fifteenth and twentieth day, the new tissue becomes isolated, begins to assume its form and to get round; sometimes a sort of thick ferrule may be distinctly felt at the point where it is in the act of uniting to the superior end of the tendon. At the expiration of a month, the consolidation has become completed, and no evidence remains, except perhaps the very small cicatrix, to show that any operation had been performed. In the cases of some individuals of a lymphatic temperament, the progress of cure may be less rapid, but two months will always prove sufficient for the indicated results to obtain.

Direct experiments have been made on animals, with the view of discovering the mechanism of the reproduction of the ligamentous cord which supplies the place of the divided tendon. M. Bouvier presented to the Academy of Medicine of Paris the tendons of the extensor muscles of the foot of a dog, which had been killed thirty days after they had been divided, and which were found to have been reunited by a solid substance. The two ends of the tendon were seen to be separated about the distance of an inch, and their continuity re-established by a new fibrous tissue, which had formed in the interval. This substance presented the same form and external appearance as the tendon itself, and, like it, adhered loosely to the cellular tissue which served as its sheath, so that as far as solidity and mobility were concerned, it fulfilled perfectly all the functions of a tendon. Nevertheless it has been found from this case, and many more similar experiments, that the new tendinous substance differs from the true tendon in being of a grayish colour, and in having a more condensed texture,—so that its formation bears about the same relation to the regeneration of tendinous tissue, as the production of cicatrices of the skin does to the teguments, the true structure of which is but imperfectly replaced by them.[1]

[1] Bulletin of the Academy, 15th Oct., 1836, p. 32.

Remarkable changes are soon manifested in the member operated on; the muscles of the calf become developed, the cellular tissue is distended with fat, the sub-cutaneous veins are made apparent, the callosities become effaced, and if the deformity has not been highly aggravated, the leg gradually assumes the form and size of an originally well-shaped limb. There are, however, some persons, who are never wholly divested of all the effects arising from the deformity.

DIVISION OF THE TENDONS OF THE LATERAL PERONEI MUSCLES FOR THE CURE OF EVERTED CLUB-FOOT.

When the contraction of the lateral peronei muscles occasions *everted* club-foot, it becomes necessary, as in the case of the tendo Achillis, that they should be divided. This operation has been but seldom performed, as *everted* club-feet are of more rare occurrence, and generally not so highly aggravated as the *inverted* variety.

The rules to be observed in performing this operation are exceedingly simple; it is only necessary to refer to what has been already said with regard to the situation of these muscles, to comprehend the necessity of dividing their tendons at the distance of two or three lines above the malleolus externus; at this point they rest on the fibula, and are covered by the skin only.

Is it requisite that both tendons should be divided, or one only? It appears to me to be very doubtful whether the tendon of the peroneus *longus* can be easily cut without that of the *brevis* also. It could only be done in cases where the peroneus longus makes a very decided protuberance under the skin, and I have seen a case of this kind in a young lady of Alsace, who would not consent to have the operation performed. But even admitting the possibility of dividing one of the tendons alone, I do not think that it would be attended with success, for in almost all cases they both contribute to the developement of the disease.

The operation is reduced to merely introducing the ténotome under the skin, using it carefully on account of its great tenuity, and dividing the tendons of the lateral peronei muscles. We cannot admit the practicability of cutting them below the malleolus, as great difficulty would be experienced in dividing the fibrous tissues and ligaments which exist in that region.

DIVISION OF THE TENDON OF THE TIBIALIS ANTICUS FOR THE CURE OF CALCANIAN CLUB-FOOT.

The decided protuberance made under the skin by the tendon of the tibialis anticus in cases of calcanian club-foot renders this operation remarkably easy. No accident need be apprehended, if it were not for the possibility of dividing a venous branch which ramifies on the instep—and that would be of too little importance to cause a moment's uneasiness to the operator.

Is it necessary in cases of a simultaneous contraction of the extensor tendons of the big toe, and four last ones, to divide them successively? I have no hesitation in answering this question affirmatively, as it does not appear to me that nature would be more embarrassed in establishing this multiform reunion, than in the case of but one large tendon. I think, however, that it would be better not to divide all at the same height, in order to avoid weakening the skin too much at one point. I intend pursuing this course in the case of the patient whose feet are represented in the fifth plate.

INDIVIDUAL CASES.

Case 1.—Congenital inverted club-foot highly aggravated. Extreme youth of the child. Division of the tendo Achillis. Venous hemorrhage. Complete cure.[1]

Joséphine H——, of Plombières, was only eleven months old when I saw her. She was born with a club-foot of the right side; the misfortune occasioned in the parents great anxiety, and they most ardently desired that the deformity should be cured. I advised them to have the tendo Achillis divided. They acceded to the proposition, and the operation was performed on the 25th June, 1837. There was great deformity, the sole of the foot being very strongly inverted—the tendo Achillis hard, and retracted—opposed the restitution of the foot to its natural position. So very decided was the deviation, that I could expect to derive no benefit from the application of machines, or plaster and bandages. I concluded then to perform the operation, but it was impossible for me not to foresee difficulties, and even danger, in practising on so young a person. The imperfect developement of the parts, the position of the artery, which was felt distinctly beating against the tendon, and the size of the veins which surrounded it—were all very unfavour

[1] See plate I. fig. 1.

able circumstances: thinking, however, that I might by prudence avoid the dangers, I operated. The tendon was easily divided, but on withdrawing the instrument a stream of blood followed, which was red, and coagulated rapidly; in my emotion, I thought for an instant that I had cut the artery. The jet, however, was not intermittent, and was arrested by pressure made below the little wound. Being now satisfied as to the nature of the accident, I continued the pressure with my finger, and after expelling the blood contained in the wound, I applied a small pledget spread with cerate, and placing a long thick compress in the tibio-calcanian fossa, secured it with a bandage. I caused the child to be most carefully watched, and the first day passed without the occurrence of any accident. On the fourth day I removed the dressing, and found the little wound healed. The next morning the reducing apparatus was applied. It was only with the greatest difficulty, and minutest care that we were enabled to maintain the heel in a suitable position—this inconvenience, however, diminished in proportion as the foot became reduced. Ten days were found necessary to bring it back to its normal shape; on the thirtieth the child was completely cured. The apparatus was allowed to remain on during a longer time, however, in order to permit the foot to grow in a proper direction; it is impossible, at present, to detect by examination, which of the feet is the one that had been deformed.

This case presents as yet the only known example of the section of the tendo Achillis having been performed at so tender an age. The difficulties encountered, and the risks run, lead me to ask if it would not be more advantageous, and certainly more safe, to postpone the operation to a period when the organs shall have become more isolated and distinct? I do not hesitate to reply in the affirmative; but are there not other inconveniences attendant on delay? The aggravation of the accident with age, the difficulty and sometimes impossibility of walking, the wasting away and deformity of the leg, and, finally, the distress of the parents, are motives which ought to induce us to attempt the cure at as early an age as possible. In order to meet all these indications, I think it best to wait until the child has acquired the age of two years at least. I have followed this rule in my own practice, and think that I may congratulate myself on having done so.

Case 2.—Little girl, aged two years and a half. Inverted club-foot, with retraction of the toes on the sole, reduced in fifteen days. Cure completed in six weeks.[1]

Ida Auvert, aged two years and a half, was born with a club-foot of the right side, and no attempt was made by the relatives to lessen the deformity. When the child was presented to me, the following was her condition: Locomotion impossible, the foot strongly contorted inwards, the malleolus externus almost in contact with the

[1] See plate I. fig. 2.

ground, scarcely any heel, the calcaneum, in consequence of being drawn upwards and backwards, formed an acute angle with the tibia, the sole of the foot was very concave, the toes were bent, and could only be very slightly extended by the strongest effort.

On the 25th June, 1838, I prepared for the operation; the child, placed on its abdomen, was held on the knees of one of my assistants. I assured myself of the situation of the artery; it ran along the inner edge of the tibia, and seemed to be in contact with it—an unfortunate, and yet almost constant condition in young children. In order to avoid wounding the arterial vessel, I caused an assistant to hold the point of the foot firmly, whilst with the left hand I pushed the tendon off towards the fibula, by placing my thumb on its inner, and the index finger on its outer edge; with this last finger I also stretched the skin near the point where my instrument was to penetrate. All these precautions being taken, my *ténotome*, although introduced slowly and cautiously, divided the fibres of the tendon so rapidly that I could scarcely distinguish the projection and the noise which always accompanies the division of the last fibres. The child did not utter a single cry, and only a few drops of blood escaped.

Notwithstanding the section of the tendon, the foot remained deformed, and I was unable to reduce it entirely to a normal direction. Fearing that I might not have divided with my instrument all the tendinous fibres, I introduced a stylet into the wound, and discovered that some remained in fact untouched; they were promptly divided, and, what is very remarkable, the gastrocnemius muscle scarcely contracted at all, the result of which was that the interval between the ends of the tendon was very short. The little wound being covered with a pledget spread with cerate, a compress and bandage completed the dressing. The bandage was wound from without inwards, in order that the folds surrounding the foot might assist in bringing it back to a natural direction.

The following morning I saw with pleasure that the deformity had diminished; the child did not suffer at all. On the fourth day the extending apparatus was applied, and on raising the dressing on the sixth, I found the wound completely healed—the heel was gradually descending, and the toes becoming elongated. On the tenth day the interval between the ends of the tendon was filled up with a soft, elastic substance. By the twentieth day the foot had assumed a natural shape, and the newly made tendon was gaining its form, and becoming detached from the surrounding cellular tissue. By the thirtieth day the operation was completed, and the foot which had been progressively flexed on the leg, was removed from the apparatus on the 3d of August, the thirty-ninth day after the operation. For the purpose of completing the cure, I caused a half boot to be made with very stout stiffenings, to press and maintain the foot in a suitable position.

CASE 3.—A youth of ten years. Convulsions when in fourth year. Semi-paralysis of the left arm. Retraction of the gastrocnemius muscle of the same side. Inverted club-foot very decided. Reduced in eight days. Cure completed in one month.[1]

François Leturc was a strong and healthy child; when, at the age of six years, he was attacked with acute encephalitis, complicated with violent convulsions, and the child was thought to be in a desperate state. Contrary to every expectation, however, he survived, but his left arm remained partially paralysed, and there was a very evident wasting away of the muscles; the pelvic extremity of the same side was also weakened, and the gastrocnemius muscle became considerably retracted, which occasioned the developement of a most highly aggravated case of club-foot. The malleolus externus rested on the ground, and the principal weight of the body was borne by the back of the foot, whilst the sole was directed inwards and upwards, and the toes turned backwards. It was most distressing to see this child walk, and it could scarcely be conceived why so unnatural a distention of the ligaments did not give rise to such severe pain as altogether to prevent locomotion. The calf of the leg was very thin, when compared with that of the other side, and the heel was drawn up more than two inches from the ground.

On the 20th July, 1838, every preparation having been made, the child was laid on its abdomen, and supported on the knees of its mother; an assistant seized the end of the foot, and endeavoured to flex it on the leg—the tendon was thus made exceedingly tense, and the operation was over in a few seconds. The division of the last fibres was accompanied by a very decided noise. Scarcely as many as five or six drops of blood escaped, and the child did not utter a single cry. The tendon retracted with great force, and left a subcutaneous vacuity of at least fifteen lines in length. After carefully expelling the blood, which seemed to have a tendency to accumulate between the two extremities of the tendon, I brought the edges of the wound together, and applied a pledget covered with cerate, which was supported by a compress and bandage. Notwithstanding the wide separation of the ends of the tendon, the foot was but imperfectly reduced; I was desirous of applying the extending apparatus immediately, but the pain which it occasioned forced me to remove it. These circumstances caused me some apprehension as to the success of the operation, but what was my surprise on seeing, the next morning, that the foot had been almost entirely reduced by the unaided efforts of the extensor muscles? This being the case, the reducing apparatus was now applied without difficulty. The bandage which surrounded the foot having become displaced on the fourth day, I was enabled to see that the little wound was completely healed, and the cicatrix scarcely perceptible. The place which had been left hollow by the retraction

[1] See plate II.

of the tendon, was hard and slightly swollen, and the child experienced no pain. On the eighth day the foot was completely reduced, and no trace could be detected of the previously existing deformity, except a hard callosity just over the os cuboides. On the fifteenth day a very decided protuberance was felt about the superior extremity of the tendon, and the cure was completed on the twenty-fifth day after the operation.

The spontaneous reduction of the foot in this case, caused by the retraction of the extensor muscles, is a remarkable circumstance. It was to me a useful lesson, and since that time I have been very guarded in the application of the extending machine immediately after the operation. I learned the important fact, that nature, on being relieved of the obstacles which opposed the normal developement of the foot, would endeavour instantly to restore to the parts their proper position, and that she would attain this end gradually, and without any violent exertion: the deformed parts, also, not being compressed, would be less exposed to violent inflammation, which might occasion deplorable consequences.

This case serves still further to show the facility with which accidental club-feet may be restored; so decided a case of the congenital form, as that of young Leture, would have required months of treatment, and it is even doubtful whether it could ever have been completely cured.

Case 4.—Double congenital club-foot. Child five years of age. Operation. Opening of a vein. Reduction of the feet in fifteen days. Cure completed in a month.[1]

Charles de L——, aged five years, was born with both feet highly deformed; the mother affirmed that she had experienced no extraordinary pain, or noticed any particular sign during the period that she was pregnant with this child, but that she had, on the contrary, suffered much more during two consecutive pregnancies, both of which terminated in the birth of daughters.

When Charles de L—— was brought to me, I was surprised to see the extreme deformity of the members—the feet overlapped, and their external edges rested on the ground, while the heels were forcibly everted—the tibiæ were bent, and one of the patellæ thrown on the inside, and the other on the outside of the articulation of the knee. The right foot was more deformed than the left; the malleolus internus did not protrude at all, and the astragalus seemed to have entirely abandoned the tibio-fibular cavity. Hard and painful callosities existed on both feet; locomotion was accomplished with great difficulty, and falls were of very frequent occurrence. I did not hesitate, notwithstanding these unfavourable circumstances, to operate on the child, and the section of the tendo Achillis was made on the 5th of August, 1838. The child was

[1] See plate III.

laid on the lap of an assistant, and the right foot was extended and held firmly by a second assistant, whilst I divided the tendon from the outer side. The operation was over in a few seconds, but on withdrawing my instrument, it was immediately followed by an abundant stream of red blood, eight or nine ounces of which escaped instantly. I was soon satisfied, from the character of the jet, that the accident would not prove serious, but I determined never again to perform the section of the tendon from the *outer side;* indeed this is now one of my principal rules in performing the operation.

The jet of blood was stopped by pressure made with the thumb above the wound. The skin having been cleansed, I applied my little pledget and compress, then a second long compress doubled into folds, and placed in the calcaneo-fibular fossa; a bandage secured the whole.

No peculiarity was presented by the other foot, and scarcely as many as five or six drops of blood escaped.

This double operation was attended with no accident; during the first day there was some slight agitation—this, however, was soon calmed by a long and refreshing sleep.

On the fifth day after the operation, I applied the reducing machine. The greatest difficulty was experienced in reducing even slightly the anormal direction of the feet; the bones, more especially those of the right foot, had deviated so much, and the tibio-fibular articulation was so narrow, that doubts might justly have been entertained of complete success.

Nevertheless, after eight days of anxious vigilance, and efforts made to oppose the elevation of the heel, the conformation of the feet was found to have undergone considerable amelioration. The reduction was complete on the fifteenth day, except on the right side, where the astragalus still protruded slightly. The cure was terminated at the fifth week. The child did not experience the slightest inconvenience during the whole course of treatment.

CASE 5.—Accidental phalangian club-foot. A little girl nine years of age. Division of the tendo Achillis. Reduced in six days. Cured in one month.[1]

Ann Marie J—— was born, perfectly well formed, on the 2d of July, 1828; when one year old she upset a kettle full of hot milk, which occasioned a burn involving the lower extremities in nearly their whole extent. A violent fever, and other serious consequences, endangered for a time the life of the child. An evident amelioration, however, was manifested; when she commenced cutting four large teeth, a renewal of the fever was occasioned, and convulsions supervened. The child endured these accumulated evils, and after many vicissitudes during convalescence, got well. The relatives

[1] See plate IV.

were not long in perceiving that the right leg was shorter than the other; the heel was drawn up, and the foot rested on the ground only by the toes—locomotion was very difficult, and was accomplished only by decided limping. At this time I saw the child; its health was good, and I had no hesitation in proposing the operation. It was performed on the 5th of March, 1837; no accident happened, and the foot was reduced with incredible rapidity—by the sixth day after the operation it had resumed its regular form. The machine was allowed to remain applied for a month, after which time the cure was fully accomplished. Time has not weakened this prompt and remarkable success.

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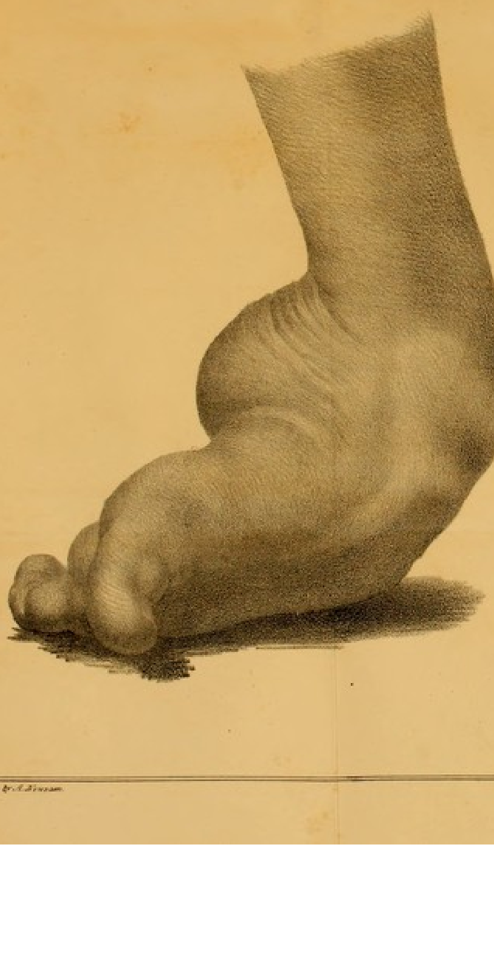
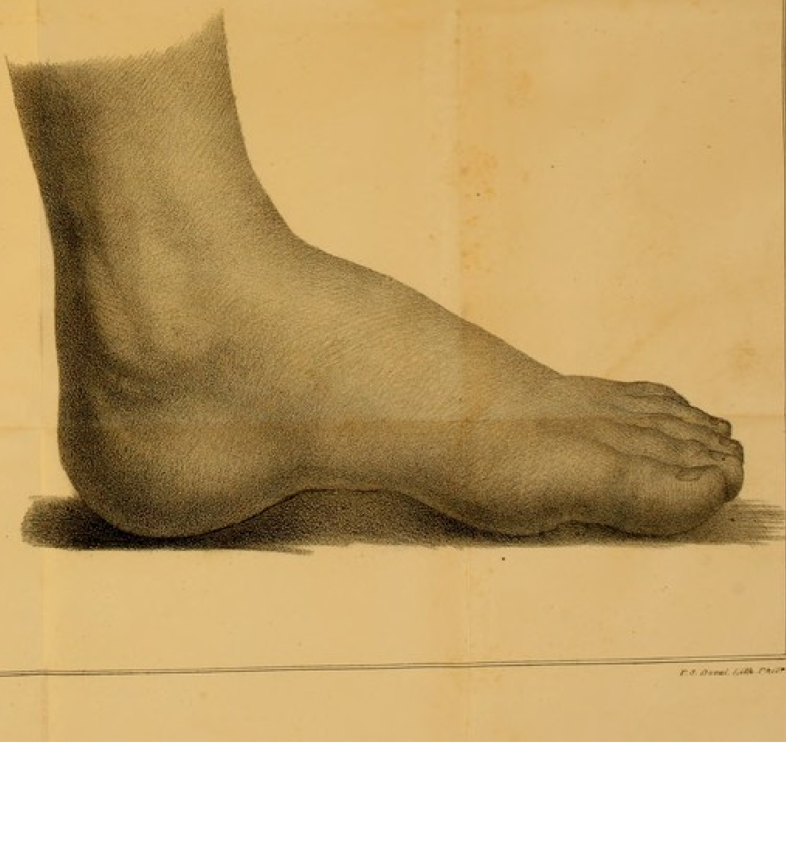
Inverted Club-foot.



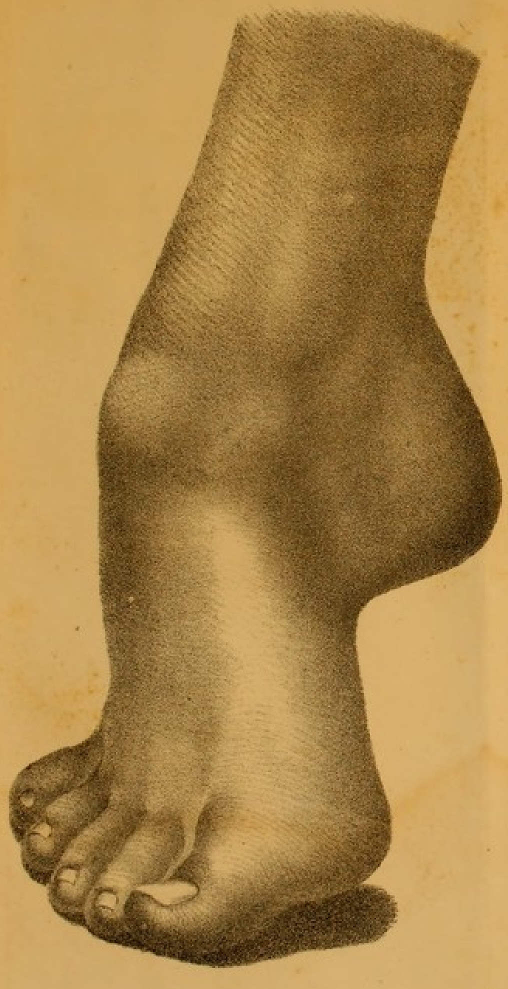
Reduced in fifteen days.



On Stone by A. Newsam

P. S. Duval, Lith. Phila

Phalangian Club-foot.

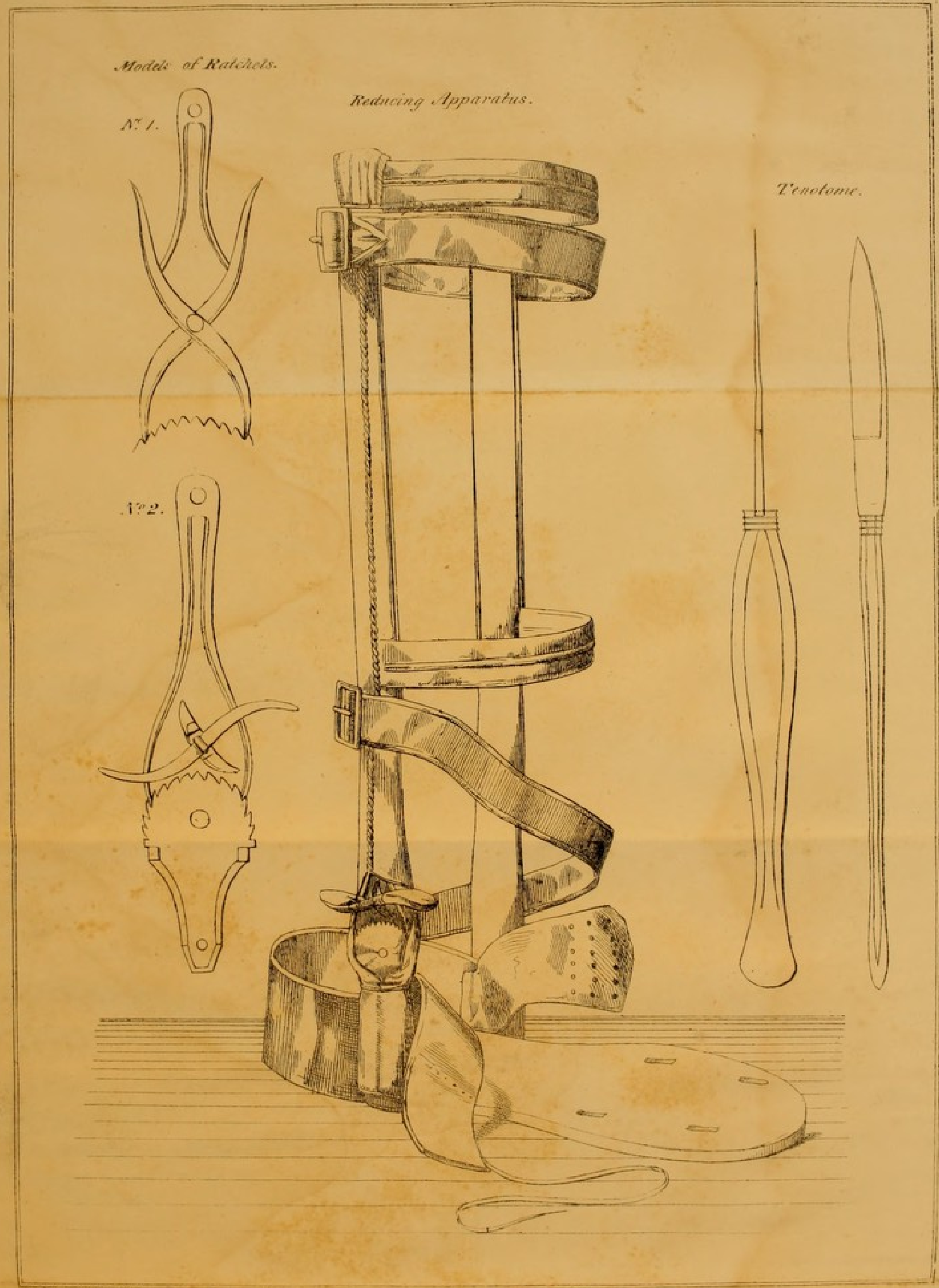


Reduced in six days.

P. S. Duval, Lith. Philad.

Calcanian Club-Feet.

Plate 6.



REPORT

OF

PRIMARY SYPHILITIC CASES.

BY CHARLES ASTON KEY.[1]

I select, for the present paper, Cases of Primary Venereal Sores, in men admitted into the Samaritan Ward, under my care, since the year 1825. They are classed under the following heads, according to the character of the sore and other circumstances connected with the case. To avoid, as far as possible, confusion, by the introduction of new names and new divisions,—a proceeding that more often tends to obscure than to elucidate the matter,—I adhere pretty closely to the received nomenclature of venereal sores: and as the term chancre is understood by all, to be a sore produced by venereal infection, I use it as applicable to all such sores, whatever character they may bear; distinguishing one class from another according as they exhibit more or less evidence of poisonous action, and also according to the character which the existing state of the constitution may impart to them. The limits of the paper render it necessary to make the report concise.

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[1] Guy's Hospital Reports, Oct. 1839, p. 411.

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The name employed to designate chancres that are remarkable for their negative rather than their positive qualities, serves well enough to express this kind of sore. It is rare to find a sore wholly devoid of the thickened base, as the word "aphthous" might lead us to suppose; but the bursting of the vesicle or pustule sometimes leaves a sore presenting to the eye appearances so like those of an aphthous sore in the mouth, as well may excuse the appellation being retained. The nature of a chancre, I apprehend, will depend on the depth to which the action of the poison penetrates. In this form, its action seems to be confined to the surface of the cutis; blistering, as it were, the epithelium, without indurating the surrounding tissue; and such a sore will often quickly heal; leaving the practitioner in doubt as to its real nature, because it wants what, in his view, is a claim to the name of chancre. When it is more tardy in healing, and its stages of ulceration, granulation, and cicatrisation are more distinct and protracted in their course, the poison usually affects the parts to a greater depth, and what was at first a simple vesicle leaves a sore with a thickened base, as if the cutis and cellular tissue had become more imbued with the poison.

It appears to me, as far as my observation has gone, that the aphthous sore will thus often run into the more fully developed chancre; and that it is impossible to predict that a sore, at first aphthous in appearance, shall heal quickly, and shall not put on the more decided character of venereal action; or it will sometimes heal, leaving behind a very slight induration, and again break out into a virulent sore, exhibiting the indurated form of venereal ulceration.

It may, however, be truly said, that this sore presents the least sign of a poisonous action, whether we look to the thickening of the base of the sore and its edge, or to the nature of the secretion and the appearance of the sore. And we are, therefore, warranted in the inference, that either it is the result of a peculiar poison mild in its nature, or caused by a virus common to all venereal sores, but exhibiting its action in its mildest form. This question leads at once to the much-debated one of a diversity of poisons; which, in spite of all that has been urged in defence of and against the doctrine, must remain in abeyance, until experiments, conducted on a large scale, by persons qualified for the purpose, shall have brought together an irresistible mass of evidence. Though the truth, in matters of science, cannot but be important and useful, the mere question, whether a variety of effects arise from one or from many causes, appears to me not to possess that importance which has been attached to it. And in saying this, I would not be thought to undervalue Mr. Carmichael's laborious services: for to him the profession owes much, as the first who successfully discriminated between the different forms of the disease, and grouped them with the hand of a master. If we admit that each group exists as this surgeon has depicted them, how does it advance us, to know that each has its peculiar poison? A virus is only known by its effects; and if it is established by sufficient testimony, that certain symptoms for the most part concur in individual cases, even though the exceptions may be numerous, all is proved that is required for the guidance of the practitioner.

When repeated experiments have proved that gonorrhœa, and every variety of primary sore, can be produced by inoculation with the same poison, I shall give in my adhesion to the doctrine of one venereal poison.

In the present state of our knowledge, the only well-grounded mode of proceeding is, to describe and distinguish sores according to their characters; as has been ably done by later writers—Carmichael, Bacon, Evans, Wallace, and others; of whom, a practitioner will take one or the other for his guide, as he finds their description confirmed by his own experience. My feeling, in regard to this matter, is, that the line attempted to be drawn between the different kinds of sores is too defined, inasmuch as nature points out no such lines of demarcation. Each sore is found, occasionally, to run imperceptibly into another class; so that it is difficult to decide to which it belongs. The aphthous sore, in its extreme form, has scarcely hardness of base or edge; but sometimes it has a slightly elevated edge, and consequently a deeper centre, as in the sore fringing the prepuce; and occasionally a rugged surface, with a somewhat hardened base, as at the corona glandis: an elevated surface, and firm base, as is often seen in a chronic sore on the prepuce.

It will be observed, that a large number in the catalogue of primary sores is classed under this head. The list includes not only the aphthous sores, in the strictest limitation of the term, but all those variations which I consider properly to come under this class —varieties depending on causes that I will briefly point out.

The hardness surrounding a venereal sore, on which so much stress is laid by most writers, as characteristic of and almost proportionate to the degree of virulence of the poison, has been looked upon, by many, as indicative of the presence of the venereal poison; and, when absent, to decide the non-syphilitic nature of a sore. Surgeons of the present day do not, perhaps, carry their views of induration so far as this; but it is usually supposed, that the greater the degree of induration the more decided is the syphilitic character; and Mr. Hunter is appealed to as authority for such opinion. But, in his work on the lues, he does not lay down any such exclusive rule: he says, "a chancre has *commonly* a thickened base; and although the common inflammation spreads much further, yet the specific inflammation is confined to this base." In speaking of a chancre on the body of the penis, he omits the characteristic hardness altogether, describing it as "a pimple that is allowed to scab, owing to its being exposed to evaporation: this scab is rubbed off, or pushed off, and one larger than the first forms." Again: "A chancre on the glans," he says, "appears as a pimple full of matter, without much hardness." We cannot, then, cite Mr. Hunter's authority in favour of the once prevailing but now declining opinion, that a true chancre is uniformly attended with a cartilaginous hardness. With his usual acumen, he had observed, and has not failed to describe, the variety in the characters of syphilitic sores. The above quotation describes one cause of this variety to be the situation of the sore.

The site of an aphthous chancre (but stating this may be considered as begging the question of identity) greatly modifies its condition and progress. It penetrates at one time only through the surface of the epithelium; and forms, on the glans or inner prepuce, a superficial sore, that often heals with one or two applications of the nitrate of silver, as a common vesicle would; the extent of poisoned tissue being so superficial as to be within the reach of this mild caustic. At the corona glandis, on the other hand, there is glandular structure and cellular tissue; and then we find this kind of chancre almost always firm at its base, deep in its action, and ragged, instead of being smooth on its surface. Over this sore the nitrate of silver has less influence, because it does not penetrate deep enough to reach the extent of the poisoned structure; and in such a case, when applied, it acts on a different principle. A chancre may be at first of the simplest kind, so as scarcely to be recognised as one: if touched with caustic, it may heal. If it breaks out again, it will sometimes evince more decided characters; and show a raised edge, and have a more firm base: or, if it begins as an aphthous sore, and is prevented healing, by friction, or want of careful dressing, it begins to acquire, as the scab is successively pushed off, different characters; and, in a week or two, presents, in all respects, the most marked effects of the action of the poison. If nitrate of silver be applied to the sore in excess, the inflammation that follows will sometimes increase the thickness of its base, and seem to increase, as it is considered, the syphilitic character. The hardness of base and edge is usually greater in proportion to the duration of the ulcer, and by no means indicates a greater intensity of poison; for the most indurated sores that I have seen, of five and six months' standing from neglect, have been accompanied with a cartilaginous hardness; and yet in no other respect (as the kind of secretion, appearance of the sore, disposition to spread, intractability, or the character of the secondary symptoms) has it exceeded the mildest aphthous chancre. Sores at the end of the preputial fold, fringing the prepuce, and occasioning partial or complete phimosis, are usually remarkable for their hard base and elevated edge, and yet not possessing the other characters of a poisoned ulcer, yield to the simplest mercurial treatment: these are exposed to friction, are not easily protected by dressings, and occupy a part where cellular tissue abounds. It does then appear to me, that induration, though usually attending a chancre when seated in some tissues, cannot, when absent or present, negative or decide the action of the virus.

The circumstances that more especially stamp the syphilitic character are, the character of the secretion, and the aspect of the sore in its different stages—points of diagnosis that appeal only to the eye for recognition, and therefore not easily communicated by description. The stages of a chancre have been so well and so minutely described by various writers, as to make it difficult to follow the description, and almost hopeless, as well as useless, to attempt any addition. The vesicular, ulcerative, granulating, and cicatrising stages have been rendered so clear, and so familiar, that I should only repeat what is known, were I to say any thing on these points. In arranging and dividing the seats and forms of disease at the beginning of this paper, I have adhered to the generally received opinions on this subject. The best writers, beginning with Mr. Carmichael, who led the way in drawing a distinction between syphilitic sores, have endeavoured to establish a line of demarcation between each class, by taking a specific appearance as characteristic of each. When I first began to study syphilis, I had Mr. Carmichael's excellent work as my text-book. His classification of primary sores threw so much light on the causes of their various appearances—which pseudo-syphilitic doctrines had, to my poor judgment, involved in much obscurity—that I divided the subject according to his views. A difficulty, however, soon arose—into which class certain sores ought to fall; partaking, as they often did, of characters of two classes, and yet wanting some of each. The simple primary sore would come so near to the description of the raised ulcer, that I could scarcely tell to which class it belonged. More extended observation at length taught me, that the line of distinction was arbitrary; and that to adhere strictly to the division of this excellent and ingenious surgeon, however one may estimate the correctness of his description, would be to draw lines that had not been drawn by the hand of nature.

When opportunities of observing these sores on a more extended scale had offered themselves, I found that the sores which might be termed syphilitic, inasmuch as they caused secondary symptoms, passed imperceptibly from one class into another. These aphthous sores I found continually to lose a part of their negative character, and to approach, in hardness of bone and edge, and appearance of surface, to the raised chancre of the prepuce, and also frequently to acquire some of the character of the indurated chancre; so that I experienced much difficulty in deciding to which order of sores they belonged. The indurated chancre of Hunter, as it is termed, would sometimes be defective in the ulcerating stage; having on its surface little more than an excoriation, covering the indurated mass, or sometimes even having an unbroken surface.

Finding that chancres possessed every variety and shade of character, I came to the conclusion, either that it must be occasioned by the difference of situation which it occupied on the penis, or by a varied action or intensity of the poison, or by a peculiarity of constitution. The former position, as offering a satisfactory explanation, is wholly untenable; for though situation must be allowed greatly to modify, in some respects, the appearance of sores; yet, as every variety of sore occasionally appears in the same part, it is obvious that some other cause must be in operation. To follow Mr. Carmichael's ingenious doctrine, of a separate poison producing each variety of sore, would be to introduce an almost endless variety of poisons: and if the line of demarcation between classes of sores be not so clear and defined as Mr. Carmichael describes them, and one class runs insensibly into its neighbour, it follows that the poisons producing them must possess but slight shades of distinction, and must, like the sores which they produce, closely resemble each other in the middle of the chain, while at the extreme points their difference must be considerable. At first, it appears inconsistent with the definite progress of disease arising from one poison, that in one person a chancre should be an excavated sore, and in another an induration of tissue with scarcely a breach of surface. We see, however, in other diseases, a similar variety of action from the same cause. In cancer of the lower lip, the disorder begins often with an excoriated surface encrusted with a scab, rising at length into a fungus with everted edges; then degenerating into an ulcer with a deep centre and raised margin, and at last presenting a foul phagedænic sore: this is an instance of the same action being (so far as a cause is in operation) productive of dissimilar effects, and bears a close analogy to the diversity of sores produced by the syphilitic poison. The explanation of the variety in the instance of cancer lies in the accidental state of the powers of the constitution, and their ability to resist the disorganising tendency of disease: if great, *cæteris paribus*, a fungous action ensues; if small, ulceration is the result.

This view of the matter differs but little from that of Mr. Carmichael. This slight difference, however, seems essential to a true understanding of the matter. I am far from wishing to derogate from Mr. Carmichael's claims to originality or usefulness, in the views that he has so well advocated. Entertaining, as I do, the opinion, founded on a pretty long course of observation, that venereal sores run one into the other, and are not separated by lines so defined as have been marked out for their distinction, it is impossible to admit more than a modification of poison. A modification may be considered equivalent to a difference of poison; perhaps it is.

The signs of the action of syphilitic poison I take to be those that are most fully developed in sores which, by common consent, are regarded as chancres, whose characters are not doubtful; and the consequence of which, if left to themselves, is, according to my experience, the occurrence of secondary symptoms. The induration on which such stress is laid, is a usual, not a constant or essential concomitant; though some degree of thickening usually attends a chancre. On this, therefore, when other signs can be obtained, I should be inclined to place less reliance than many are disposed to do: its absence certainly should not be regarded as evidence of that of all venereal taint, when other characters attest the presence of a poison. The early formation of a chancre varies in appearance, and cannot alone form a test: usually, it is vesicular, with slight excavation: sometimes there is no excavation at all in the cutis, which appears entire and level when the cuticle is removed. Sometimes induration commences with the formation of the vesicle, or even precedes it: and occasionally induration exists without vesicle or ulceration. The more mild, however, the action of the poison, both in its primary and secondary form, the more simple is the vesicle in its early stage, possessing a scarcely perceptible induration. The more intense the action of the poison, the more does the secretion differ from ordinary pus. It is of a reddish brown colour; gluey or tenacious in consistence, and semi-translucent. As the ulcerative stage ceases, this secretion gradually becomes denser and more opaque; but still retains its dark appearance, even when solidified in the first stage of granulation. When ulceration has ceased, the poisonous action still continuing, the sore is seen covered with a light brown layer of adhesive matter, not unaptly (as it has been) compared to chamois leather. In the milder forms of sores, the secretion approaches more to the appearance of common pus, more yellowish in colour, and less tenacious; and the firm deposite that succeeds the ulcerative stage resembles more the coagulable lymph of a common ulcer. These distinctions are gradually losing themselves as the sores more resemble the aphthous ulcer; so that the secretion of some differs so little from an ordinary opaque vesicle or pustule as to lead to the opinion that they are free from poisonous qualities. The nature of the secretion can be best observed when the sore scabs over on the outer skin of the penis, or when the nitrate of silver, failing to arrest the secretion, forms a crust over a depot. All shades of character are to be seen in keeping with the other signs of virulent action, more or less determined according to its intensity. Mr. Evans has been led to believe that the activity of the disease depends on the stage or period at which the poison is communicated: if this be so—a position that would require a series of well conducted experiments to verify—it is only necessary to extend the principle, to explain all the various degrees in which the disease is found to exist.

The change which the sore undergoes, in its transition from the stage of ulceration to that of granulation, also presents characters sufficiently peculiar, to distinguish it easily from an ordinary ulcer. Usually, the only appearance to be observed in a common sore is, that the surface which had been the seat of active ulceration is gradually covered with granulations that become more and more defined, and assume, as they form, a healthy character. The process by which they are formed is hardly to be observed: but in a syphilitic sore, a distinct adhesive stage is to be seen preceding that of granulation, which, in a common sore, can only be observed under an accidental attack of inflammation. If a chancre proceed ever so favourably towards cicatrisation, unless mercury be employed to destroy its venereal character, the sore is usually seen covered with a yellow or brown layer of fibrine or buff, varying in colour according to the greater or less intensity of the action, and disappearing as the sore is more disposed to granulate. The granulations also possess a peculiarity in the minuteness as well as distinctness of their points, the great regularity of surface, and elevation of the granulating mass above the level of the surrounding skin: this latter feature is owing, possibly, to the induration of the base of the sore not having subsided before granulations are formed. The granulating stage is sometimes remarkable for its irregular action; the edge and several parts of the surface becoming prominent, and dark-coloured or venous in appearance, presenting a livid and rugged aspect. This is more usually the case in sores that have been disposed to slough, but in which the specific action has not been destroyed by the sloughing process, but becomes developed as the granulating action sets in. In the cicatrisation of the sore, there is little or no difference perceptible from that process, as it takes place in common sores.

Chancres evincing the greatest intensity of poisonous action are more frequently seen on the outer prepuce than on other parts of the organ; while the milder kinds are found on the thin covering of the glans, inner prepuce, and corona; the latter being covered with a finer cutis, and therefore more susceptible of the action of a milder poison; while the dense common integument of the body of the penis, resisting the action of the milder forms of virus, are acted on only by the more active causes of infection. Hence, on the body of the penis every stage of a chancre can be then more fully developed, and its characters, in its different stages, more satisfactorily observed. Another reason for this may be, that sores on the integuments are less noticed by patients; or not regarded as chancres, but as excoriations; and therefore have the early part of their career undisturbed by dressings, and unchanged by mercury. The mild forms of sores that are seen fringing the extremity of the prepuce, and causing phimosis, are exceptions to the usual sores found on the skin of the penis: they are mild in their nature, often not followed by absorption or secondary symptoms; and when these do appear, they are of an unimportant kind. These sores are produced by the mild secretion lodging upon the end of the prepuce for a considerable time, and making up, by continued application, what it wants in intensity.

The early stages of chancre are rarely seen in hospital practice. Patients are not admitted, or do not apply, till some anormal change has taken place in the sore, or some difficulty has arisen in healing it. The class of sores seen in the wards are, therefore, different from those seen by the private practitioner, who alone can study the early phases of chancre, and learn what treatment is best adapted to them.

In the majority of cases of common vesicular chancre, the nitrate of silver is the best application. In the opinion of its advantages, as detailed by Dr. Wallace and others, I fully concur. When used properly, and under circumstances which ought not, in the eye of an ordinarily judicious practitioner, to forbid its employment, it altogether destroys the seat of the syphilitic virus, and thus prevents infection, both local and constitutional. Such an effect can only be looked for when the vesicle is seen in its commencement. If the action is not wholly arrested, an eschar is formed, which serves to protect the surface and limit its extension. Most commonly the ulceration extends; but is still benefited by this application, more than by milder astringents. When used as an astringent, in healing the sore, it should be applied more lightly than when employed for its escharotic action: for this purpose, the surface should be brushed with the caustic, and reapplied as often as the eschar peels off. Even in the granulating stage of a chancre, I often employ it, where common dressings are inconvenient, or likely to be improperly or carelessly made. The solid sulphate of copper is a good substitute for the nitrate of silver, when the latter excites too much action. Mercurial applications seem, in the early stages, to be peculiarly noxious, as if the action was rather increased than stayed by them; the secretion being rendered more copious, and ulceration more inclined to spread. Mercurial washes or ointments, in the ulcerated stage, I employ, not as a general rule, but as the exception in sores indolent, not sensitive, and secreting but sparingly. In the larger number of sores, mercurial applications are hardly admissible in our list of remedies: the common astringent salts—as the preparations of silver, lead, zinc, and copper—varied as the state of the sore will bear, check the disposition to spread quickly, and bring on an appearance of granulation. To the premature use of mercurial dressings, much of the troublesome career of their sores may be attributed: their injurious action is seen in the conversion of the surface into a yellowish mass, a change that usually indicates ulceration, an increase of secretion, a disposition to spread, and an increased degree of sensibility: and as soon as these applications are replaced by astringents, the changes in the appearances of the sore show on what its previous condition depended. The same remark will not have escaped the notice of the experienced surgeon, in the influence of mercury, internally administered, on these sores: and while they remain in the ulcerative stage, it should be sparingly given and cautiously watched. Its beneficial effect, in lessening the thickened base of a chancre, cannot be doubted; but while it does this, it often acts injuriously on the surface, and gives to the sore a character approaching the phagedænic. Much of this evil may be obviated, by combining the internal action of mercury with local astringents, and increasing the quantity of mercury according as the sore seems disposed to granulate. When the granulating action is once established, the mercurial may then be increased with safety and with efficacy, and carried on until cicatrisation is complete. The diminution of mercurial action, as the stage of granulation proceeds, under the impression that the virus is destroyed, leaves an induration, after the sore is healed, difficult to remove, and forming a nidus of future mischief. As the inclination in the sore to spread ceases, and the surface becomes more disposed to granulate, I usually increase the quantity of mercury; as the sore now bears it better, and a greater security is gained against a reappearance of the disease. I cannot do better than quote the words of Mr. Hunter: "It should be given during the whole time of the cure (that is, as soon as its curative action can be brought to bear), and continued for some time after the chancre is healed. The quantity given should be such as may, in common, affect the mouth slightly." I do not, in this advice, see any recommendation of the proposed salivation to which Mr. Hunter is said to be inclined; nor do I see much in which it differs from the modern method of those who see much venereal practice.

In sores whose syphilitic character is not equivocal, even during the ulcerative stage, mercurial applications are found not to disagree. If the sore be bounded by a thick and firm margin which is raised and prominent, presenting, at its outer edge, a raised granulating boundary, while the inner edge is slowly ulcerating, and thus enlarging and perhaps deepening the sore, mercurial washes—either the chloride with lime-water, or the bichloride dissolved in water—act well, in retarding the ulcerating process. In the aphthous chancre, the disposition to spread is often remarkable: it is a sore of irritable temperament, and requires much caution, and more common, than specific treatment. But in the more decided chancre, the disposition to be "set astray" is less; and the syphilitic characters being more developed, mercurial application agrees better with them, and may be applied with less apprehension of the ulceration extending. In these sores, local mercurial action does not render the secretion copious; nor does it render the surface yellow, loose, and spongy, or the edge disposed to break up, as it does in the aphthous sore: on the contrary, the edge becomes less raised and firm, but not disposed to extend by ulceration; the secretion is altered, but not increased; the surface becomes more solid and fibrinous, and inclined to granulate. If they present not the most decided characters, but verge towards the aphthous ulcer, a combination of the two plans may be had recourse to: an astringent may be used, for the purpose of protecting the sore from the injurious effects of mercurial action, while the sore is still receiving the benefit of that action: thus, it may be dressed with the black wash, and washed with a pretty strong solution of some of the salts alluded to. The tone and vigour of the tissue are preserved by the astringent, while the mercurial corrects the morbid action induced by the virus.

In the treatment of primary sores, I commence with mercurial medicines as soon as the preceding indications show the sore needs them, and carry them to the extent that the patient's constitution is able to bear. The principles by which the practitioner should be guided, in deciding on this difficult point, are those of general pathology. The remedial agency of mercury, in arresting the action of the syphilitic virus, is known to all, and acknowledged by all who study the course of this disease and the action of this medicine; but the numerous conditions that interfere with its action as a remedy, and tend to convert it into a poison, are less known, because they are more difficult to appreciate. I know of no rules that can be laid down for the guidance of the practitioner, except such as are so general, that they can hardly serve as rules: they are rather principles than rules; and where the straight line of action afforded by a rule fails—as in this, and indeed every other disease, it occasionally does—principle comes to our aid, as a never-failing guide. In the employment of mercury, its power of exciting the irritability of all the actions of the body is to be borne in view, and jealously watched. Its action on the heart and nervous systems, and, through them, on the functions of all the organs of the body both nutrient and reparative (for no organ is withheld from its influence), is to be carefully noted; lest, while it quickens all the organic actions, their energy and strength are not exhausted in proportion to the increase of their irritability. Every individual is affected by this remedy, in a manner peculiar to himself; nor is it easy to foresee how it will act on any individual constitution. In primary syphilis, an index fortunately exists, by which the injurious action of mercury is at once perceived: this is, the sore; a more delicate test cannot be desired: often, before any feeling of the patient, or any of his functions, show a sign of disturbance, the sore evinces a wayward disposition, that calls for a discontinuance of the remedy; and though opium, combined with it, may lessen the irritability of the system, and dispose the sore to bear it, the idiosyncrasy of constitution is often such as to preclude the possibility of employing it, even in the smallest doses, without the risk of establishing an ulcerative action, attended with extreme irritability.

The sores that are attended with induration, as a distinguishing feature, are of three kinds. They form the opposite end of the chain to the aphthous ulcer; the various grades of chancre last alluded to constituting the intermediate links of junction. They are remarkable for their indolent character, and for possessing a hardness, from which the aphthous sore in some forms is quite free. Of these, that which is most commonly met with in practice is the sore familiarly known as the Hunterian chancre; which appears as an ulcer with an excavated centre, a mass of indurated tissue surrounding the sore on all sides, and an edge raised and slightly everted. These are, or rather are said to be, the tests of what Mr. Hunter considers a true chancre. Those who think so, I refer to Mr. Hunter's writings, with the recommendation, not to form an opinion from one or two expressions, but, from a fair and careful comparison of his remarks, to gather his full meaning. It is not my object here to rescue Mr. Hunter from the errors imputed to him,—that has been recently done by his commentators; but I would not seem to state an opinion opposed to that of so great a pathologist. I feel satisfied that Mr. Hunter would not have measured venereal sores by the degree or extent of induration. So acute an observer must have known, that many sores possessed of the greatest hardness are often greatly deficient in all the other signs of syphilitic action, in the nature of the secretion, in the aspect of the granulations, and in the entire absence of contamination of the inguinal glands, and constitution. The last instance that I have seen of this form of sore, occurred in a man about thirty-five years old, florid in complexion, and temperate in his habits. It appeared at the corona, as a common aphthous sore; which gradually spread, and ate its way deep, but slowly, between the glans and corpus cavernosum. When I saw it, its size was that of a large sixpence; and it felt like cartilage under the finger. Neither its secretion nor surface were those of a venereal sore; nor has any form of secondary infection made its appearance, although it has existed between four and five months. It healed quickly under a small dose of blue pill at night, and with a rapid diminution of the hardness. When combined with the other evidences of poison, induration is of some value in determining the nature of a sore; but alone, it is indecisive of the poisonous character of an ulcer, especially when seated in the cellular membrane, deep beneath the cutis. Sores are occasionally met with, where the induration amounts to a cartilaginous hardness, that possess scarcely a trace of a virus, having acquired the hardness by time and place. The deep chronic chancre of the corona glandis, mild in its character, and usually harmless in its effects, will last for months, and acquire a degree of induration that gladdens the heart of a *soi-disant* disciple of Hunter, grieved to find the good old chancre fast disappearing from the land. This form of indurated sore is hardly to be classed with the two following; as its negative characters, with the exception of induration, coincide with the mild aphthous sore.

Among the chancres that claim the appellation of "indurated" are such as commence with a thickening of the cutis, or subjacent cellular tissue. Of these I have notes of two kinds, occurring oftener in private than in hospital cases. One begins with a redness and tenderness of the inner prepuce or corona; and the patient, feeling something wrong, looks for an excoriation, but discovers only a slight tumefaction, without breach of surface. If the red part, which is usually somewhat more diffused than in an ordinary character, be pinched up, the whole tissue feels harder than common, and very circumscribed. If neglected, as it commonly is, from the supposition of its harmless nature, these appearances increase, until the skin becomes glossy, and at length excoriated. The appearance of the excoriated part is highly florid and prominent, and a minute quantity of secretion can be seen oozing from it: there is not any appearance of ulceration. The vesicular and ulcerative stages are also wanting; the virus at once irritates the substance of the cutis into action; it swells, and becomes firm under the irritation, and throws off its cuticle without the intervening process of vesication. Such a sore is always followed, so far as my experience has gone, by absorption, and a train of secondary symptoms.

In the treatment, two circumstances force themselves on the attention of the surgeon,—the inability of the sore to bear mercurial applications, and the necessity of giving mercury in a cautious manner. Common mercurial dressings, lotions, or ointments, produce a painful degree of erythema, that soon renders it necessary to drop them, and to employ some mild lead astringent with opium, to soothe the irritability of the part: warm-water dressing is as good as any other; a few leeches on the body of the penis, if the pain be great, and the constitution show signs of disturbance. Mercury should be used at once; but given at first to tranquillise, and therefore with some form of opium, as calomel and Dover's powder; and I prescribe the same in the day-time, as disposing the patient to bear better the action of mercury. Desirable as it is to get the patient as soon as possible under the influence of mercury, too much care cannot be taken to watch its action: for though the sore may require it, the patient's constitution will sometimes become irritable under it; and the secondary symptoms of the disease are certain to exhibit the evil effects of this remedy, should its action have been carried on injudiciously, in the treatment of the primary sore. The form of medicine, therefore, should be such as will be least likely to increase the constitutional irritability of the patient, and effective enough to induce a curative action. From whatever cause it may be, the character of the secondary symptoms following this sore is usually severe, even when the constitution has not been influenced by mercury; and therefore much circumspection is required, not to exceed the bounds of prudence in its administration. When prudently given, its beneficial influences will be evident; as its action will leave behind most mischievous effects, if it be indiscreetly employed.

The other kind of induration resembles, in many respects, the former. The virus neither excoriates nor ulcerates the skin; but the first intimation the patient has of infection, is a remarkable induration of the under-layer of the cutis, extending into the surrounding cellular membrane, forming a lump beneath the skin, from which it seems to grow. It gives but little uneasiness, even when pressed; and scarcely raises in his mind a suspicion of venereal infection. The points of difference from the former sore are, the entire freedom from inflammation and consequent excoriation or ulceration; the action being of the most chronic kind. The cause of this difference seems to reside more in the natural constitution of the patient, and his accidental condition at the time of infection, than on any essential difference in the virus. The obedience of the action to mercury, and the similarity of secondary symptoms, though they are usually of a less severe kind, stamp the sores as of the same kind, only differing in intensity. There is here no impediment in the prompt administration of mercury till the gums are affected, and keeping up the action till the mass softens and subsides. The constitution is usually in a state to bear it; and unless it is given to the full extent to produce its specific effect, secondary effects will arise in the skin and throat. The length of time that usually is allowed to elapse between the period of infection and the commencement of remedies gives the opportunity of absorption; which, in all the instances that I have seen of this form of the disease, has invariably occurred in a marked degree. The freedom from irritation of the part also invites the application of a mercurial; and the mercurial ointment is the best that can be used.

In the management of venereal affections, it is a point of the first importance to distinguish between the essential characters of the unmixed effects of the poison, and those features which they acquire from accidental circumstances. In the treatment of chancres, this distinction cannot too forcibly engage the attention of the practitioner; as upon it will depend, in great measure, the correctness of the opinion formed, as to the propriety of employing mercury, or withholding it. There are few chancres, when the disease takes, if it may be so expressed, its own course, undisturbed by external accidents or peculiarity of constitution, that will not bear this remedy with advantage: and, on the other hand, it may, I think, be safely and truly assumed as an axiom in practice, that when the character of a sore denotes the interference of an unusual action, by which it acquires a character foreign to the usual appearances of a sore under the influence of the virus, other remedies must be sought for, and employed in the place of mercury.

The next principle that ought to engage the attention of the surgeon, is the kind of action that has, to borrow a phrase of Mr. Carmichael, "set the sore astray." A knowledge of the true appearances of a venereal ulcer gives him a correct idea of the extent to which the virus may be acting, in any given sore: but it is necessary to do more than this, and to determine on what depends the deviation of a chancre from its ordinary character, as well as what means will best check its anormal course. These three considerations always bear their due share in the opinion that I form of a venereal primary sore: first, the extent to which the virus is in operation: secondly, how far irregular or anormal actions are wound up with the action of the poison, and the proportion that each bears in determining the nature of the sore; and, thirdly, what peculiarity of action it is that creates the anormal character. Those causes, as giving rise to the class of sores forming the latter part of the list at the commencement of this paper, will be next considered.

The first head includes those which are usually called irritable, and which I have termed the mild, phagedænic sore. Irritability is the main cause of sores becoming phagedænic, and is a state assumed by chancres that ultimately become phagedænic. A chancre may become irritable from a local cause, or from a morbid peculiarity of constitution natural to the patient, or induced by habits of life, and mercury.

The former of these causes is often seen in operation in chancres seated on the penis, or the extremity of the glans, near the opening of the urethra. Such sores almost always are tardy in healing, from some untoward impediment. A frænal chancre at first resembles sores in other parts, and is treated in the same way. It seems obedient to the remedies, and promises well. At length, it ceases to be benefited by the means employed: the sore becomes, as it is called, indolent, and stronger measures are employed: the sore becomes painful, and the surrounding skin and frænum inflamed; and neither mercury within, nor stimulants without, are found to answer. If the ulcer does not spread, it becomes stationary, and is covered with minute red points of granulation, amid a yellow surface. Such is the common course of a chancre so situated, proceeding in this way, sometimes, for weeks; and unless principle be called to our aid, to explain the reason of its intractable state, applications are changed to but little purpose. The cause lies in an irritable kind of inflammation induced by local stimulants that disagree with the sore, and influence it and the surrounding tissue: neglect of the observance of a proper system of diet and regular hours increase the inflammation, and produce an irritability of the nervous and circulating systems which is increased often by the use of mercury. If mercury be withdrawn, or given in the smallest doses, with full doses of Dover's powder, to obtain rest—and, in the place of irritating applications, warm water, or lime-water and opium, be substituted—the tranquillity of the sore is soon obtained, the pulse of the patient soon shows the improvement of constitution, and the process of reparation begins. The nitrate of silver is often useful in this irritable sore by keeping its surface unirritated and protected. The only remedy, in addition to purgation, that I employ, is the cold infusion of sarsaparilla in lime-water: its powder in allaying irritability of action, local and general, is incontestable: it lessens the frequency of the heart's action, softens the quick beat of the pulse, and diminishes the irritability of brain, evinced in the eyes; and of the intestinal canal, as indicated by the tongue, of most patients. When the languor of debility is present, this form of sarza is of little use; it is only when there is inordinate action, short of inflammation, that its benefits are distinctly seen; and not only in this, but in all forms of venereal sores accompanied by such conditions of irritability.

When seated on the extremity of the glans, and surrounding the urethra, the sore becomes irritable, and indisposed to heal under the continual irritation of urine, or if mercury be employed, it assumes at once a phagedænic disposition, and spreads rapidly. When irritable, it usually extends as far as the influence of the urine reaches, generally to about the size of a half-sovereign. It spreads slowly, making every now and then an abortive attempt to granulate; which ends in covering the surface, not with fibrine, but with a soft yellowish coating. The ulcer generally presents this projecting yellow sloughing surface,—arising, as I conceive, from the deposit not having tenacity or firmness enough to form the material for future granulations; but gradually softening down, and passing into the state of ulceration. In all sores of this description, maintained in their anormal state by local causes, longer time must be allowed for their passing through their different stages. If the same active mercurial treatment be adopted, in the hope of speedily correcting the action, the surgeon is disappointed; and the mercurial action induced is converted into one of irritation, as respects the ulcer. The only course he has to pursue, is, to act on the defensive, and to watch the appearances of the sore. If the sore is mild in its anormal deviation, and mercury, in small doses, seems admissible, it should be combined with sarza, or quinine, or opium, with the view of lessening its irritating effects. Mercury, however, in any form, is rarely admissible: it is better to begin, as soon as this disposition is observed in the sore, with the application of a solution of nitrate of silver,—from three to six grains, to the ounce, as can best be borne; and to continue it as long as the coating of the ulcer is indisposed to become firm in texture. As soon as the whitish slough becomes firmer in consistence, it shows that the disposition to ulceration on the surface is on the decline; and in this state it will bear a weak solution of mercury, occasionally applied, at first as a lotion, and afterwards as a continued dressing. A grain of the bichloride, dissolved in an ounce and a half of water, with the addition of three or four minims of the hydrochloric acid, forms a good lotion; and alternated with the astringent already mentioned, or with one of the metallic sulphates, will be found to correct the sore as soon as any application that can be used. Smearing the sore with oil, at each time of micturition, protects it from the contact of urine, and is not to be neglected.

Mr. Hunter has much laid to his charge, of which he is wholly innocent. The excessive and indiscriminate use of mercury in all sores thought to be syphilitic, as recommended and practised by surgeons educated in the school of Hunter, had no authority in the precepts of that great master of our art. Observations of the same tendency as the following are dispersed throughout his work, and show how familiar he was with the tendency of sores to assume an irregular character, depending on some peculiarity of constitution at the time of infection. "The immediate or local effects of the venereal disease," he observes, "are seldom wholly specific; but they partake of the constitutional and specific inflammation; and therefore it is very necessary to pay some attention to the manner in which chancres first appear, and also to their progress; for they often explain the nature of the constitution at the time." And further on, he describes more explicitly the various irregular actions into which chancres are thrown, by peculiarities of constitution. "If the inflammation spreads fast, it shows a constitution more disposed to inflammation than natural: if the pain is great, it shows a great disposition to irritation: it also sometimes happens, that they very early begin to form sloughs: when this is the case, they have a strong tendency to mortification." In these discriminating observations, that point out, in the clearest though concise manner, the various causes that modify the course of venereal sores, are to be seen the doctrine of modern pathology, stated in the simplest form. Mr. Hunter's object, in all his writings, was the elucidation of principle: a less profitable minuteness of detail he left to others. The distinctions that he makes between the action of the virus, and the accidental features imparted by circumstances not confined to primary ulcers, are to be met with in different parts of his work where he speaks of the secondary forms of infection: and the spirit of them so deeply tinctures the whole of his syphilitic views, as to make it matter of surprise, that his immediate successors, by overlooking them, should have brought his doctrines into disrepute.

The more immediate effect of a phagedænic tendency in sores is an extension of the ulcerated surface; and the cause lies in a morbid degree of susceptibility or irritability of the system. Ulceration is the destruction of tissue by inflammation: it is clearly not a process of absorption, but one of simple disintegration of tissue: it occurs only when the vital powers are reduced, and are unable to control the action that tends to disorganise the structure. It differs from gangrene in this, that while, in gangrene, vitality ceases before the disintegration of the tissue has time to take place, in ulceration the parts are still subject to the vital powers while they are undergoing a change from a solid organised texture to a fluid inorganic mass. What the state of circulation is in parts undergoing ulceration, is difficult to ascertain: it cannot wholly cease at once, as gangrene would be the result. It is probable that the influence of the nervous and circulating systems are gradually withdrawn from the surface of parts about to ulcerate. Whatever may be the physical explanation, the physiological state is one of weakness, accompanied with an excess of action in both the vascular and nervous system of the part.

The circumstances that bring on this irritability of frame ought to be an object of attention, in the treatment of phagedænic ulcers; for it is to this condition especially that the practitioner has to direct his remedies. In large towns, thronged with a vicious population, these sores are among the most common forms of primary syphilis. Irregular hours, impure air, hard labour, overstrained powers, and intemperance, contribute, each their share, towards disturbing the course of a venereal sore. It first becomes inflamed, and exceedingly painful: the inflamed tissue breaks down, and ulcerates away: the former healthy limits of the sore, in their turn, undergo the same process. The constitutional state of the patient is evinced in his irritability of manner and loss of rest, in his pallid aspect and slightly vascular conjunctiva, while the heart acts quickly but feebly.

In the adaptation of treatment to these sores, the degree of power which the patient possesses, and the degree of inflammation in the sore, as they materially influence its character, should be special objects of the surgeon's attention. The general principles of allaying irritability, and giving tone, is the course which the surgeon traces for himself; but something more than this is required, to enable him to arrest these spreading and sometimes intractable sores. The distinctions between an irritable and an inflamed ulcer are sufficiently broad; and yet the terms are often confounded, and even misapplied. An inflamed ulcer, because it is painful, is regarded often as an irritable sore;—an error that leads to most painful mistakes in practice, inasmuch as the treatment most apposite to the reduction of inflammation is neglected, and the sore is brought under the action of remedies that tend rather to increase than allay inflammation. The vivid colour of the surface, the fibrinous deposit covering the granulations, the ichorous discharge, and the thickened edge, one or all evince the existing degree of inflammation; while the absence of those signs, and, in their place, a degree of sensitiveness disproportioned to the extent of inflammation, or a disposition to spread by ulceration, is evidence of an irritable state of sore. But though the extreme of each class of sore is distinct enough, the line that divides them is not so clear or defined. Many sores exhibit more or less of both characters. An ulcer may be highly sensitive, and at the same time inflamed; and yet not be disposed to spread in consequence of the patient's vis vitæ not being sufficiently reduced: while a similar ulcer, in another patient, attended with the same degree of inflammation, shall become phagedænic from want of constitutional vigour. Inflammation, therefore, as a cause of phagedæna, is not to be lost sight of;

nor an exclusive regard be paid to the irritable state of the sore or of the patient. A mixed view of a case leads to a mixed mode of treatment. The degree of inflammation present, and the degree of irritability existing, combined in various proportions, are the conditions that modify the progress of ulcers: and the discernment of the practitioner should be directed to ascertain in what proportions they do exist. Inflammation in one degree, combined with much irritability, tends to destructive ulceration: a higher degree of inflammation, with a less degree of irritability, leads to the yellow slough: while the highest degree of inflammatory action, with a further diminished irritability, produces the dark slough, or common gangrene.

In the constitutional treatment of these sores, if some such principles as the foregoing be borne in view, it is not difficult to arrest them. Mercurial action is wholly inadmissible: it tends to increase irritability, to lower the powers of the patient, and therefore to quicken the phagedænic action. Loss of rest, and the irritability of the arterial and nervous systems to which it gives rise, are the prominent points in these cases. Opium, and its various preparations, must be given, to obtain rest: moderate doses only are required; except in some few cases, that hard drinking and debauchery have rendered uncontrollable by smaller doses of opium. In such persons, three or four grains are required, to procure sleep. When this desirable object is obtained, the sore often quickly improves in appearance. If the aspect is marked by much vascular action as well as nervous excitement, the cold alkaline infusion of sarza is the remedy that deserves our confidence. When, in place of a vascular conjunctiva, and flushed face and white tongue, the aspect bears marks of depression and debility, ammonia or quinine, or similar stimulants, are called for. The remedy, however, on which most reliance is to be placed, is iodine, and its combinations.

Before this powerful remedy was known, the medicines on which most reliance could be placed, for the purpose of arresting anormal syphilitic action, when induced by mercury or any other similar cause, were sarsaparilla and mineral acids, especially the nitric. To these may be added some other tonics in general use. Much as these were esteemed, they were not generally allowed to possess any specific action over the disease, beyond their properties of giving tone to the system, and tranquillising irritability. That they have great power in arresting unhealthy ulceration of venereal sores cannot be questioned; and in persons with constitutions impaired by irregularity and disease, in whom mercury is inadmissible, these medicines have a strong claim on our confidence: and when they failed, perhaps more was to be attributed to the inefficient dose, than to a want of efficacy. The salts of iodine have, in great measure, superseded them; as experience has proved them to exert a control over anormal syphilitic action that no remedy, hitherto known, possesses. Its property seems to be stimulant or tonic: it increases vital energy and action, rendering the pulse strong and full: it improves the appetite and powers of digestion, imparting vigour to the chylopoietic viscera: hence its benefit seems especially adapted to that kind of ulceration which depends on want of power, combined with an excess of irritability. In both the mild forms of phagedæna, and in those sores that are covered with the yellow slough, it is found most serviceable; it imparts vigour to the weak textures, and enables them to resist the disorganising process of ulceration. The inflammation that attends these sores seems also to be within its control; for in a day or two after its exhibition, the sore that had been painful becomes easy, and the blush of inflammation assumes a fainter colour, and its area diminishes. This action of the remedy is seen in chronic inflammation of glands in strumous persons, and is improperly attributed to its absorbent property: absorption is the consequence of the arrest of inflammation; and when iodine can be brought to bear with effect on chronic inflammation, absorption of the effused fluids follows. How much of the control that iodine exerts on anormal sores is to be attributed to a specific power over the poison, is difficult to say; but we are limiting its powers too narrowly, I think, if we confine its action to the common inflammation that surrounds the sore. Both in the primary and secondary forms of this disease, it is often found to arrest the progress of syphilitic action, in persons who cannot bear mercury; and, next to that mineral, iodine seems to possess the highest anti-syphilitic powers. Its effects are less permanent, and less certain, in the normal forms of disease; but its action is less injurious to the constitution. Mercury increases the irritability of the system in many persons, enfeebles the constitution, and disposes sores to phagedænic action: the effect of iodine is the reverse of this: it may be said that iodine fulfils that in which mercury is deficient. In the normal forms of syphilis, this mineral is rarely found to disappoint the expectation of the practitioner; and in the anormal forms of primary sores, it as rarely fails to do harm: while iodine exerts, comparatively, little influence over the normal chancre, chiefly confining its good services to the sores that are "set astray" by some peculiar condition of constitution. The forms in which I employ it, are, the iodide of potassium alone or combined, and the solution of iodine in this salt. I do not find it necessary to increase the dose beyond seven grains of the salt, or half a grain of the pure iodine. In some of those sores that are not amenable to the action of iodine, the aid of mercury, in small doses, is wanted, and in such forms as produce the least disturbance of the system. It is best given at night, with Dover's powder, in form of the chloride, or the gray oxide with chalk. The action of mercury is sometimes wanted for sores that, having shown an anormal disposition, have lost it under the action of iodine, and yet will not granulate or cicatrise. The syphilitic action still predominates in them; and yields only to mercury, which should be given in the most guarded manner.

The more intense forms of phagedæna are those in which a sloughing action alternates, or coexists with ulceration. The action is similar to that which attends the milder phagedænic sores: but the causes that operate are more active, and the destructive ulceration is proportionally more severe and rapid; it may be properly enough called sloughing phagedæna. The principles that should regulate the treatment of these sores are the same as guide us in the milder phagedæna. The powers of life, in such patients, rarely permit the use of the lancet; nor, indeed, does the nature of the sores require it, as the inflammation is of the asthenic kind, and requires rather an opposite plan of treatment. Rest is usually sufficient to subdue the inflammation that may be present: and when inflammation of a more active kind attends the early stage of phagedæna, a few leeches will suffice for its reduction. To tranquillise the excessive irritability that always accompanies them, is the main object. Opium, or morphia, in full doses, should be given at night, to procure rest; and if that fails, it should be given at intervals of four or six hours, combined with such stimulants as the previous habits of patients may render proper. Camphor, capsicum, and quinine, form a useful addition to opium; with the allowance of wine or spirits, that custom has rendered necessary. Stimulants are usually required in the treatment of these sores; but harm is sometimes done by having recourse to them indiscriminately, in all cases. When irritability of the nervous system is joined with great vascular excitement, evinced by a sharp and rather full pulse, a vascular conjunctiva, and a flushed cheek, opium should be given only in small doses at night, and other measures employed that tend to allay irritation, without increasing vascular action. The cold alkaline infusions of sarza form, in such cases, a good substitute for the stimulants and tonics above mentioned: and as soon as the pulse is quiet, iodine, in some form, is found to put a stop to the ulcerative action. These measures often check the more severe, as they do the milder forms of phagedænic sore; and the propriety of using them, in preference to stimulants, must depend on the condition of the patient; the latter should only be used when the powers of life are enfeebled, and irritability maintained by want of the accustomed stimulus. The local applications that have most efficacy are those of a stimulating kind. The undiluted nitric acid is one of the most effective, as well as most safe; and one application to the whole surface of the ulcer, so as to imbue the whole ulcerating and sloughing textures, is usually sufficient to arrest the mischief: it converts the ulcerative action into a sloughing one; and the white or yellow parts become brown, die, are cast off, and leave a healthy granulating surface. Solutions of nitro-muriatic acid with opium, the cataplasma cumini, Peruvian balsam, with equal quantity of liq. opii sedativi, are useful when the sloughing prevails more than the ulcerative action. I cannot confirm the propriety of giving mercury for the white sloughing sores, as advised by a late writer on syphilis. The recommendation seems fraught with danger: it is inadmissible so long as the ulcerative action is going rapidly on; and should be given, if at all, only when the white coating of the sore has acquired a firmness that indicates the cessation of phagedænic action. Happily, mercury is altogether needless; as iodine is sufficient of itself to check the ulceration, and to produce a healthy granulating surface. Even when every sign of phagedænic action has left the sore, it seems better to defer the use of mercury, for the healing of the sore, or with the view of preventing secondary symptoms. Mr. Carmichael's advice on this head is valuable; and his observations on the action of mercury, in these sores, will be found correct.

The dark brown slough, approaching almost to a black, is the result of an action different from the former, in the process of ulceration being wanting, and the texture at once passing into a state of sphacelus, from the rapid change effected in it by inflammation. This kind of sore may be either the effect of a neglected aphthous chancre on the inner prepuce, or may commence as a black sloughing spot on the glans itself. The worst instance that I have witnessed of it began as an aphthous sore on the corona, that healed in three days; and broke out again, after some excess in wine; and immediately assumed a sloughing action of a most destructive kind. The high degree of inflammation induced by the poison seems to be the cause of this dark sloughing sore; which is therefore usually more painful than the white sloughing one, and attended with greater constitutional disturbance. It is almost always attended with phimosis; which is not unfrequently the cause of the inflammation that renders the aphthous chancre sometimes so destructive. The tense and turgid state of the prepuce, the escape of a dark sanies from under it, and the general vascular disturbance, point out the nature of the action, and the measures that are promptly to be put in force. When the glans is denuded by a division of the prepuce, a dark-brown or purple slough is seen involving a part of the glans or prepuce; and presenting no defined margin, but gradually terminating in a livid texture about to undergo the same change. So rapid is this action, sometimes, that in twenty-four hours it will have gained an inch on the sound structure. The difference between this and phagedænic action is, that in the latter the texture of the part affected retains its vitality, but not its integrity; while in the former, the reverse takes place; the circulation quickly ceasing, while the texture appears to undergo but little change, or even none, if the gangrenous action be rapid.

Whatever may be the cause of parts thus suddenly passing into a gangrenous state—whether the specific action of the poison, or common inflammation in a peculiar constitution—the disease is to be regarded as one of an inflammatory kind, requiring, especially in the commencement, vigorous antiphlogistic measures. A more fatal error cannot well be committed, than to stimulate these sores on the principle of supporting vital action. In looking back upon the cases of black slough that I have treated, I have never had occasion to regret having used early active depletion; and on the other hand, when the action has not been stopped, it has been from depletion having been either not carried far enough, or not early enough adopted. The loss of blood, by division of the prepuce, is often sufficient to arrest the inflammation, independently of the good the operation occasions by exposure of the unsound part; and it is well to encourage the bleeding to the extent the patient's power will permit. One active depletion will also prevent secondary hemorrhage —an accident that may occur with benefit to the patient: but if happening when the disease is advanced, and the patient's powers low, it tends rather to spread the gangrenous disposition, than to check it. The sore should be freely exposed, and dressed with lint steeped in the compound tincture of benzoin; which is more effective in the dark than even in the white slough, for the arrest of the sloughing action, and separation of the dead mass. It is seldom necessary to seek the aid of any other local application; as this is more to be relied upon than the chlorides of lime or soda, or the carrot-and-yeast poultices, which are also useful, or than the balsams. As soon as depletion has been carried far enough, and the inflammatory state checked, the slough is usually cast off with rapidity; and a healthy surface, altogether free from syphilitic appearance, is established. If the sloughing action has been active and extensive in its operations, it removes all the parts involved in the specific action of the poison: hence mercury is seldom required in the granulating stage of these sores, and secondary symptoms are not often to be apprehended.

The heads at the beginning of this paper, which I have not touched upon, I reserve for another notice.

REPORT

ON THE

PHYSIOLOGY OF THE NERVOUS SYSTEM.

BY WILLIAM CHARLES HENRY, M. D.,

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Introduction.—The science of Physiology has for its object to ascertain, to analyse, and to classify, the qualities and actions which are peculiar to living bodies. These vital properties reside exclusively in organised matter, which is characterised by a molecular arrangement, not producible by ordinary physical attractions and laws. Matter thus organised consists essentially of *solids*, so disposed into an irregular network of laminæ and filaments, as to leave spaces occupied by *fluids* of various natures. "Texture," or "tissue," is the anatomical term by which such assemblages are distinguished. Of these the cellular, or *tela cellulosa*, is most elementary, being the sole constituent of several, and a partial component of all tissues and systems. Thus the membranes and vessels consist entirely of condensed cellular substance; and even muscle and nerve are resolvable, by microscopic analysis, into globules deposited in attenuated cellular element.

But though the phenomena, which are designated as vital, are never found apart from organisation, and have even by some naturalists been regarded as identical with it, yet in the order of succession vital actions seem necessarily to stand to organised structures in the relation of antecedents; for the production of even the most rudimentary forms and textures implies the previous operation of combining tendencies or "vital affinities." The origin and early developement of these vital tendencies, and of organised structures, are beyond the pale of exact or even of approximative knowledge. But it is matter of certainty, that life is the product only of life; that every new plant or animal proceeds from some pre-existent being of the same form and character; and thus that the image of the great Epicurean poet, "Quasi cursores vitai lampada tradunt,"

[1] Report of the third meeting of the British Association, p. 59.

[We publish this Report at the the request of the chairman of the Committee of Publication of the Medical Society of the State of New York. It is referred to in connection with their proposed prize question on the Physiology of the Nervous System, and is accessible to but few.—Ed.]

possesses a compass and force of illustration which, as a supporter of the doctrine of fortuitous production, he could not have himself contemplated.

The popular notions respecting life are obscure and indeterminate; nor are the opinions even of philosophers characterised by much greater distinctness or mutual accordance. Like other complex terms, "life" can obviously be defined only by an enumeration of the phenomena which it associates. This enumeration will comprehend a greater or a smaller number of particulars, according to the station in the scale of living beings which is occupied by the object of survey. In its simplest manifestation, the principle of life may be resolved into the functions of nutrition, secretion, and absorption. It consists, according to Cuvier, of the faculty possessed by certain combinations of matter, of existing for a certain time, and under a determinate form, by attracting unceasingly into their composition a part of surrounding substances, and by restoring portions of their own substance to the elements. This definition comprehends all the essential phenomena of vegetable life. Nutritive matter is drawn from the soil by the spreading fibres of the root, through the instrumentality of spongioles or minute turgid bodies at their extremities, which act, according to Dutrochet, by a power which he has called "endosmosis." The same agency raises the nutrient fluid through the lymphatic tubes to the leaves, where it seems to undergo a kind of respiratory process, and becomes fit for assimilation. These changes, and the subsequent propulsion of the sap to the different parts and textures, plainly indicate independent fibrillary movements, which are represented in animal life by what Bichat has termed "the phenomena of organic contractility." The power residing in each part of detecting in the circulating fluid, and of appropriating, matters fitted to renovate its specific structure, is designated in the same system by the term "organic sensibility."

Ascending from the vegetable to the animal kingdom, the term "life" advances greatly in comprehensiveness. The existence of a plant is limited to that portion of space in which accident or design has inserted its germ; while animals are for the most part gifted with the faculties of changing their place, and of receiving from the external world various impressions. Along with the general nutritive functions, the higher attributes of locomotion and sensation are therefore comprised in the extended compass of meaning which the term "life" acquires with the prefix "animal." The nutritive functions, too, emerging from their original simplicity, are accomplished by a more complex mechanism, and by agencies further removed from those which govern the inanimate world.

Locomotion is effected either by means of a contractile tissue, or of distinct muscular fibres. These fibres have been said to consist of globules resembling, and equal in magnitude to, those of the blood, disposed in lines, in the elementary cellulosity, which, by an extension of the analogy, is compared to serum. But the latest microscopical observations of Dr. Hodgkin are opposed to this globular constitution of the contractile fibre. "Innumerable very minute but clear and fine parallel lines or striæ may be distinctly perceived, transversely marking the fibrillæ." Irritability, or the faculty of contracting on the application of a stimulant, is a property inherent in the living fibre. It is an essential element of all vital operations, except of those which have their seat in the nervous system, such as sensation, volition, the intellectual states, and moral affections. All the phenomena of life, in the higher animals, may then be ultimately resolved into the single or combined action of these two elementary properties—irritability and nervous influence, each residing in its appropriate texture and system.

These preliminary remarks are designed to unfold the principles to be followed in classifying the vital functions. In general or comparative physiology, a strictly scientific arrangement would contemplate first the phenomena of the most elementary life, and would successively trace the more perfect developement of those simple actions and their gradual transition into more complex processes, as well as the new functions, superadded in the ascending scale of endowment. But such a mode of classification is wholly inapplicable to the particular physiology of man and of the more perfect animals, viewed by itself, and without reference to inferior orders of beings; for the nutritive functions of this class, which correspond with the elementary actions of the simplest vegetable life, are effected by a complex system of vessels and surfaces, deriving their vital powers from contractile fibres, and controlled, if not wholly governed, by nervous influence. It is then manifest, that in the higher physiology the general laws of contractility and "innervation" must precede the description of the several functions, which all depend on their single or united agency. The particular functions will afterwards be classed, as they stand in more immediate relation to one or other of the two essential principles of life.

In the present state of physiological knowledge, it is impossible to determine absolutely, and without an opening to controversy, whether the functions of muscle or those of nerve are entitled to precedency. If each were equally independent of the other in the performance of their several offices, the question of priority would resolve itself into one of simple convenience. The actions of the nervous system, if contemplated for the short interval of time during which they are capable of persisting without renovation of tissue, are entirely independent of the contractile fibre. But it is certain that the co-operation of nerve is required in most, if not in all, the actions of the muscular system. Thus the voluntary muscles in all their natural and sympathetic contractions receive the stimulant impulse of volition through the medium of nerve; and though the mode in which the motive impression is communicated to the involuntary muscles is still matter of controversy, there seems sufficient evidence[1] to sanction the conclusion that nerve is in this case also the channel of transmission;—"that the immediate antecedent of the contraction of the muscular fibre is universally a change in the ultimate nervous filament distributed to that fibre." If this be correct, the physiological history of muscle cannot be rendered complete without reference to that of nerve.

In the higher manifestations of life, nervous matter is invested with the most eminently vital attributes. It is the exclusive seat of the various modes of sensation, and of all the intellectual operations; or, rather, it is the point of transition, where the physical conditions of the organs, which are induced by external objects, pass into states of mind, becoming perceptions; and where the mental act of volition first impresses a change on living matter. These two offices, of conducting motive impressions from the central seat of the will to the muscles, and of propagating sensations from the surface of the body and the external organs of sense to the sensorium commune, have been of late years shown to reside in distinct portions of nervous substance.

The honour of this discovery, doubtless the most important accession to physiological knowledge since the time of Harvey, belongs exclusively to Sir Charles Bell. It constitutes, moreover, only a part of the new truths, which his researches have unveiled, regarding the general laws of nervous action, and the offices of individual nerves. His successive experiments on function, guided always by strong anatomical analogies in structure, in origin, or in distribution, have led to the entire remodelling of nervous physiology, and to the formation of a system of arrangement, based on essential affinities and on parity of intimate composition, instead of on *apparent* sequence or proximity of origin. Among the continental anatomists, MM. Magendie and Flourens have contributed most largely to our knowledge of this part of physiology; the former by repeating and confirming the experiments of Bell, as well as by various original inquiries; the latter by his important researches into the vital offices of the brain and its appendages. Much light, too, has been thrown on the functions of several of the encephalic nerves, and especially of those supplying the face and its connected cavities, by Mr. Herbert Mayo, who has analysed their anatomical composition, and pursued their course with singular precision, and has thus been enabled to correct some errors of detail in the system of Sir Charles Bell.

Nervous System.—In man, and in other vertebrated animals, the nervous system consists of the cerebrum, cerebellum, medulla oblongata, medulla spinalis, and of the encephalic, spinal, and ganglionic nerves. It seems most natural to observe this order of anatomical sequence in recording what is known of nervous functions.

[1] See "A Critical and Experimental Inquiry into the Relations subsisting between Nerve and Muscle," in the 37th vol. of the Edinburgh Medical and Surgical Journal.

Cerebrum, or Brain-proper.—The physiology of the brain has received of late years very considerable accessions, and its vital offices, *viewed as an entire organ*, have now probably been ascertained with sufficient precision. Some portion of this newly acquired knowledge has been gathered from experiments on living animals, but the greater and more valuable part has flowed from the study of comparative developement. In this latter field of inquiry, Tiedmann's elaborate history of the progressive evolution of the human brain during the period of fœtal existence, with reference to the comparative structure of that organ in the lower animals, merits an early and detailed notice. It had been discovered by Harvey, that the fœtus in the human species, as well as in inferior animals, is not a precise facsimile of the adult, but that it commences from a form infinitely more simple, and passes through several successive stages of organisation before reaching its perfect developement. In the circulatory system, these changes have been minutely observed and faithfully recorded.[1] Tiedemann has traced a similar progression in the brain and nervous system, and has moreover established an exact parallel between the *temporary* states of the fœtal brain in the periods of advancing gestation, and the *permanent* developement of that organ at successive points of the animal scale. The first part of his work is simply descriptive of the nervous system of the embryo at each successive month of fœtal life. It constitutes the anatomical groundwork upon which are raised the general laws of cerebral formation, and the higher philosophy of the science. In the second part, Tiedemann has established, by examples drawn from all the grand divisions of the animal kingdom, the universality of the law of formation, as traced in the nervous system of the human fœtus, and the existence of one and the same fundamental type in the brain of man and of the inferior animals.

The facts which have been unfolded by the industry of Tiedemann, besides leading to the universal law of nervous developement, throw important light upon nervous function: for it is observed that the successive increments of nervous matter, and especially of brain, mark successive advances in the scale of being; and, in general, that the developement of the higher instincts and faculties keeps pace with that of brain. Thus, in the zoophyta, and in all living beings destitute of nerves, nothing that resembles an instinct or voluntary act is discoverable. In fishes the hemispheres of the brain are small, and marked with few furrows or eminences. In birds they are much more voluminous, more raised and vaulted than in reptiles; yet no convolutions or anfractuosities can be perceived on any point of their surface, nor are they divided into lobes. The brain of the mammalia approaches by successive steps to that of man. That of the rodentia is at the lowest point

[1] See an excellent Essay on the Developement of the Vascular System in the Fœtus of Vertebrated Animals, by Dr. Allen Thomson.

of organisation. Thus the hemispheres in the mouse, rat, and squirrel are smooth and without convolutions. In the carnivorous and ruminating tribes, the hemispheres are much larger and marked by numerous convolutions. In the ape tribe the brain is still more capacious and more convex; it covers the cerebellum, and is divided into anterior, middle, and posterior lobes. It is in man that the brain attains its greatest magnitude and most elaborate organisation. Sömmerring has proved that the volume of the brain, referred to that of the spinal marrow as a standard of comparison, is greater in man than in any other animal.

Various attempts have been made of late years, chiefly by the French physiologists, to ascertain the functions of the brain by actual experiment. It will appear from a detailed survey of their labours, that little more than a few general facts respecting the function of its *larger* masses and great natural divisions have flowed from this mode of research. The offices of the *smaller* parts of cerebral substance cannot with any certainty be derived from the phenomena that have been hitherto observed to follow the removal of those parts, since the most practised vivisectors have obtained conflicting results. Nor is it difficult, after having performed or witnessed such experiments, to point out many unavoidable sources of fallacy. In operations on living animals, and especially on so delicate an organ as the brain, it is scarcely possible for the most skilful manipulator to preserve exact anatomical boundaries, to restrain hæmorrhage, or prevent the extension to contiguous parts of the morbid actions consequent upon such serious injuries, and to distinguish the secondary and varying phenomena, induced by the pressure of extravasated blood, or the spread of an inflammatory process, from those which are essential and primary. The ablation of small and completely insulated portions of brain must, then, be classed among the "agenda" of experimental physiology.

The most decisive researches, that have been hitherto instituted on the functions of the brain, are those of M. Flourens. His mode of operating was to remove cautiously successive thin slices of cerebral matter, and to note the corresponding changes of function. He commenced with the hemispheres of the brain, which he found might be thus cut away, including the corpora striata and thalami optici, without apparently occasioning any pain to the animal, and without exciting convulsive motions. Entire removal of the cerebrum induces a state resembling coma; the animal appears plunged in a profound sleep, being wholly lost to external impressions, and incapable of originating motion; it is deprived, too, according to Flourens, of every mode of sensation. Hence the cerebrum is inferred to be the organ in which reside the faculties of perception, volition and memory. Though not itself sensible, in the ordinary acceptation of the word,—that is, capable, on contact or injury, of propagating sensation,—yet it is the point where impressions made on the external organs of sense become objects of perception. This absence of general sensibility observed in the brain has also been experimentally demonstrated in the nerves dedicated to the functions of sight, of smell and of hearing, and constitutes, perhaps, one of the most remarkable phenomena that have been disclosed by interrogating living nature. Flourens appears, however, to have failed in proving that *all* the sensations demand for their perception the integrity of the brain. He has himself stated that an animal deprived of that organ, when violently struck, "has the air of awakening from sleep," and that if pushed forwards, it continues to advance after the impelling force must have been wholly expended. Cuvier has therefore concluded, in his Report to the Academy of Sciences upon M. Flourens' paper, that the cerebral lobes are the receptacle in which the impressions made on the organs of sight and hearing only, become perceptible by the animal, and that probably there too all the sensations assume a distinct form, and leave durable impressions,—that the lobes are, in short, the abode of memory. The lobes, too, would seem to be the part in which those motions which flow from spontaneous acts of the mind have their origin. But a power of effecting regular and combined movements, on *external stimulation*, evidently survives the destruction of the cerebral hemispheres.

A very elaborate series of experiments on the functions of the brain in general, and especially on those of its anterior portion, have been since performed by M. Bouillaud.[1] That observer concurs with Flourens in viewing the cerebral lobes as the seat of the *remembrance* of those sensations which are furnished to us by sight and hearing, as well as of all the intellectual operations to which these sensations may be subjected, such as comparison, judgment and reasoning. But he proves that the ordinary tactual sensibility does not require for its manifestation the presence of the brain. For animals entirely deprived of brain were awakened by being struck, and gave evident indications of suffering when exposed to any cause of physical pain. Bouillaud observes, too, that the iris continues obedient to the stimulus of light, after ablation of the hemispheres, and on this ground calls in question the loss of vision asserted by Flourens. Nor are the lobes (he contends) the only receptacle of intelligence, of instincts and of volition: for to admit this proposition of Flourens would be to grant that an animal which retains the power of locomotion, which makes every effort to escape from irritation, which preserves its appropriate attitude, and executes the same movements after as before mutilation, may perform all those actions without the agency of the will or of instinct. Another doctrine of Flourens, which has been experimentally refuted by Bouillaud, is, "that the cerebral lobes concur *as a whole* in the full and entire exercise of their functions; that when one sense is lost, all are lost; when one faculty disappears, all disappear;" in short, that a certain amount of cerebral matter may be cut away without appa-

[1] Magendie, Journal de Physiologie, tom. x. p. 36.

rent injury, but that when this limit is passed, all voluntary acts and all perceptions perish simultaneously. Bouillaud, on the contrary, has described several experiments which show that animals, from whom the anterior or frontal part of the brain had been removed, preserved sight and hearing, though deprived of the knowledge of external objects, and of the power of seeking their food.

The second part of M. Bouillaud's researches is entirely devoted to the functions of the anterior lobes of the brain. These were either removed by the scalpel, or destroyed by the actual cautery, in dogs, rabbits and pigeons. Animals thus mutilated feel, see, hear and smell; are easily alarmed, and execute a number of voluntary acts, but cease to recognise the persons or objects which surround them. They no longer seek food, or perform any action announcing a combination of ideas. Thus the most docile and intelligent dogs lost all power of comprehending signs or words which were before familiar to them, became indifferent to menaces or caresses, were no longer amenable to authority, and retained no remembrance of places, of things, or of persons. They saw distinctly food presented to them, but had ceased to associate with its external qualities all perception of its relations to themselves as an object of desire. The anterior or frontal part of the brain is hence inferred to be the seat of several intellectual faculties. Its removal occasions a state resembling idiotism, characterised by loss of the power of discriminating external objects, which, however, co-exists with the faculties of sensation.

It will be unnecessary to describe fully in this place the experiments of Professor Rolando, of Turin, performed in 1809, and published in Magendie's *Journal*, tom. iii., 1823, since the more important of his facts have reference, not to the brain proper, but to the cerebellum. His paper certainly contains some curious anticipations of phenomena, since more accurately observed by Flourens and Magendie; yet, as regards the brain, properly so called, his results are vague and inconclusive. Accident, rather than a well matured design, seems to have directed what parts of the brain he should remove; and from having comprehended in the same injury totally distinct anatomical divisions, he has rendered it impossible to arrive at the precise function of any one part. Thus we are told that injury of the thalami optici and tubercula quadrigemina in a dog was followed by violent muscular contractions. Now all subsequent experimenters agree, that irritation of the thalami is incapable of inducing convulsive motions; and Flourens has proved that this property has its beginning in the tubercula,—an important fact, which Rolando, with a little more precision in anatomical manipulation, could scarcely have failed to discover.

Magendie has described[1] some curious experiments on the corpora striata, which, though closely analogous in their results to those on

[1] Journal de Physiologie, tom. iii. p. 376.

the cerebellum, have their proper place in this section. Removal of one corpus striatum was followed by no remarkable change; but when both had been cut away, the animal rushed violently forwards, never deviating from a rectilinear course, and striking against any objects in its way. In his lecture of February 7, 1828, Magendie, in the presence of his class, removed both corpora striata from a rabbit. The animal attempted to rush forwards, and, if restrained, appeared restless, continuing in the attitude of incipient progression. One thalamus opticus was then cut away from the same animal. The direction of its motion was immediately changed from a straight to a curved line. It continued for some time to run round in circles, turning towards the injured side. When the other thalamus was removed, the animal ceased its motions, and remained perfectly tranquil, with the head inclined backwards. These experiments, it may be observed, furnish no support to the opinions of MM. Foville and Pinel Grandchamps, who have assigned the anterior lobes and corpora striata as the parts presiding over the movements of the inferior extremities, and the posterior lobes and thalami as regulating the superior.

Cerebellum.—It may be regarded as nearly established by modern researches, that the cerebellum is more or less directly connected with the function of locomotion. The precise nature and extent of its control over the actions of the voluntary muscles are, however, far from being clearly determined. In the higher animals, the mental act of volition probably has its commencing point, as productive of a physical change, in the brain proper; though it must be confessed that some of the experiments of Flourens, and all of those of Bouillaud, indicate the persistence of many instinctive, and even of some automatic motions, after destruction of the brain. But there *does* appear sufficient evidence to prove that these volitions which have motion as their effect, whatever be their origin, whether in the cerebrum, cerebellum, or medulla oblongata,[1] require for their accomplishment the co-operation of the cerebellum. This evidence has been mainly supplied by the same inquirers whose researches on the cerebrum have been already analysed.

In the order of time, though not of importance, the experiments of Professor Rolando stand foremost. Injuries of the cerebellum, he observed, were always followed by diminished motive power; and this partial loss of power was always in direct proportion to the amount of injury. A turtle survived upwards of two months the entire removal of the cerebellum, continuing sensible to the slightest stimulus; but when irritants were applied, it was totally unable to move from its place. M. Flourens has since arrived at similar, but more definitive results. He removed in succession thin slices from the cerebellum. After the first two layers had been cut away, a slight weakness and want of harmony and system in the automatic movements were noticed. When more cerebellic substance

[1] Flourens, Mémoires de l'Académie, tom. ix.

had been removed, great general agitation became apparent. The pigeon which was the subject of operation retained, as at first, the senses of sight and hearing, but was capable of executing only irregular unconnected muscular efforts. It lost by degrees the power of flying, of walking, and even of standing. Removal of the whole cerebellum was followed by the entire disappearance of motive power. The animal, if laid upon its back, tried in vain to turn round; it perceived and was apprehensive of blows, with which it was menaced, heard sounds, seemed aware of danger, and made attempts to escape, though ineffectually,—in short, while it preserved, uninjured, sensation and the exercise of volition, it had lost all power of rendering its muscles obedient to the will. The cerebellum is hence supposed by Flourens to be invested with the office of "balancing, regulating or combining separate sets of muscles and limbs, so as to bring about those complex movements depending on simultaneous and conspiring efforts of many muscles, which are necessary to the different kinds of progressive motion." Bouillaud, who has successfully disputed several of the opinions of Flourens respecting the functions of the cerebrum, fully concurs with him as to those of the cerebellum.

Yet, it must be admitted, that there exists also conflicting experimental testimony on this subject. M. Fodera[1] states, that he has found the removal of a part of the cerebellum to be followed, in all cases, either by motion *backwards*, or by that position of the body which precedes retrograde movement. The head is thrown back, the hind-legs separated, and the fore-legs extended forwards, and pressed firmly against the ground. More complete destruction of the cerebellum occasions the animal to fall on its side; but the head is still inclined rigidly backwards, and the anterior extremities agitated with convulsive movements, tending to cause retrograde motion of the body. Injuries of one side of the cerebellum were observed to produce paralysis of the same side of the body; as might, indeed, have been anticipated from the direct course, without decussation, of the restiform columns which ascend to form the cerebellum. Magendie has described[2] precisely the same results. A duck, whose cerebellum had been destroyed, could swim only backwards. In the course of his experimental lectures, Magendie, having removed the cerebellum in several rabbits, demonstrated to his class the phenomena of retrograde movement, exactly as they have been recorded by Fodera. It is then impossible to regard the conclusions of Flourens as fully established, opposed as they are by those of so skilful an experimenter as Magendie. Indeed, while Flourens conceives the cerebellum to preside over motion, MM. Foville and Pinel Grandchamps attribute to it the directly opposite function of sensation: and this doctrine seems to derive some support from anatomical disposition; for it has been proved by Tiedemann that the cerebullum is nothing more than an expansion or

[1] Journal de Physique, July, 1823. [2] Ibid. tom. iii. p. 157.

prolongation of the corpora restiformia, and posterior columns of the spinal medulla, which columns have been shown by Sir Charles Bell to have the office of conveying sensations. But it is not the less true that all recent experiments, even those of Fodera and Magendie, point to some connection between the cerebellum and the power of voluntary motion. In the present state of our knowledge, it would be unsafe to contend for more than the probable existence of some such general relation.

This, then, is all that seems deserving of confidence respecting the functions of the cerebellum itself. But there are some singular phenomena which, though residing in other structures more or less near to the cerebellum, are so analogous to those already described as to call for notice in this place. Magendie has described[1] the results of injury to the crura cerebelli of a rabbit. Complete division of the right crus was followed by rapid and incessant rotation of the body upon its own axis, from left to right. This singular motion having continued two hours, Magendie placed the rabbit in a basket containing hay. On visiting it the following day, he was surprised to find the animal still turning round as before, and completely enveloped in hay. The eyes were rigidly fixed in different lines; that of the injured side being directed forwards and downwards, that of the other side backwards and upwards. If both crura were divided, no motion followed. Magendie hence concluded, that these nervous cords are the conductors of impulsive forces which counterbalance one another, and that from the equilibrium of these two forces result the power of standing, and even of maintaining a state of rest, and of executing the different voluntary motions. The inquiry naturally presented itself, whether these forces are inherent in the crura themselves, or emanate from the cerebellum or some other source. To determine this question, portions of substance were removed from both sides of the cerebellum, but unequally, so as to leave intact $\frac{3}{4}$ on the left side, and $\frac{1}{4}$ only on the right. The animal rolled towards the right side, and its eyes were fixed in the manner already described. But the left crus being divided, the animal rolled to the left side. Hence it appears that section of the crus has more influence over the lateral rotation of the body than injury of the cerebellum itself; and that the impulsive force does not belong (at least exclusively) to the cerebellum. When the cerebellum was divided precisely in the median line, the animal seemed suspended between two opposing forces, sometimes inclining towards one side, as if about to fall, and again thrown suddenly back to the opposite side. Its eyes were singularly agitated, and seemed about to start from the orbits. Similar movements followed division of the continuous fibres in the pons Varolii. Serres has described a case of similar rotatory motion occurring in the human subject. A shoemaker, habituated to excess in alcoholic liquors, after great intemperance, was seized with an irresistible disposition

[1] Journal de Physiologie, tom. iv. 399.

to turn round upon his own axis, and continued to move so till death ensued. On inspecting the brain, one of the crura cerebelli was found much diseased, and this was the only alteration of structure visible in any part of the nervous system.

M. Flourens has published in a recent volume of the *Mémoires de l'Académie des Sciences*[1] a description of some striking abnormal motions which followed the division of the semicircular canals of the ears of birds. Though these organs have no anatomical relation to the cerebrum or cerebellum, the altered motions resulting from their division are so analogous to those observed by Magendie after lesions of the corpora striata and crura, that they may be most conveniently described in the same section. Two of the semicircular canals are vertical, and one horizontal. Division of the horizontal canals on each side occasioned a rapid horizontal movement of the head from right to left, and back again, and loss of the power of maintaining an equilibrium, except when standing, or when perfectly motionless. There was also the same singular rotation of the animal round its own axis, which follows injury of the crura cerebelli. Section of the inferior vertical canal on both sides produced violent vertical movements of the head, with loss of equilibrium in walking or flying. There was in this case no rotation of the body upon itself, but the bird fell backwards, and remained lying on its back. When the superior vertical canals were divided, the same phenomena were observed as in section of the inferior, except that the bird fell forward on its head, instead of backward. All the canals, both vertical and horizontal, having been divided, in another pigeon, violent and irregular motions in all directions ensued. When, however, the bony canals were so cautiously divided as to leave their internal membranous investment uninjured, these abnormal motions were not produced. It is, therefore, in these membranes, or rather in the expansion of the acoustic nerve which overspreads them, that the cause of this phenomenon must reside. No explanation is proposed by Flourens of the control thus exercised by a nerve supposed to minister exclusively to the sense of hearing, over actions so entirely opposite in character. It is remarkable that the irregular movements should observe the same direction in their course as the canals, by the section of which they are induced. Thus the direction of the inferior vertical canal is posterior, that of the superior is anterior, corresponding perfectly with the directions of the abnormal motions.

Medulla Oblongata.—The medulla oblongata, or "bulbe rachidien," is reducible into six columns, or three pairs, viz., two anterior or pyramidal, which partially decussate, two middle or olivary, and two posterior or restiform, which proceed forwards without crossing. It is continuous in structure with the spinal marrow, and enjoys, by virtue of this relation, the same function of propagating motion and sensation. But it is distinguished from the spinal medulla by

[1] Tom. ix. p. 454.

special and higher attributes, being endowed with the faculty of originating motions, as well as with that of regulating and conducting them. The medulla oblongata, with the cerebrum and cerebellum, constitute, in short, according to Flourens,[1] those portions of the nervous system which exercise their functions "spontaneously or primordially," and which originate and preside over the vital actions of the subordinate parts. To this latter order of parts, which require an exciting or regulating influence, belongs the spinal medulla. In the superior class, Flourens seems to assign even a higher place to the medulla oblongata than to the cerebrum or cerebellum. For the cerebrum, he observes, may act without the cerebellum; and this latter organ continues to regulate the motions of the body after removal of the cerebrum. But the functions of neither cerebrum nor cerebellum survive the destruction of the medulla oblongata, which seems to be the common bond and central knot combining all the individual parts of the nervous system into one whole.

The medulla oblongata was regarded by Legallois as the mainspring or "premier mobile" of the inspiratory movements. He repeated before a commission of the Institute of France the leading experiments on which his opinion rested.[2] In a rabbit, five or six days old, the larynx was detached from the os hyoides and the glottis exposed to view. The brain and cerebellum were then extracted without arresting the inspirations, which were marked by four simultaneous motions,—a gaping of the lips, an opening of the glottis, the elevation of the ribs, and the contraction of the diaphragm. Legallois next removed the medulla oblongata, when all these motions ceased together. In a second rabbit, instead of extracting at once the entire medulla, it was cut away in successive thin slices. The four inspiratory movements continued after the removal of the three first slices, but ceased after the fourth. It was found that the fourth had reached the origin of the eighth pair of nerves. If, instead of destroying the part in which this motive influence resides, it be simply prevented from communicating with the muscles which are subservient to inspiration, a similar effect ought to be produced. Now it is obvious that the medulla oblongata must transmit its influence to the muscles which raise the ribs, through the medium of the intercostal nerves, and therefore of the spinal marrow, and to the diaphragm through the phrenic nerves, and to these through the spinal marrow. In another rabbit, therefore, the medulla spinalis was cut across about the level of the seventh cervical vertebra. The effect of this operation was to arrest the elevation of the ribs, the other three inspiratory motions still continuing. A second section was made near the first cervical vertebra, and consequently above the origin of the phrenic, with the effect of suspending the contraction of the diaphragm. The par vagum was next divided

[1] Mémoires de l'Académie des Sciences, tom. ix. p. 478.
[2] Œuvres de Legallois, tom. i. p. 247.

in the neck, and the opening of the glottis ceased. There remained then, of the four inspiratory movements, only the gaping of the lips, which, however, was sufficient to attest that the medulla oblongata still retained the power of producing them all. This power had ceased to call forth the other three motions, only because it no longer had communication with their organs.

M. Flourens, in a recent memoir already referred to,[1] has confirmed and extended the views first announced by Legallois. He has distinctly traced the comparative action of the medulla spinalis and oblongata, on respiration, in the four classes of vertebrated animals. In birds, he found that all the lumbar and the posterior dorsal medulla might be destroyed without impeding the respiratory function, though it was arrested by removal of the costal medulla. In the mammalia the costal also might be removed, for though the raising of the ribs ceased, the action of the diaphragm continued as long as the origin of the phrenic nerve remained uninjured. In frogs, all the spinal medulla may be destroyed, except the portion, whence spring the nerves supplying the hyoideal apparatus. Every part of the spinal marrow may be removed in fishes without affecting respiration; for all the nerves distributed to the respiratory organs of fishes have their origin in the medulla oblongata. It is hence apparent that the spinal marrow exercises only a variable and relative action on the respiratory function, in the different classes of vertebrated animals. In descending from the higher to the lower points of this scale, the spinal marrow is seen progressively to disengage itself from co-operation in these movements, while the medulla oblongata tends more and more to concentrate them in itself, till in fishes the proper functions of the two medullæ show themselves completely distinct, the spinal ministering to locomotion and sensation, and the oblongata to respiration. The medulla oblongata is then the "premier moteur," or the exciting and regulating principle of the inspiratory movements in all classes of vertebrated animals; besides participating, by virtue of its continuity with the spinal marrow, in the proper functions of that organ. From a second series of experiments, M. Flourens concludes, that there exists a point in the nervous centres at which the section of those centres produces the sudden annihilation of all the inspiratory movements; and that this point corresponds with the origin of the eighth pair of nerves, commencing immediately above, and ending a little below that origin—a result precisely agreeing with that obtained by Legallois.

Spinal Marrow.—It is apparent that the functions of the three grand divisions of the nervous system, already described, have not yet been distinctly and fully ascertained. Our knowledge of those, which next fall under survey, is more definite and substantial. The vital offices of the spinal medulla—regarded by Legallois as the mainspring of life, and as alone regulating the actions of the heart

[1] Mémoires de l'Académie, tom. ix. 1830.

and nobler organs,—are now reduced to conveying to the muscles the motive impulse of volition, and to propagating to the sensorium commune, impressions made on the external senses. It is not invested with the power possessed by the cerebrum and cerebellum, and perhaps by the medulla oblongata, of spontaneously originating muscular motions. It is mainly, if not exclusively, a *conductor;* a medium of communication between the brain and the external instruments of locomotion and sensation. Flourens, indeed, conjectures that it also has the office of associating the partial contractions of individual muscles into "mouvemens d'ensemble," necessary to the regular motions of the limbs.

Before recording what is known of the spinal cord itself, it will be proper to advert to some recent experiments of Magendie, on the serous fluid in which it is immersed. It would appear that a quantity of liquid, varying from two to five ounces in the human subject, is always interposed between the arachnoid tunic and the pia mater, or proper membrane of the cord. The intermembranous bag, occupied by this fluid, communicates with the ventricular cavities at the calamus scriptorius by a round aperture, often large and patent in hydrocephalic subjects. Magendie has therefore named this serous liquid "cerebro-spinal." In living animals, it issues in a stream from a puncture of the arachnoid. Its removal occasions great nervous agitation, and symptoms resembling those of canine madness. The sudden increase of its quantity induces coma. Its presence seems essential to the undisturbed and natural exercise of the nervous functions; and this influence probably is dependent upon its pressure, temperature, and chemical constitution, since any variation of these conditions is followed by the phenomena of nervous disorder.

The great medullary cord is divided by a double furrow into two lateral halves: and each of these is again subdivided by the insertions of the ligamenta dentata into two columns, one posterior and one anterior. It has been long known that section of any part of the spinal marrow excludes from intercourse with the brain all those parts of the body, which derive their nerves from the cylinder of medulla *below* the point of injury. The muscles, so supplied, are no longer obedient to the control of the will, and the tegumentary membranes similarly situated entirely lose their sensibility. This interruption of the relations which subsist between the central seat of volition and sensation, and the rest of the body, whether due to direct injury of the great nervous masses or communicating nerves, or produced by the pressure of extravasated fluids, by morbid growths, or by various poisonous matters, constitutes the condition known by the name "paralysis." In cases of this kind it is frequently observed that the powers of sensation and locomotion are simultaneously impaired or destroyed. But examples are not wanting, even in the earliest clinical records, of the total loss of one of those faculties with perfect integrity of the other. Such facts naturally suggested the belief that the power of propagating sensations, and that of conveying motive impressions, resided in distinct portions of the nervous system. This opinion, however, remained mere matter of conjecture until a recent period, when it was unequivocally established by Sir Charles Bell. From the original experiments of that most distinguished physiologist, repeated and confirmed by Magendie, it follows that the faculty of conducting sensations resides exclusively in the two posterior columns of the medulla, while that of communicating to the muscular system the motive stimulus impressed by volition is the attribute of the two anterior columns. The same limitation of function is found in the nervous roots which spring from these separate columns. Thus each spinal nerve is furnished with a double series of roots, one set of which have their origin in the anterior medullary column, and one in the posterior. The spinal nerves are, in consequence of this anatomical composition, nerves of twofold function, containing in the same sheath distinct continuous filaments from both columns, and exercising, in the parts to which they are distributed, the double office of conductors of motion and sensation. It will afterwards appear, in our history of individual nerves, that all those which spring from the brain, except the fifth and eighth pairs, possess only a single function.

Sufficient experimental proof of the foregoing propositions has been furnished by Sir Charles Bell and by M. Magendie. Thus, division of the posterior roots of the spinal nerves is uniformly followed by total absence of feeling in the parts of the body to which the injured nerves are distributed, while their motive power remains undiminished. Magendie has further observed, that if the medullary canal be laid open, and the two posterior cords be touched or pricked slightly, there is instant expression of intense suffering; whereas, if the same or a greater amount of irritation be applied to the anterior columns, there are scarcely any signs of excited sensibility. The central parts of the medulla seem also nearly impassable.[1] They may be touched, and even lacerated, according to Magendie, without exciting pain, if precautions are taken to avoid the surrounding medullary substance. In general, the properties of the spinal marrow, and especially its sensibility, seem to reside mainly on its surface; for slight contact, even of the vascular membranes covering the posterior columns, caused acute pain.

The first experiment of Sir C. Bell consisted in laying open the spinal canal of a living rabbit, and dividing the posterior roots of the nerves that supply the lower limbs. The animal was able to crawl. In his second trial he first stunned the rabbit, and then exposed the spinal marrow. On irritating the posterior roots, no motion was induced in any part of the muscular frame; but on grasping the anterior roots, each touch of the forceps was followed by a corresponding contraction of the muscles supplied by the

[1] Annales de Chimie et de Physique, tom. xxiii. p. 436.

irritated nerve. Magendie has described[1] the following experiments, which he has since declared were made without any knowledge of the prior ones of Sir C. Bell. The subjects chosen for the operation were puppies about six weeks old, for in these it was easy to cut with a sharp scalpel through the vertebræ and to expose the medulla. In the first, the posterior roots of the lumbar and sacral nerves were divided, and the wound closed: violent pressure, and even pricking with a sharp instrument, awakened no sensation in the limb supplied by the nerves which had been cut; but the motive power was uninjured. A second and a third trial gave the same results. Magendie then divided in another animal, though with some difficulty, the anterior roots of the same nerves on one side. The hind limb became flaccid and entirely motionless, though it preserved its sensibility. Both the anterior and posterior roots were cut in the same subject with destruction of motion and sensation. In a second paper[2] Magendie has related the following additional facts. The introduction of nux vomica into the animal economy is well known to give rise to violent tetanic convulsions of the whole muscular system. This property was made available as a test of the functions of the separate orders of nervous roots. It was found that, while all the other muscles of the body were agitated, when under the influence of this poison, by violent spasmodic contractions, the limb, supplied by nerves whose anterior roots had been previously divided, remained supple and motionless. But when the posterior roots only had been cut, the tetanic spasms were universal. It would seem, however, that the seats of the two faculties of conducting motion and sensation are not strictly insulated by exact anatomical lines, but that they rather pass into each other with rapidly decreasing intensity. Thus irritation of the *anterior* roots, when connected with the medulla, gives birth, along with motive phenomena, to some evidences of sensibility; and, *vice versâ*, stimuli applied to the posterior roots, also undivided, occasion slight muscular contractions. In this last case it is, indeed, probable that the irritation travelled from the posterior roots upwards to the brain in the accustomed channel, and gave rise to a perception of pain, which prompted the muscular effort. Indeed, after division of the posterior nervous roots, ordinary stimulants, applied to the ends not connected with the medulla, produced no apparent effects; though the galvanic fluid directed upon either order of roots, gave rise to muscular contractions. These were more complete and energetic when the anterior roots were the subjects of the experiment.

Besides the evidence thus obtained by direct experiments on living animals, several important facts have been gathered from the pathology of the nervous system in man. These consist of cases of insulated paralysis of either motion or feeling, referred to the changes in structure observed after death. Sir Charles Bell has himself

[1] Journal de Physiologie, tom. ii. p. 276. August, 1822.
[2] Ibid, tom. ii. p. 366.

recorded several examples of this kind strongly confirming his experimental results; and others of similar tendency are scattered through the successive volumes of Magendie's Journal.[1] But it must be admitted, that evidence of this kind is seldom distinct and conclusive. The structural changes, induced by disease, are rarely so circumscribed in seat and extent as to represent adequately the operations of the scalpel; and often when they are thus isolated within anatomical bounding lines, they affect, by pressure, or by the spread of the same morbid process, in a degree too slight to leave decided traces, the functions of contiguous parts, thus clouding the judgments of the best pathologists, and invalidating their inferences. There is, however, a very remarkable case described by Professor Royer Collard, to which these objections do not apply. Sprévale, an invalided soldier, was upwards of seventeen years the subject of medical observation in the Maison de Santé of Charenton. This individual remained for the last seven years of his life with the legs and thighs permanently crossed, and totally incapable of *motion*, though retaining their sensibility. On opening after death the spinal canal, there was found the pultaceous softening (*ramollissement*) of the whole *anterior* part of the medulla, and of almost the whole of the fibrous cords which form it. The *anterior* roots of the spinal nerves had also lost their accustomed consistency; while the posterior surface of the spinal cord, and its investing membrane, were healthy. Several of the cases observed by Sir Charles Bell furnish also unequivocal proof of the soundness of the views developed by experiment.

There exist, indeed, few truths in physiology established on so wide and solid a basis of experimental research and pathological observation, as those deduced by Sir Charles Bell, the original discoverer, and by Magendie, his successor in the path of inquiry, respecting the offices of the spinal medulla. This organ may now be regarded as mainly, if not solely, a medium of intercourse between the external world and the brain, and again between the brain and the voluntary muscles, its two anterior columns being subservient to motion, its two posterior to sensation. In the present state of our knowledge, it would be fruitless to try to penetrate into the minute philosophy of these actions: but it seems probable, from recent discoveries on the ultimate anatomy of tissue, that these actions are molecular, having their place in the globular elements, into which all living textures are resolvable by microscopic analysis;—that the physical changes, *e. g.* impressed by external objects on the delicate net-work of nerve which invests the tegumentary membranes and open cavities, are propagated thence, from particle to particle, along the continuous filaments, to their origins in the posterior spinal columns, and thence to the central point, where they become objects of perception;—and that the motive

[1] See in particular Dr. Rullier's case, tom. iii. p. 173; and Dr. Koreff's, tom. iv. p. 376.

stimulus of volition is similarly transmitted down the anterior columns and nerves, to the organs of locomotion. Indeed, it is a legitimate inference from Sir Charles Bell's discoveries, that a simple nervous filament, or medullary column, can only propagate an impression in one line of direction, viz., either towards or from the central seat of perception and of will; and this curious law of nervous actions would seem to point at some insensible molecular *motion* as their essential condition.

It remains to investigate the arguments which have been supposed to prove the residence in the spinal marrow of the power of originating and controlling the actions of the heart. This question has been matter of eager controversy, from its bearing upon the general relations of nerve and muscle. Without prejudging this latter topic, it may simplify its future consideration, and will at the same time be more consistent with strict arrangement, to state here merely the facts which have reference to the spinal medulla.

The work of Legallois, entitled "Expériences sur le Principe de la Vie, notamment sur celui des Mouvemens du Cœur et sur le Siége de ce Principe,"[1] was the first remarkable essay on the relations between the heart and the spinal cord. It will, however, be sufficient to allude in general terms to the conclusions of Legallois, since they have been entirely subverted by the subsequent researches of Dr. Wilson Philip and M. Flourens. Legallois's main doctrine was, that the principle which animates each part of the body resides in that part of the spinal medulla whence its nerves have their origin; and that it is also from the spinal cord that the heart derives the principle of its life and its motion.[2] The experimental proof supposed to establish these propositions consisted in destroying in different rabbits portions of the cervical, dorsal and lumbar medulla. Cessation of the heart's action was affirmed to be the constant result of the operation; but even in some of Legallois's own experiments,[3] the motions of the heart continued after considerable injury had been inflicted on the spinal cord, and especially on its lower divisions. Still more unequivocal is the evidence that has been advanced by Dr. Wilson Philip, in his Inquiry into the Laws of the Vital Functions. His experiments, which were very numerous and judiciously varied, show that the circulation continues long after entire removal of the spinal marrow, and that by artificially maintaining respiration, the motions of the heart may be almost indefinitely prolonged. Flourens, in the 10th vol. of the Mém. de l'Académie,[4] has lately confirmed Dr. Philip's views: he has shown that the circulation is entirely independent of the spinal marrow. The influence apparently exerted is only secondary, being due to the suspension of the respiratory movements. Thus all those portions of the spinal marrow which can be destroyed in

[1] Œuvres de Legallos, tom. i. pp. 97, 99, &c.
[2] p. 259.
[3] pp. 100, 101, 105.
[4] p. 625.

the different classes of animals without arresting respiration, may be removed without affecting the circulation. In fishes and frogs the entire spinal cord may be destroyed without checking the heart's motions, because in these classes the medulla oblongata presides exclusively over the respiratory function.

Nerves.—The classification of nerves, which is most convenient to the physiologist, is based upon their vital properties or functions. Such an arrangement would distribute them into—1, nerves of motion; 2, nerves both of motion and sensation; 3, the nerves ministering to the senses of sight, smell and hearing; and 4, the ganglionic system, or, according to Bichat, nerves of organic life. Sir Charles Bell has added a fifth class, comprising nerves which he supposes are dedicated to the respiratory motions. But it will afterwards appear, that the existence of an exclusive system of respiratory nerves is not supported by sufficient evidence.

The first class of nerves exercising the single office of conveying motion comprehends the 3d, 4th, 6th, portio dura of the 7th, the 9th, and perhaps two divisions of the 8th, viz. the glossopharyngeal and spinal accessory. Mr. H. Mayo's experiments, detailed in his Anatomical and Physiological Commentaries, No. 11. (and Journal de Physique, tom. iii.) throw much light on the functions of several of these nerves. The motions of the iris, he shows, require the integrity of the third pair, division of these nerves being always followed by full dilatation of the pupils, which cease to be obedient to the stimulus of light. If the divided end of the nerve communicating with the eye be pinched by the forceps, the iris contracts. Hence it is apparent that diminution of the aperture of the pupil is the result of action, and dilatation of the pupil the result of relaxation, of the iris. Flourens has shown that complete extirpation of of the tubercula quadrigemina also paralyses the iris, and that irritation of those bodies excites its contractions. The same effect is noticed by Mayo to arise from division or irritation of the optic nerve. He divided the optic nerves within the cranium of a pigeon immediately after decapitation. When the end of the nerve connected with the ball of the eye was seized in the forceps, no action ensued; but when the end attached to the brain was irritated, the iris immediately contracted. These several experiments clearly indicate the dependence of the iris upon the optic nerve, upon the tubercula from which one root of that nerve springs, and upon the third pair. The stimulus of light impinges upon the retina, is conveyed along the optic nerve through the tubercle to the sensorium, whence the motive impression is propagated to the iris by the third encephalic nerve.

It is not so easy to define the precise mode of action of the pathetici, or fourth pair of nerves. Sir Charles Bell[1] supposes that they are destined "to provide for the insensible and instinctive rolling of the eyeball, and to associate this motion of the eyeball with

[1] Natural System of Nerves, p. 358.

the winking motions of the eyelids." He even conjectures that "the influence of the fourth nerve is, on certain occasions, to cause a relaxation of the muscle to which it goes." It is certain, however, from its exclusive distribution to the superior oblique muscle, that the fourth is a nerve of motion. The sixth nerve is also a nerve of voluntary motion, and is sent to the rectus externus of the eye-ball.

Sir Charles Bell has placed the portio dura of the seventh pair among his respiratory nerves. There is, however, no doubt that it is simply a motive nerve, and that it is indeed the only nerve of motion, which supplies all the muscles of the face, except those of the lower jaw and palate. Division of this nerve occasions no expression of pain, according to Bell; but Mayo's experience is opposed to this absence of sensibility.[1] "The motion of the nostril of the same side instantly ceased, after its section in an ass,[2] and that side of the face remained at rest and placid during the highest excitement of the other parts of the respiratory organs." These and similar observations are all consistent with the opinion, that the seventh is simply a nerve of voluntary motion. It will afterwards appear that it has no claim to any further endowment.

Mr. Herbert Mayo infers from his experiments, that the three divisions of the eighth pair are all nerves both of motion and sensation. Thus the glossopharyngeus is a nerve of motion to the pharynx, and perhaps of sensibility to the tongue. He observed that "on irritating the glossopharyngeal nerve in an animal recently killed, the muscular fibres about the pharynx acted, but not those of the tongue."[3] Irritation of the spinal accessory produced both muscular contractions and pain. The par vagum, he conceives, bestows sensibility on the membrane of the larynx, besides conveying the motive stimulus to its muscles. This nerve has been the subject of experiment from the earliest times, and Legallois has minutely described the results obtained by successive inquirers.[4] These were singularly discordant, and gave origin to the most opposite theories of the mode of action of the par vagum. In the greater number of experiments, section of this nerve was followed, after a longer or shorter interval, by death. Piccolhomini contended that the division of the nerve was fatal from its arresting the movements of the heart, and after him Willis supported the same doctrine. By Haller, on the contrary, the cause of death was sought in disturbance of the digestive functions. Bichat and Dupuytren seem to have been the first to obtain a glimpse of the true seat of injury. The former remarked that the respiration became very laborious after section of the nerve, and Dupuytren distinctly traced death to asphyxia. Legallois has established by numerous experi-

[1] See Mr. H. Mayo's Anatomical and Physiological Commentaries, Part I.; and Outlines of Human Physiology, 2d edit. p. 334.

[2] pp. 105, 107.

[3] Outlines of Human Physiology, 2d edit. p. 337.

[4] Œuvres, p. 154 et seq.

ments the accuracy of this last view. He has shown that in very young animals death is the immediate consequence of the operation of cutting either the par vagum or its recurrent branch, and that the suddenness of the effect is due to the narrowness of the aperture of the glottis in early age. In adult animals, the asphyxia is induced by the effusion of serous fluids and ropy discoloured mucus into the bronchial tubes and air-cells. More recently, Dr. Wilson Philip has practised the section of the par vagum with an especial reference to its influence upon digestion. He divided the nerve below the origin of the inferior laryngeal branch, as in this case the dyspnœa is much less considerable than when the wound is inflicted on the higher portion.[1] It was found, in all these trials, that food introduced into the stomach after the operation remained wholly undigested. Hence Dr. Philip infers the dependence of secretion upon nervous influence, a conclusion, it has been remarked by Dr. Alison, not logically deducible from the experimental data.[2]

The par vagum cannot then, it is obvious, be included in the class of nerves subservient solely to motion; and it is even doubtful whether the other two divisions of the eighth pair are not also endowed with sensibility. Respecting the function of the ninth, or lingual, there is, however, no place for hesitation. It has been experimentally proved by Mr. Mayo to supply the muscles of the tongue; though he also asserts, that pinching it with the forceps excited pain. Three of these nerves, the third, sixth, and ninth, arise, it was first remarked by Sir Charles Bell, from a tract of medullary matter continuous with the anterior column of the spinal marrow: and hence their exclusive office of conducting motive impressions.

II. There are thirty-two pairs of nerves of similar anatomical origin and composition, which possess the twofold office of communicating motion and sensation. Of these, all excepting one, (the fifth pair of the cerebral nerves,) spring from the spinal marrow. These thirty-one pairs are precisely analogous in formation, being all constituted of two distinct series of roots, one from the anterior column, and one from the posterior column of the spinal marrow. The posterior funiculi collected together form a ganglion, seated just before this root is joined by the anterior root. It has been already stated, that the power of propagating sensation resides in the posterior column, and in the nervous roots arising from it, and that the motive faculty has its seat in the anterior column and roots. The evidence, also, supplied by Bell and Magendie, that the spinal nerves are hence nerves of double office, has been fully detailed. It remains then to establish the title of the fifth pair of cerebral nerves to be included in the same class with the spinal nerves.

The analogy in structure and mode of origin between the fifth pair and the nerves of the spine, has been long matter of observa-

[1] Experimental Inquiry, 3d edit. p. 109.
[2] Dr. Alison, Journal of Science, vol. ix. p. 106.

tion. Prochaska has thus distinctly noticed it in a passage of his Essay De Structurâ Nervorum, published in 1779, first pointed out to me by my friend Dr. Holme: "Quare omnium cerebri nervorum, solum quintum par post ortum suum more nervorum spinalium, ganglion semilunare dictum, facere debet? sub quo peculiaris funiculorum fasciculus ad tertium quinti paris ramum, maxillarem inferiorem dictum, properat, insalutato ganglio semilunari, ad similitudinem radicum anteriorum nervorum spinalium?" Sömmering has also pointed out with equal clearness the resemblance in distribution between the smaller root of the fifth, and the anterior roots of the spinal nerves. But Sir Charles Bell was the first to establish the identity of their functions, and to arrange them prominently in the same natural division. His experiment consisted in exposing the fifth pair at its root, in an ass, the moment the animal was killed. "On irritating the nerve, the muscles of the jaw acted, and the jaw was closed with a snap. On dividing the root of the nerve in a living animal, the jaw fell relaxed." In another experiment, the superior maxillary branch of the fifth nerve was exposed. "Touching this nerve gave acute pain; . . . . . the side of the lip was observed to hang low, and it was dragged to the other side." Sir Charles Bell concluded, that the fifth nerve and its branches are endowed with the attributes of motion and sensation. This, though correct as regards the nerve itself, viewed as a whole, is strictly true only of the lowest of its three *divisions*, viz., the inferior maxillary. The ophthalmic and the superior maxillary, the subject of the last experiment, are nerves simply of sensation. Mr. Herbert Mayo, in the essay already referred to, has pointed out this error, and has defined with minute precision the relative offices of the fifth and seventh nerves. By a careful dissection of the fifth nerve, he found that the anterior branch, or smaller root, which goes, as Prochaska was aware, entirely to the inferior maxillary, is distributed exclusively to the circumflexus palati, the pterygoids, and temporal and masseter *muscles*. He observed that section of the supra and infra orbitar branches, and of the inferior maxillary, near the foramina, whence they emerge, induces loss of sensation in the corresponding parts of the face. It may then be regarded as fully proved, that the trigeminus or fifth pair is the nerve which bestows sensation on the face and its appendages, and motion only on the muscles connected with the lower jaw. The other muscles of the face derive their motive power from the portio dura of the seventh nerve.

M. Magendie has also published several memoirs on the functions of the fifth pair. In these he attempts to prove that the olfactory nerve is not the nerve of smell; that the optic is but partially the nerve of vision; and that the auditory is not the principal nerve of hearing. It is in the fifth pair that he supposes all these distinct and special endowments to reside. But the experimental proof will be found to be singularly inconclusive. The olfactory nerves were entirely destroyed in a dog. After the operation it continued sensible to strong odours, as of ammonia, acetic acid, or essential oil of lavender; and the introduction of a probe into the nasal cavity excited the same motions and pain as in an unmutilated dog. The fifth pair was then divided in several young animals, the olfactory being left entire. All signs of the perception of strongly odorous substances, as sneezing, rubbing the nose, or turning away the head, entirely disappeared. From these facts, Magendie infers that the seat of the sensations of smell is in the fifth, and not in the first pair of nerves. It is obvious that Magendie has confounded two modes of sensation, which are essentially distinct in their nature and in their organic seat, viz. the true perceptions of smell, and the common sensibility of the nasal passages. The phenomena, which he observed to cease after the section of the fifth nerve, are the results of simple irritation of the pituitary membrane, and are manifestly wholly unconnected with the sense of smelling, since they are producible by all powerful chemical agents, even though *inodorous*, as, for example, by sulphuric acid. No proof has been given that the true olfactory perceptions do not survive the destruction of the fifth pair. Indeed, in a subsequent paper, Magendie confesses that the loss of sensibility in a nasal membrane, after section of the fifth, does not prove the residence of the sense of smell in the branches of that nerve; but merely that the olfactory nerve requires, for its perfect action, the co-operation of the fifth pair, and that it possesses only a special sensibility to odorous particles.

There is even less ground for supposing that the fifth pair is in any degree subservient to the senses of sight and hearing. After cutting this nerve on one side, the flame of a torch was suddenly brought near the eye, without inducing contraction of the pupil; but the direct light of the sun caused the animal to close its eyelids. Thus the sensibility of the retina, though somewhat impaired, was not destroyed by division of the fifth pair. But section of the optic nerves was immediately followed by total blindness. In another rabbit, Magendie divided the fifth pair on one side, and the optic nerve on the other. The animal, he states, was completely deprived of sight, though the eye, in which the fifth pair only had been cut, remained susceptible to the action of the solar rays. No evidence, however, is offered to show that the animal was entirely blind: on the contrary, the only change observed, on approaching a torch to an *uninjured* eye, was contraction of the iris; and this we are told was actually observed in the eye of the side on which the fifth nerve had been divided.

Magendie has assigned another singular function to the fifth pair, viz., to preside over the nutrition of the eye. Twenty-four hours after section of this nerve, incipient opacity of the cornea was observed, which gradually increased till the cornea became as white as alabaster. There was also great vascularity of the conjunctiva extending to the iris, with secretion of pus, and formation of false membranes in the anterior chamber. About the eighth day, the cornea began to detach itself from the sclerotica, the centre ulcerated, and the humours of the eye finally escaped, leaving only a small tubercle in the orbit. In this experiment, the nerve had been divided in the temporal fossa, but when cut immediately after leaving the pons Varolii, the morbid changes were less marked, the movements of the globe of the eye were preserved, the inflammation was limited to the superior part of the eye, and the opacity occupied only a small segment of the circumference of the cornea. After division of the nerve near its origin in the medulla, no traces of disease were discoverable in the eye till the seventh day, and these symptoms never became very prominent. Several cases have been since recorded of structural disease of this nerve in the human subject, with the concomitant symptoms. That of Lainé, described by Serres in the 4th vol. of Magendie's *Journal*, furnishes strong support to the views of Magendie.[1]

A different explanation of this fact, and of others which have a tendency to refer secretion and nutrition to the control of the nervous system, has been proposed by Dr. Alison. Mucous surfaces are protected from the contact of air and foreign bodies by a copious secretion, which is evidently regulated in amount by their sensibility, since it is increased by any unusual irritation. This is especially true of the membrane of the eye. Now, section of the fifth pair is known to paralyse the sensibility of that organ, and the contact of air or other irritating body upon the *insensible* membrane, instead of inducing an augmented mucous discharge, will excite the inflammatory process described by Magendie. The disorder of the digestive function,[2] which followed division of the par vagum in the experiments of Dr. Wilson Philip, and the ulceration of the coats of the bladder after injury of the lower part of the spinal marrow, are attributed by Dr. Alison to the same cause.

The class of nerves which comprehends the fifth pair and the thirty-one pairs of spinal nerves, becomes, after the union of their roots, invested with a twofold endowment, and continues so throughout their entire course and final distribution to the muscular tissue. It would appear, indeed, from a later paper of Sir Charles Bell,[3] that nerves of sensation, as well as of motion, are necessary to the perfect action of the voluntary muscles. "Between the brain and the muscles there is a circle of nerves; one nerve conveys the influence from the brain to the muscle, another gives the sense of the condition of the muscle to the brain." In the case of the spinal nerves this circle of intercourse is at least probable; but proof of its necessity must be obtained, from observing the habitudes of those encephalic nerves, which minister exclusively to motion. Now it is found, on minute dissection, that the muscles of the eyeball, which are supplied by the third, fourth and sixth motive nerves, also receive sensitive filaments from the ophthalmic branch of the fifth; and that the muscles of the face, to which the portio dura is distributed, are also furnished with branches of sen-

[1] See also a case of destruction of the olfactory nerves, tom. v.
[2] Outlines of Physiology, p. 71.
[3] Philosophical Transactions, 1826, p. 163.

sation from the fifth. Sir Charles Bell has further shown that the muscles of the lower jaw, to which the motive impression is propagated by the muscular branch of the inferior maxillary, draw nervous supplies also from the ganglionic or sensitive branch of that division of the fifth pair. This complicated provision has its origin, he supposes, in its being "necessary to the governance of the muscular frame, that there should be consciousness of the state or degree of action of the muscles."

III. The olfactory, auditory and optic nerves are gifted with a special sensibility to the objects of the external senses, to which they respectively minister. Magendie seems to have been the first to prove, experimentally, that they do not also share the common or tractile sensibility. He exposed the olfactory nerves, and found that, like the hemispheres of the brain from which they spring, they are insensible to pressure, pricking, or even laceration. Strong ammonia was dropped upon them without eliciting any signs of feeling. The optic nerve, and its expansion on the retina, participate with the olfactory in this insensibility to stimulants. This was proved by Magendie in the human subject as well as in animals. In performing the operation of depressing the opaque lens, he repeatedly touched the retina in two different individuals without awakening the slightest sensation. The portio mollis, or acoustic nerve, was also touched, pressed, and even torn without causing pain.

IV. The functions of the ganglia, of the great sympathetic nerve, and its intricate plexuses and anastomotic connections, are matter, at present, of conjecture. Dr. Johnstone, in an essay on the Use of the Ganglions, published in 1771, has described a few inconclusive experiments on the cardiac nerves. He supposes that "ganglions are the instruments by which the motions of the heart and intestines are rendered uniformly involuntary,"—a notion which Sir Charles Bell has shown to be totally unsound. The best history of opinions, to which indeed our knowledge reduces itself, will be found in the physiological section of Lobstein's work, De Nervi Sympathetici Fabrica, Usu, et Morbis.[1]

In the earliest of his communications to the Royal Society, as well as in his last work on the Nervous System,[2] Sir Charles Bell has maintained the existence of a separate class of nerves, subservient to the regular and the associated actions of respiration. The origins of these nerves[3] "are in a line or series, and from a distinct column of the spinal marrow. Behind the corpus olivare, and anterior to that process, which descends from the cerebellum, called sometimes the corpus restiforme, a convex strip of medullary matter may be observed. From this tract of medullary matter, on the side of the medulla oblongata, arise, in succession from above

[1] Paris, 1823.
[2] 4to, 1830.
[3] The Nervous System of the Human Body, p. 129. 4to, 1830.

downwards, the portio dura of the seventh nerve, the glossopharyngeus nerve, the nerve of the par vagum, the nervus ad par vagum accessorius, and, as I imagine, the phrenic and the external respiratory nerves." The fourth pair is also received into the same class.

This doctrine of an exclusive system of respiratory nerves, associated in function by virtue of an anatomical relation of their roots, has not, as Sir Charles Bell seems himself aware,[1] received the concurrence of many intelligent physiologists of this country or of the continent. Mr. Herbert Mayo, in the admirable essay already referred to, was the first to point out the true relations of the fifth and seventh nerves. He has shown that the muscles of the face, excepting those already enumerated, which elevate the lower jaw, receive their motive nerves exclusively from the seventh, and consequently that this nerve must govern *all* their motions, voluntary as well as respiratory. But Dr. Alison, in his very elaborate paper[2] "On the Physiological Principle of Sympathy," has cast considerable doubts on the soundness of this part of Sir Charles Bell's arrangement, as respects not only the individual nerves thus classed together, but even the general principle on which the entire system rests. The reasoning of Dr. Alison consists, first, in referring the phenomena of natural and excited respiration to the comprehensive order of sympathetic actions. In these "the phenomenon observed is, that on an irritation or stimulus being applied to one part of the body, the voluntary muscles of another, and often distant part, are thrown into action." Now it has been long since fully established by Dr. Whytt, that these associations in function cannot be referred to any connections, either in *origin* on in course, of the nerves supplying remote organs so sympathising; and that a *sensation* is the necessary antecedent of the resulting muscular action. Thus it is known that these actions cease in the state of coma; are not excited when the mind is strongly impressed by any other sensation or thought; and that the same muscular contractions may be induced by the irritation of different parts of the body, provided the same sensation be excited. Dr. Alison has, however, failed to show[3] that the essential acts of inspiration, viz. the contractions of the diaphragm and intercostals, require the intervention of a sensation. Their continuance in the state of coma, as in the experiments of Legallois and Flourens after the entire removal of the brain, and their distinct reference by these two inquirers to the medulla oblongata, which has never been supposed to be the seat of sensation, prove them to be independent of the will and of perception. But this is true only of the essential, not of the associated respiratory phenomena.

[1] Op. cit., p. 115.

[2] Transactions of the Medico-chirurgical Society of Edinburgh, 1826, vol. ii. p. 165.

[3] P. 176 and note

Dr. Alison proceeds to show that there is equal reason for classing almost all nerves of the brain, and many more of the spinal nerves, with those exclusively named respiratory by Sir Charles Bell. Thus the lingual nerve governs an infinite number of motions strictly associated with respiration: the inferior maxillary "moves the muscles of the lower jaw in the action of sucking,—an action clearly instinctive when first performed by the infant, frequently repeated voluntarily during life, and always in connection with the act of respiration." Again, the sensitive branches of the fifth pair co-operate in the act of sneezing. But if these nerves be admitted into the system, the fundamental principle of that system, viz. origin in a line or series, is at once violated. Nor is this connection in origin more than matter of conjecture, as regards two of the most important of the nerves, classed by Sir Charles Bell himself as respiratory,—the phrenic and the external respiratory. These two nerves branch from the cervical or regular double-rooted series. Moreover, the circumstance of rising in linear succession is not found to associate nerves in function. "Between the roots of the phrenic nerve and those of the intercostals, there intervenes in the same series the origins of the three lowest cervical nerves, and the first dorsal, which go chiefly to the axillary plexus and to the arm, and which are not respiratory nerves."

In recapitulation, the following facts are among the most important that have been fully ascertained in the physiology of the nervous system.

1. One universal type has been followed in the formation of the nervous system in vertebrated animals. The brain of the human fœtus is gradually evolved in the successive months of uterine existence; and these stages of progressive developement strictly correspond with permanent states of the adult brain at inferior degrees of the animal scale.

2. These successive increments of cerebral matter are found to be accompanied by parallel advances in the manifestation of the higher instincts and of the mental faculties.

3. That the brain is the material organ of all intellectual states and operations, is proved by observation on comparative developement, as well as by experiments on living animals, and by the study of human pathology. But there does not exist any conclusive evidence for referring separate faculties, or moral affections, to distinct portions of brain.

4. Certain irregular movements are produced by injuries of the corpora striata, thalami optici, crura cerebelli, and semicircular canals of the internal ear.

5. The tubercula quadrigemina preside over the motions of the iris, and their integrity seems essential even to the functions of the retina. They are also, according to Flourens, the points at which irritation first begins to excite pain and muscular contractions.

6. The cerebellum appears to exercise some degree of control

over the instruments of locomotion; but the precise nature and amount of this influence cannot be distinctly defined.

7. The cerebrum, cerebellum and medulla oblongata possess the faculty of acting primordially, or spontaneously, without requiring foreign excitation. The spinal cord and the nerves are not endowed with spontaneity of action, and are therefore termed subordinate parts.

8. The medulla oblongata exercises the office of originating and regulating the motions essential to the act of respiration. By virtue of its continuity with the spinal marrow, it also participates in the functions of that division of nervous matter.

9. The function of the spinal cord is simply that of a *conductor* of motive impulses, from the brain to the nerves supplying the muscles, and of sensitive impressions from the surface of the body to the sensorium commune. These two vital offices reside in distinct portions of the spinal medulla,—the propagation of motion in its anterior columns, the transmission of sensations in its posterier columns. There is no necessary dependence of the motions of the heart, and the other involuntary muscles, on the spinal marrow.

10. The nerves are comprehended in the following classes:—I. Nerves simply of motion; II. Of motion and sensation; III. Of three of the senses; IV. The ganglionic system.

I. The nerves of motion are the third, fourth, sixth, portio dura of the seventh, and the ninth. It is not ascertained whether the glossopharyngeal and spinal accessory nerves belong to this or to the second class.

II. The function of ministering both to motion and sensation is possessed by the fifth pair of cerebral nerves, and by the spinal nerves, which agree precisely in anatomical composition. The par vagum, however, which is one of the irregular nerves, has also a twofold endowment.

III. This division comprises the first and second pairs, and the portio mollis of the seventh pair. These nerves are insensible to ordinary stimulants, and possess an exclusive sensibility to their respective objects,—viz. odorous matter, light, and aërial undulations.

IV. The system of the great sympathetic nerve, and its associated plexuses and ganglia.

SKETCH

OF

THE ORIGIN AND PROGRESS

OF

ASIATIC CHOLERA.

BY ROBERT J. GRAVES, M. D.[1]

While the art of navigation was in its infancy, and communication by land between distant countries unfrequent and insecure, the different races and families of mankind who dwell far asunder on the earth's surface, were necessarily unacquainted with the appearance of new, or the existence of remarkable diseases amongst each other, and consequently, that department of medical science which may with propriety be termed, the geography of diseases, remained uncultivated. Now, however, we approach a new era, when the means of intercourse between the most distant nations have been so facilitated by the aid of an improved system of navigation, a commerce almost universal, and the daily increasing efficiency of steam power, that we may indulge in the rational hope of seeing the sciences studied after a new method, which will embrace within the range of observation, not merely the phenomena occurring in a single district or country, but those which take place over the whole surface of the globe. Already have the enlightened efforts of our own university, and the genius of one of its professors, prompted the rulers of many kingdoms to join in an alliance destined to establish magnetic observatories in distant regions, so as to make the globe of the earth itself a subject of extended experiment; the philosophers of the new world have combined with those of the old to examine simultaneously meteorological phenomena, and already have the records preserved by observers at sea and land, revealed the hitherto mysterious course of storms, and enabled us to map out the extent and direction of the shocks of earthquakes. When we investigate the physical changes which occur on our planet, we are encouraged to repeat and multiply observations, in the hope of discovering general laws, whose application will enable

[1] Dublin Journal of Medical Science, Jan. 1840.

us to explain the past and predict the future. But the surface of the earth abounds with beings in whom the creative powers of life display an order of phenomena more complicated and refined than any thing existing in unorganised matter. But for this very reason, and on account of this superiority conferred on organised matter, through the agency of vitality, each being thus animated is governed by laws which seem incapable of extension even to other living creatures of the same species; and consequently we are led to expect an individuality, an insulation among animals, which will prevent them from exhibiting changes occurring simultaneously among great numbers, and capable of being traced to the operation of general laws. A closer examination, however, proves that animals and plants are subject to the operation of physical agencies, which act upon numbers of individuals at the same time, and thus give rise to great varieties of diseases. Such diseases should be made a special object of study; many of them are, as it were, fixed, stationary, and confined to certain countries and districts. Thus the goitres, the *tumidum sub Alpibus guttur*, has from the earliest times been endemic in the valley of the Rhone, and other parts of Switzerland; modern travellers have observed it in certain parts of South America, and in *Kemaon*, a subalpine department of Hindostan. Agues, typhus, yellow fever, elephantiasis, berri-berri, Guinea-worm, yaws, Egyptian ophthalmia, are chiefly confined to the inhabitants of certain districts, and with a host of other complaints, would afford ample materials for the geography of fixed diseases.

On the other hand, there are affections of men and animals which travel from nation to nation, and tribe to tribe; sometimes these moving epidemics progress with such rapidity, that they speedily migrate over the whole earth; at other times they creep along with a slow and stealthy step, but their journey is continued year after year, until they have travelled round the world. The Asiatic cholera affords an example of the latter class, having been twenty years in compassing the earth; while influenza, an example of the former, often traverses the same space in a few months. Thus, the epidemic influenza of 1830–32, existed in Australia, and was afterwards noticed in the northern hemisphere at Moscow, whence in eight months it extended to St. Petersburgh, Warsaw, Frankfort, Paris, London;[1] three months subsequently, it appeared in Italy, and shortly afterwards in Gibraltar. Now it is deserving of attention, that this influenza travelled from Moscow to London in eight months, and to the United States of America in seven months more, and allowing something for the inaccuracy of dates, these data give its rate across the Atlantic only a little speedier than across the continent. This forms, as we shall hereafter see, a striking contrast with the progress of cholera from Britain to Quebec, as compared with its march from Moscow to London, and is a fact of

[1] British and Foreign Medical Review, No. xiii. p. 105.

considerable weight in arguing whether cholera, like influenza, is propagated by atmospheric influences.

The influenza of 1833, travelled much more rapidly than that of 1832, for originating in the northeast, there was but a few days' interval between its appearance in Moscow, Odessa, Alexandria, and Paris!

Influenzas differ from each other, not merely as to their rate of travelling, but as to the extent of the earth's surface which they affect. Some, as that of 1782, spread from China all over the inhabited parts of Asia, Europe, and America; while others, as for instance the great influenza of 1837, did not reach the new world at all, although it passed the equinoctial line, and was severely felt at the Cape of Good Hope and Australia. These facts alone are sufficient to stimulate our curiosity, and ought to direct the attention of philosophers as well as physicians, to the study of endemic and epidemic diseases; nor will their study be destitute of practical benefit, for were the rulers of civilised nations to bring into active operation a number of institutions, which discharging the functions of *medical observatories*, should observe and record the appearance and symptoms of epidemics, many curious facts relating to their origin and progress would be soon brought to light, and we might then perhaps be enabled to arrive at a knowledge of some general laws respecting their motions. Thus we could ascertain whether, as has been asserted, influenza always progresses from east to west, never from west to east; whether originating on one side of the equator it often passes to the other. As the means of communication are now-a-days so rapid, it is quite possible to learn the character, and the best mode of treating an epidemic disease long before its arrival amongst ourselves; we knew, for instance, the symptoms and best method of treating the influenza of 1837, several weeks before we experienced its shock, and we had for many years been familiar with the symptoms of cholera before we actually witnessed its baneful effects. I have still by me a manuscript copy of a lecture I gave at the Meath Hospital in 1826; in that lecture I accurately described, from eastern authors, the symptoms of spasmodic cholera, and prepared the class for its future arrival in Great Britain,—a prediction not my own, but derived from that illustrious philosopher, and truly excellent man, Dr. Brinkley, then President of the Royal Irish Academy.

The origin and march of the spasmodic cholera will form the subject of the remarks which I now mean to lay before this meeting. In India, or more properly speaking, in Hindostan, the spasmodic cholera is not a new disease; partial epidemics of it have occurred at different times since that empire has been familiarly known to the English. These epidemics, however, being almost exclusively confined to the natives, comparatively circumscribed in extent, and limited in duration, did not attract much attention on the part of European writers.

"In 1762 it prevailed very extensively in upper Hindostan, destroying, according to Le Begue de Presle, thirty thousand negroes, and eight hundred Europeans. Dr. Paisley, in a letter from Madras in 1774, states that it was often epidemic, especially among the blacks. M. Sonnerat, in the account of his travels in India between the years 1774 and 1781, mentions that cholera prevailed on the Coromandel coast, and at one period more particularly, assumed an epidemic and malignant character. Curtis, in his work on the diseases of India, and Girdleston, in his essay on the Spasmodic Affections of that country, speak of an unusual prevalence of the disease during 1781 and 1782. It prevailed in the northern Circars in the early part of 1781, and in the latter end of March it affected at Gangam, a division of Bengal troops, consisting of five thousand men, who were proceeding under the command of Colonel Pearse, of the artillery, to join Sir Eyre Coote's army on the coast. Men, previously in perfect health, dropped down by dozens, and those even less severely affected, were generally dead, or past recovery, within less than an hour. Above five hundred were admitted into the hospital in one day, and in three days, more than half the army were affected.

"In April, 1783, it broke out at Hurdwar, on the Ganges, a spot held peculiarly sacred by the Hindoos, among a crowd of between one and two millions of persons, assembled for the purpose of ablution in the holy stream. It is the custom of the pilgrims to repair to the bed of the river, where they pass the night with little, if any shelter. Very soon after the commencement of the ceremonies, the cholera attacked the pilgrims, and in less than eight days, is supposed to have cut off twenty thousand of them. The disease was, however, on this occasion so confined in its influence, as not to reach the village of Jawalpore, only seven miles distant."[1]

In Europe no such disease as spasmodic cholera had been known; this assertion, though opposed to some authorities, may be considered as well founded, and indeed I have no doubt of its accuracy. With us spasmodic cholera is an imported disease; in Hindostan a resident endemic. What causes combined to convert a malady habitually confined to the Indian peninsula, into a disease which overshadowed the earth, sparing no nation or language, it would be useless to inquire; the subject is buried in profound obscurity: in the mean time let us hope that it will not prove a permanent addition to the nosology of every country, and that it will soon return within its former limits. It was in the spring of 1817, that the cholera of India assumed a new and more powerful character: it was then it became endowed with properties that rendered its extension steadily progressive over the earth, in spite of all the obstacles interposed by diversity of soil or climate. The disease first assumed the migratory and epidemic form in districts bordering on the Ganges, and some of its tributary rivers, at a distance varying from 80 to 150 miles from Calcutta. This took

[1] American Cholera Gazette, p. 3.

place in the spring and summer, but the date of its commencement is usually referred to the period of its outbreak at Jessore, on the 19th of August, 1817, where the epidemic was first medically observed and described by Dr. Tytler, who erroneously attributed it to the use of bad rice. Jessore is situated in the Gangetic Delta, about one hundred miles northeast of Calcutta. The cholera was now observed in general to follow the course of the rivers, and soon arrived at Calcutta, where it commenced its ravages in September, 1817, and continued to rage during nearly the whole of 1818.

"By the latter end of September, the disease was prevailing throughout the whole province of Bengal, from the most easterly limits of Purnea, Dinagepore and Silhet, to the extreme borders of Balasore and Cuttack; and from the mouth of the Ganges nearly to the confluence of that river with the Juhmna, a space of upwards of four hundred miles in length and breadth. In this area of several thousand miles, few places escaped the invasion, and the cities of Dacca and Patna, the towns of Balasore, Burrissaul, Rungpore, and Malda suffered severely. The large and populous city of Mooshedabad, which, from extent and local position, was apparently favourably circumstanced for the attacks of the epidemic, it is remarkable, escaped with comparatively little loss, whilst all around was severely scourged.

"During the autumn of 1817, the disease extended itself to Muzufferpore and beyond the precincts of Bengal, and appeared at Chuprah, and at the cantonment of Gazeepore; its attacks in these places were, however, confined to the towns themselves, or villages in their immediate vicinity; the principal portion of the adjoining country at this period, entirely escaping the disease. Early in November it attacked the grand army, then stationed at Bundlecund, a portion of the Allahabad province. This army had been assembled in anticipation of a war with the Pindarees, and the centre division, consisting of ten thousand fighting men, and eighty thousand camp followers, was encamped on the banks of the Sinde, under the immediate command of the Marquis of Hastings. Here the cholera exercised its most destructive power. It is uncertain whether it made its first approaches on the 6th, 7th, or 8th of the month. After creeping about, however, in its wonted insidious manner for several days among the camp followers, it seemed all at once to have gained vigour, and burst forth with irresistible violence in every direction, extending through the whole camp before the 14th of the month. Old and young, European and native, fighting men and camp followers, were alike subject to its attacks, and all equally sunk in a few hours under its pestilential influence. It was a common occurrence for sentries to be suddenly seized at their posts, and having been carried in, to have two or three successors before the two hours' duty was performed. Many of the sick died before reaching the hospitals; and even their comrades, whilst bearing them from out-posts to medical aid, sunk themselves suddenly seized with the disorder. The mortality at length became so great that there was neither time nor hands to carry off the bodies, which were thrown into the neighbouring ravines, or hastily committed to the earth on the spots where they expired, and even round the walls of the officers' tents. In the five days, included between the 15th and 20th of November, the number of deaths amounted to five thousand. The natives thinking their only safety lay in flight, deserted in great numbers; and the highways and fields for many miles round were strewed with the bodies of those who had left the camp with the disease upon them, and speedily sank under its exhausting influence. The camp being now cumbered with the sick, the Marquis of Hastings determined to seek a purer air for the recovery of his sick. Although every means was put in requisition for their removal, a part was necessarily left behind. 'And as many who left the carts, pressed by the sudden calls of the disease, were unable to rise again, and hundreds dropped down during every subsequent day's advance, and covered the roads with dead and dying, the ground of encampment, and line of march, presented the appearance of a field of battle, and of the track of an army retreating under every circumstance of discomfiture and distress.'[1] The exact mortality could not be ascertained, but it appears that of the fighting men seven hundred and sixty-four fell victims, and it was estimated that about eight thousand camp followers, or one tenth of the whole, were cut off. On arriving at the high and dry banks of the Betwah, at Erich, the army soon got rid of the pestilence and met with returning health.

"During December the disease appears to have every where abated, and in January of 1818, to have become nearly extinct. Towards the latter end of February it however revived with great force, and before the close of the year, the whole peninsula of India, from Silhet on the east to Bombay on the west, and from Deyrah on the north to Cape Comorin on the south, had suffered from its ravages."[2]

The ravages of the disease were much facilitated and increased by the superstition of the people, who, in obedience to the Brahmins, collected in prodigious multitudes on pilgrimages to certain favourite shrines, where they prayed for the cessation of what they were taught to believe the cause of the epidemic, viz. a violent and protracted battle between the god and goddess answerable for the tranquillity and happiness of that part of the world.

During the year 1818 the cholera pursued a threefold route. First, ascending the Ganges and the Juhmna, it reached the northern provinces of Hindostan, but was there checked in its progress for several years by the Nepaulese mountains, and finally entirely arrested by the Himalaya range. This is easily accounted for by the thinness of the population in these situations, and the little intercourse which takes place between the mountainous dis-

[1] Bengal Report, pp. 12-15. [2] American Cholera Gazette, p. 19.

tricts and the lower regions. Cholera did not in India attain to an elevation beyond six thousand feet above the level of the sea; in June, 1818, it had reached the range of mountains between Nepaul and Hindostan; it was at *Schaurapoor*, many hundred miles to the northwest, in October; and before the end of the year had ravaged nearly all the numerous cities and villages situated in the vast tract of country watered by the Ganges, the Juhmna, and their tributaries. This was one of the most thickly inhabited parts of India, and the destruction of life was awful.

The second route was southward along the coast from one seaport to another, until it reached Madras on the 24th of October, 1818. Here, at the very onset of the disease, twenty medical men were attacked, of whom thirteen died.

Sadras, Pondicherry, and the whole Carnatic, were affected during the succeeding year; but even in December, 1818, it had reached Jaffnapatam, the most northern town of Ceylon, having passed thither after travelling along the whole coast of Coromandel. On the 10th of January, 1819, it broke out in Colombo, and produced dreadful devastation on the western coast of Ceylon; the disease became exhausted there, but at the same moment burst forth with renewed vigour in Candi, the capital, 2500 feet above the level of the sea. The cholera did not arrive at the east coast of Ceylon until 1820, when it appeared imported, as was said, into Trinkamalay by the flag-ship Leander. The epidemic was brought to the western coast of the Indian peninsula, partly by sea round Cape Comorin, and partly by the great over-land lines of communication which connect the presidency of Bombay with the presidencies of Madras and Bengal.

It first showed itself at Bombay on the 9th of August, 1820, and in that presidency carried off 150,000 persons.

The third route of cholera in India I have already referred to, it was across the peninsula from the east coast to the west; it came by Nagpoor, Ellishpoor, Aurungabad, Siroor, and Poonah, to the Bombay coast, and was introduced either by troops or travellers.

From Ceylon the disease went to the Mauritius, and the Isle of France; whither it was said to have been imported on the 29th of October, 1819. The distance thus traversed at one spring was three thousand miles. Thence it soon passed to the Isle of Bourbon; and in the year 1820 to the east coast of Africa at Zanguebar. It is remarkable that it never reached the Cape of Good Hope, where the strictest quarantine was observed.

The following are the dates of its arrival in the subjoined places:—

Burmese empire generally; Aracan, Ava, 1819.
Malacca, 1818.
Sumatra, 1819.
Java, Batavia, (fearful,) 1821.
Madura; Macassar; after Batavia.
Amboina, in Moluccas, 1823.

Amboina was the farthest south-easterly point it attained to.

The disease visited Borneo and Celebes; and in 1820 broke out with extraordinary violence in the Philippine Islands, principally at Manilla, where the natives, misled by the idea that they were the victims of poison administered by the Europeans and Chinese, rose *en masse*, and were not put down until 15,000 lives had been sacrificed in the contest. Similar manifestations of feeling led to some loss of life even in Petersburgh and Paris, when cholera reached those cities. The same suspicions agitated the inhabitants of Europe during the ravages of the black death in the fourteenth century, when the Jews were slain in great numbers as authors of the plague. In Great Britain I am not aware that any such insane popular ideas were manifested when cholera appeared. In Ireland nothing of the sort was displayed; and barbarous, cruel, and uneducated, as we are said to be, the visitation was in no country met with greater intrepidity and resignation, than in our native land. When a city or town was attacked in Ireland, we never witnessed the flight of the better classes; there was neither migration into the country, nor desertion of their poorer fellow-citizens. No; I record the fact with pride, every one remained, every one was ready to do his duty and abide in his place until the plague was stayed. In Dublin, and generally throughout Ireland, the members of the medical profession, and the public at large, believed the malady to be contagious, and yet the sick were never abandoned by their friends in private houses, nor in the least neglected in the hospitals.

In 1819 the cholera appeared in Siam, Bankok, Tonkin, Cochinchina, and caused immense loss of life in Cambodia. In 1820 it arrived at Macao, and was said to have been imported by some ships; thence it travelled to Canton in China, and coming to Nanking in 1820, penetrated as far as Peking in 1821. In China the disease proved particularly fatal on account of the denseness of the population of the Celestial Empire.

So far we have followed the cholera chiefly southward and eastward in the first instance, but afterwards far to the north; in this part of its course it passed 10° to the south of the line, and then resuming a northerly direction, went on to Peking, in latitude 40° north. Even this portion of its progress leads forcibly to the conclusion, that it followed the track of commerce, whether by land or sea, and was not dependent for propagation on mere local influences, or climate. *There is a popular idea current, that its course was westward; such was the case in Europe, but in most of Asia it was eastward.*

I have already said that the Himalaya range opposed the progress of the disease northward from Hindostan, and that the highest altitude it attained to was six thousand feet. W[illegible] respect to this latter point, I learn f[illegible] [illegible]om my friend Captain Meredith of the 13th regiment, and who has just returned from India, that it broke out in the medical depot at Landour in 1838, for the first time, at a height of eight thousand feet above the level of the sea. It is worthy of remark that cholera did not come to New Holland, although it was in several islands, as Borneo, and Celebes, to the north of Australia; but it is to be noted that there is little or no communication between them and the settled portions of New Holland.

Let us now trace its progress westward from Hindostan. The general belief in Persia is, that the disease was brought in ships from Bombay to Mascate, Bender-abassi and Bassorah, in which places it appeared nearly at the same period, in spring, 1821.

From Bassorah and Bender-abassi, the epidemic spread in a well-defined and marked manner, along the rivers and routes most frequented by commercial travellers.

Thus from Bassorah it crept up the Euphrates and Tigris; and in August, 1821, was at Bagdad, where it carried off great numbers of the Persian army then besieging that city. Along the Euphrates it proceeded to the ruins of Babylon, and by the great route of the caravans across the desert, it arrived at Aleppo. Here it did not commit great ravages, and ceased in the following December; but afterwards extended to different towns in Asia Minor, as Mosul, Merdin, Darbeker. At Alexandretta, situated on the Gulf of Scanderoon, it did not arrive until 1823. It is strange that cholera did not continue very long in Asia Minor or Syria, and did not at that period penetrate into Egypt.

From Bender-abassi in Persia, cholera travelled along the great mercantile road to Shiras in August, 1821; and thence to Yezd, where it appeared towards the end of September, but on the approach of winter lay dormant until spring, 1822, when it again showed itself, and spread north-westward, committing the greatest ravages in every town and village situated on the great caravan road. Tauris, Korbia, Ardabil, and the provinces of Kalkhai, Masinderan, and Gilan, (on the Caspian,) were soon infected. In most of these places it seemed to cease for a time, but reappeared in the middle of 1823; and travelling along the Persian seaports of the Caspian, it reached the province of Shirwan, then lately ceded to Russia. Here it ascended the river Cur, and progressed along the high roads to the fortress Baku; and on the 21st September, 1823, Astrachan was attacked. In June, 1823, cholera showed itself in the neighbourhood of Laodicea and Antioch, (modern names,) and then spread in two directions along the coast of the Mediterranean, but disappeared again both there and on the coast of the Caspian Sea.

On the whole, then, the epidemic, from its commencement in 1817 till the end of 1823, had travelled over ninety degrees of longitude, and sixty-six degrees of latitude, viz. from the Philippine Islands to the coast of Asia Minor, and from the island of Bourbon to Astrachan, and to the Caspian Sea.

It is very remarkable that cholera did not come to Europe by way of Asia Minor; this circumstance may perhaps be explained by the accident of its not having infected Smyrna, the chief seaport of communication between Asia Minor and Europe. Had Egypt likewise been then attacked by cholera, it is doubtful whether Europe would have been so long spared. Be this as it may, from the end of 1823, until its out-break at Orenburgh in 1829, cholera seemed to halt on the very confines of Europe, so that we may consider the years from 1817 to 1823 as constituting the first period in the progress of this epidemic.

But although the cholera ceased to attract much attention in Europe during the interval which elapsed between 1823 and 1829, yet we are not on that account to conclude that it lay entirely dormant, for we find it continued its ravages in its original seat, India, and extended itself from Asia Minor, Persia, and China, through the vast regions of Tartary and Chinese Tartary.

The thinness of the population in these half desert regions, may be the reason why the progress of the disease through them was at once so uncertain and so slow; the want of frequent communication between even neighbouring districts, may have baffled for a time the march of the pestilence, and may have occasioned its remarkably slow progress towards the Russian frontier. Certain it is that this march in Persia, Tartary, Mongolia, and Thibet, countries absolutely destitute of regular roads, formed a striking contrast with its rapid transmission through more populous and highly cultivated countries, or its still quicker passage from one maritime nation to another, when connected by a constant trade, as from Germany to England, from England to Canada, and from the East Indies to the Isle of France. In the latter cases the epidemic sprung from one country to another; *but it is remarkable that it never traversed the ocean at a rate exceeding that of ships.*

We next come to the second period of the history of cholera, when it broke out at Orenburgh, in August, 1829, where it raged with great violence, spreading throughout the whole of that Russian province; while the disease, after long lingering in the north of Persia, assumed, in 1829, an increased energy in that kingdom, from whose northern portions it spread along the western coast of the Caspian, arriving at Salian, and the province Shirwan in June, 1830; and thus spreading to Baku, Kuba, and Sheki, in Chomath Talisch, and in the district Elizabethpol. From this the epidemic pursued a twofold route; the one following the Kura, upwards, led to Tiflis, where the mortality reached five thousand; and thence to the provinces between the Black Sea and the Caspian, until it a second time came to Astrachan, and proved much more fatal in that city than in 1823, now counting more than eight thousand victims.

From Astrachan the progress of the cholera up the Wolga or Volga was very remarkable, as it spread from town to town on that river, in the direct route of intercourse and traffic. I here may remark, that whenever cholera travels up the highest mountain passes, as in India, or traverses the ocean, as to the Isle of Bourbon, or accompanies the caravan across the desert, as when it arrived at Mecca and Medina, or when it ascends rivers, making the towns on its banks the successive stages of its journey; in all such cases, cholera, I say, seems regulated by no common physical circumstances, except human traffic and human intercourse; for in other things these lines or routes differ remarkably from each other. But to follow its ascent of the Volga: in 1830, in August, it came to Saratow, and shortly after to Kasan, Nischnei Nivogrood, Kostroma, Jarislaw, and so on to the circle Tischwin, in the government Nowgorod, where it was only 250 versts distant from Petersburgh, and where it attained for that year to its highest northern limit.

From the country between the Caspian and Black Sea, it spread through the Caucasus to the Don, which it ascended, while it coasted the Black Sea to Cherson and Odessa, in September and October, 1830.

The stream of cholera which entered Russia from the northern provinces of Persia, as it may be seen from the foregoing account, soon formed a junction with that which flowed from Tartary through Orenburgh.

In the middle of September, 1830, the disease appeared in the government of Moscow; and on the 20th of September in the capital itself, and did not cease until the end of the following March. In Moscow a severe frost and snow set in towards the end of November, without in the least diminishing the diffusion or the intensity of cholera. Its unabated continuance throughout the whole of a Moscow winter, is a fact worthy of attention; in Moscow, according to Jahnichen, there sickened between thirty and forty per cent. of the persons who had hospital duty to perform, including physicians, nurses, &c., while of the whole population not more than three per cent. took the disease. In Dublin likewise great numbers of the hospital attendants were affected and many died; still more were saved by the timely exhibition of remedies. It is not quite correct to affirm that cholera ceased in Moscow in March, for in the autumn of 1831 more than one thousand cases occurred.

During the winter and spring, 1830–31, cholera spread far to the west and south, viz. to Kaluza, Talu, Pultawa, Kiew, Podolia, Bessarabia, Bulgaria, and Silistria, and through the river provinces of the Dnieper, the Bug, and the Dniester.

In the more northerly and eastern governments, the disease had ceased, while it continued, though in a milder form, in the provinces Nicolajaw, Crakow, Tauris, and among the Cossacks of the Black Sea. Petersburgh a second time remained untouched, although the disease had arrived at Tishwin, within one hundred miles of it, an immunity to be attributed to the strict precautionary measures adopted, and the *cordon sanitaire* drawn around the capital for the protection of its inhabitants, but not of its emperor, Nicholas, who, it is but just to add, had gone to Moscow the moment he had ascertained the existence of cholera in that city, in order to exert himself in alleviating the sufferings of his subjects. The fear of infection proved no obstacle to the Czar, who zealously performed his duty on that trying occasion. The following facts relative to Russia are taken from Dr. Simpson's *brochure*.

" *Pensa.*—From the accounts of the progress of the cholera in Russia, where the disease was so accurately observed, we shall subjoin only two cases, the first of them containing the history of the introduction of the malady into a village, in the government of Pensa, as detailed by Sir William Russell, (on what he considers to be sufficiently credible authority,) in one of his letters from St. Petersburgh :—[See Edinburgh Medical and Surgical Journal for February 1832, Supplemental Number, pages 173-4.] The son of an inhabitant of the village, who was coachman to a nobleman, at fifty versts distance, died of cholera. The father went to the place to collect the effects of the son, and brought home with him his clothes, which he put on and wore for a day or two after his arrival in his native village. He was shortly after seized with cholera and died of it. Three women who had watched him in sickness, and washed his body after death, were also seized, and died of the disease. The common street of the village was then barricaded on that side which the disease had not reached, and all intercourse interdicted with the infected side. In that side of the village where the disease first broke out, upwards of 100 cases of cholera occurred, and of these 45 died, while on the other side which had been barricaded, no case was observed."

" *Iletsk.*—We select the following case from the official Russian reports, as affording a remarkable instance of the transportation of cholera by exposed and infected individuals over a wide tract of country to a distant locality, while all the intervening district remained for the time totally unaffected. In the fortress of Iletsk, in the government of Orenburgh, the first cases of cholera, which were observed on the 2d of October, occurred in a soldier and a woman, who were taken ill of the disease while returning together from the city of Orenburgh, (forty-two miles distant,) in which the cholera was at that time raging. The intermediate line of country between Orenburgh and Iletsk was still unaffected. The soldier and woman, before leaving Orenburgh, had been in company with a man affected with cholera, and they both died of the disease on the day after their arrival at Iletsk. The malady soon spread to other persons in the garrison, and Dr. Schimanski, the staff-physician, traced out very distinctly the progress of the disease, throughout the first eight cases. The two first victims, the woman and soldier, contracted, as I have just stated, the disease in Orenburgh. The husband of the woman was seized three days after her ; about the same time two girls, who lived in the immediate neighbourhood of her male travelling companion and fellow victim, and who had visited him soon after his arrival at Iletsk, were attacked. The aunt of these two girls, who nursed them, next suffered ; and from her it spread to her two sons. The disease subsequently became diffused with such rapidity, that in the course of twenty days 113 persons had been attacked."—[Edinburgh Medical Journal, l. c. p. 49.]

"In the official medical report upon the cholera, in the government of Orenburgh, which mentions the above case of Iletsk, it is stated, that in the same province alone *eight* similar instances had been ascertained judicially, and by physicians who were attending the course of the epidemic, in all of which a person, who had contracted a tendency to the disease, in a place where it prevailed, arrived in an uninfected locality, and there sickened, and communicated a morbific condition to the atmosphere of his new residence."

"*St. Petersburgh.*—When the cholera invaded St. Petersburgh in 1831, the city prison, containing about 400 inmates, remained perfectly free of the disease until the 23d of June, O. S. when a prisoner who had been sent out some weeks before to a public hospital to be treated for a syphilitic complaint, was returned back to the jail *with a diarrhœa upon her*. She saw and embraced her husband for a moment as she passed to the room of observation. In a few hours her symptoms became those of true cholera, and she died that night, forming the first case of the disease in the prison. The next persons attacked in the prison were three women placed in the same room with the first, and one of whom had rubbed the deceased. These three all died within three days after the first. The husband of No 1 became next affected. He lived in a separate part of the jail. After this man, others in his room took the disease; and it extended itself ultimately to 27 of the inmates of the prison, in all, 15 of whom died; and Drs. Russell and Barry, who have reported the case on the authority of Dr. Bish, the resident physician, state that there was but one out of these 27, to whom contagion could not at the time be traced. None of the noble class, who were lodged in a separate part of the building, were attacked.—See Edinburgh Journal for February, 1832, p. 175."

The war in Poland accelerated the invasion of cholera into that unhappy country, into which the Russian army commenced its march on the 5th of February, 1831, in three columns, of which many battalions came from infected provinces. Thus the governments of Volhynia, Grodno, and Wilna, were extensively under the influence of disease in the spring of 1831; during this campaign the Russian army lost great numbers by cholera, and Marshal Diebitch himself died at Pultusk, on the 10th of June, 1831, of a few hours' illness, a circumstance which gave rise to the unfounded rumour that he was poisoned; the details of his illness have been published by an eye-witness, Dr. Koch, of the Prussian service. In Warsaw, the disease appeared on the 14th of April, after the battle of Iganie, where the Poles took many prisoners, who were brought to Warsaw. In Poland the disease advanced and retreated with the infected armies in a striking and remarkable manner. Westwards and southwards from Warsaw, it spread rather slowly towards the Prussian confines, arriving on the 23d July at Koziegłow, a little town nine miles south of Czenstochowa, and but two German miles from the frontier of Silesia.

Northwards the disease had spread in March and April through Lithuania to the seaports of the Baltic, particularly Riga. From Riga the cholera advanced through Courland and Liefland (Livonia).

Petersburgh was now threatened on every side, for the disease broke out with renewed violence in the European provinces formerly affected, while most of those which had hitherto escaped suffered in their turn. Under these circumstances the metropolis, considering the great quantity of goods and passengers who arrive by water carriage from the interior of the country, could not be expected to remain long exempted, although all possible precautions, short of entirely preventing communication with the country, were adopted; accordingly cholera appeared in Petersburgh in July, 1831. Very serious disturbances arose in the Russian metropolis among the lower orders, who considered the pestilence as artificially produced for their destruction by secret friends of struggling Poland. These troubles were only appeased by the presence of the emperor, but not before the mob had destroyed the cholera hospital, and murdered one of the physicians. During this epidemic seventeen medical men died in Petersburgh, and a great many others were attacked, some slightly, some severely. The hospital nurses, porters, and attendants, suffered in a very large proportion, as did a great number of the mob engaged in sacking the cholera hospitals. Cholera had already invaded several of the most northern provinces of Russia, and had arrived at Archangel in May, 1831. Archangel is the most northern emporium of commerce in the world, and is the highest latitude attained to by cholera, which in a population of 19,000 destroyed more than 1200. In the beginning of August cholera arrived at Helsingfor; and of September, at Abo in Finland. After this Aland and the neighbouring islands were affected, and so it passed into Sweden. Danzig, 30th May, 1831; Elbing, 11th July; consequently eleven weeks after its appearance in Danzig; but there was an interruption, or rather a great diminution of the intercourse between these towns. From Danzig the disease radiated in every direction throughout the neighbouring provinces. Thorn, 21st July, 1831; Konitz, 22d August; Memel, 27th July; Königsburgh, 22d July. Here a formidable cholera insurrection took place. Stettin, 25th August, 1831; Berlin, 30th August; Frankfort on Oder, end of September; Magdeburgh, 3d October.

From Magdeburgh the disease spread extensively upwards, along the course of the Elbe. Halle, 20th December, 1831; Merseburg, 1st January, 1832; Breslau, 23d September, 1831. In the first months of 1832, cholera had nearly disappeared from the German provinces of Prussia. Deaths 31,000. Hamburgh, 7th

October, 1831. Mecklenburg-Schwerin took most extraordinary precautions, and escaped.

Saxony, though Prussia and Austria on either side of it were severely visited, adopted strict measures of precaution, and escaped; the cholera was neither at Leipzig nor Dresden! Hanover also escaped, with the exception of Lüneburg, 22d October, 1831. Sachsen-Weimar, Gotha, Anhalt, Hessia, Brunswick, and some other small principalities, all escaped, and apparently by the same means, viz. non-intercourse with infected places.

In some Saxon villages, as Cosing and Edderitz, the disease broke out but did not spread, apparently in consequence of the measures of precaution instantly put in force by the authorities.

Austria suffered most severely; Brody, (Gallicia), 5th May, 1831; Limberg, 22d May; all over Gallicia in 1831. Died 97,770.

Cracow seems to have been infected, not from Poland, but from Gallicia.

Beginning of July, 1831, cholera began in Hungary. In beginning of June, 1831, much popular violence. Spread very rapidly. Pesth, middle of July; Presburg, 9th September, 1831.

In Hungary cholera had ceased as an epidemic by the beginning of April, 1832, having proved fatal to at least 240,000 persons! Vienna, 15th August, 1831; Prague, 28th November, 1831.

Bohemia was widely affected; but the disease did not spread from Vienna far either to the south or west, and accordingly Carinthia, Stiermark, and the Tyrol escaped, all being protected by the strictest precautionary measures.

It is worthy of being noted, that cholera remained, as it were, stationary and in a suppressed form during the winter of 1831–32, in Hungary, Bohemia, and Germany. It did not spread into Saxony, Mecklenburg, Bavaria, and scarcely into Hanover, although these bordered on infected states, an immunity not to be accounted for by the existence of any natural boundaries, as mountains or rivers, for the limits are mostly conventional between the infected principalities and those which escaped; many have therefore attributed their escape to the precautionary measures taken. It is strange that Leipsig was spared, while Halle suffered so long and so severely; the situation of the former city appearing to be much more favourable to the developement of *miasma* than that of the latter.

Moldavia, spring, 1831. In Jassy the deaths exceeded 6000, out of a population of 27,000. The disease began in June; and no doubt its diffusion was favoured by the unhealthy position of the town, and the condensation of a wretched population, chiefly Jews and Gipsies, in its filthy narrow streets. All the medical men, except three, perished, with most of their families. Bucharest, July, 1831; Bulgaria, July, 1831; Constantinople, July, 1831; Adrianople, Gallipoli, Philippopili, Sept. 1831.

It is to be noted that plague broke out in Constantinople at the same time with cholera; but while the latter epidemic ceased towards the end of September, the former continued for several months longer. Cholera now a second time invaded Asia Minor, and simultaneously with plague caused great devastations. Corfu, October, 1831; Monastori, in Greece, November, 1831.

The destruction of religious pilgrims at Mecca was appalling. The place resembled a field of battle, so great were the numbers of the unburied dead; and at last even the fanaticism of Mussulmen was forced to yield, and the survivors sought safety in a hasty and tumultuous flight. Three fourths of the pilgrims are calculated to have perished during the three days they were densely crowded together at Mecca; and of the fugitives 10,000 fell victims on their journey. The Pasha of Egypt now repeated the precautions so successful in 1823, but this time they were taken in vain, because, as is supposed by many, they were not resorted to sufficiently soon; be this as it may, cholera broke out first at the two quarantine stations, where the pilgrims from Arabia were detained; and in the middle of August, 1831, it appeared in Cairo and Damietta, and towards the end of the month in Alexandria. Egypt lost on the whole 150,000. The cholera ascended the Nile, and was at Luxor, the site of ancient Thebes, by the end of September.

We next find the cholera visiting England, it arriving about the 4th of November at Sunderland, a seaport directly opposite to, and commercially connected with Hamburgh. The cholera spread to many towns in the north of England, but did not any where rage with very destructive violence, a circumstance attributable perhaps to the more complete separation of families in Great Britain, as compared with our continental neighbours. The existence of the disease was announced on the 27th of January, 1832, in Edinburgh, and on the 10th of February in London.[1] The ravages of the cholera in the metropolis were comparatively insignificant, its victims during the whole epidemic not exceeding 1500.

The following very interesting facts connected with the progress of cholera in Scotland, are taken from a highly important *brochure* by my friend, Dr. James Y. Simpson, of Edinburgh, on the Evidence of the occasional contagious Nature of Cholera.

"*Edinburgh.*—Before cholera reached Edinburgh, it raged for some time previously in a severe degree in the district of country lying to the east of the city, as in Haddington, Tranent, Prestonpans, &c., and particularly in the town of Musselburgh, six miles distant. The first cases of the disease which were observed in Edinburgh occurred towards the latter end of January, 1832, and were all in the persons of individuals who had been visiting some of the places to the eastward where the cholera was prevailing, and who had consequently been directly exposed to the morbific cause

[1] The progress of cholera in Great Britain will be found accurately traced in the annexed map.

or causes of the malady (whatever we allow these to be) which were operating in these infected localities. The second case (27th January) afforded an instructive example of the great difficulty which is often experienced in endeavouring to arrive at the truth in such investigations as the present. The subject of the case, an Irish woman, residing in a close off the West Bow, was taken to one of the cholera hospitals, and was for some time conceived to afford the strongest possible evidence against the doctrine of contagion, for she stoutly denied having been out of Edinburgh. During the period of her convalescence, however, she voluntarily mentioned to Dr. Ransford, then clerk to the hospital, that she had been some days previously singing in the streets of Haddington, Tranent, and Musselburgh, and had slept in Prestonpans in the bed of a cholera patient; and she stated that she had been before deterred from making this confession, under the dread that she would be punished for bringing the disease into the town.

"None of the three first cases of importation of cholera into the city proved effectual in propagating it to any of the resident inhabitants; and no instance of a person being attacked with the malady, who had not been in the infected eastern districts, occurred until Saturday, the 28th of January, when a woman, widow Mac Millan, died of it in Skinner's Close, High-street, after nursing her grandson, who was previously ill of the disease, and had been exposed to its contagion by residing in a house in Musselburgh, in which several fatal cases took place. Professor Alison has been so kind as to draw up for me the history of these two cases, in as far as they bear upon the question of imported contagion; and I shall here give the communication with which he has favoured me in his own words, and with his own excellent prefatory remarks and comments.

"'It seems to me clear,' he observes, 'that the evidence of the contagious nature of any disease turns ultimately on a calculation of chances. The question always comes to this,—Is the circumstance of intercourse with the sick followed by the appearance of the disease, in a proportion of cases so much greater than any other circumstance common to any portion of the inhabitants of the place under observation, as to make it inconceivable that the succession of cases occurring in persons having that intercourse should have been the result of chance. If so, the inference is unavoidable, that that intercourse must have acted as a cause of the disease. All observations which do not bear strictly on that point are irrelevant, and in the case of an epidemic *first* appearing in a town or district, a succession of two cases is sometimes sufficient to furnish evidence, which, on the principle I have stated, is nearly irresistible.

"'For example, in the case of Widow Mac Millan, in Skinner's Close, it is certain, as the whole town was under medical serveillance at the time, and every one on the watch for cases of even suspicious cholera, that she was the *first* person in Edinburgh or Leith (i. e. in about 160,000 people) who took the disease without having been in the district of Musselburgh, Tranent, &c., where it prevailed; nor was there any case in Edinburgh or Leith, in a person who had not left the town for ten days after. And in regard to this first case of the disease in Mrs. Mac Millan originating in Edinburgh, the following points were ascertained by a judicial inquiry or precognition made, at the request of the board of health, by the sheriff of the county, who examined different witnesses on each point till he was perfectly satisfied of its truth. 1st, That the woman herself had never been out of the close in which she lived, during the existence of the disease in the neighbourhood. 2nd, That her son, a hawker, had slept in a house in Musselburgh in which a woman was dying of the cholera, on the Monday. 3rd, That after returning to town, he was seized on Wednesday with vomiting and purging of whitish or watery matter, cramps, and feeble pulse. I saw this lad myself on that day, and immediately suspected that he had been at Musselburgh, which was at the time denied, but afterwards admitted, and confirmed by abundant other evidence. 4th, That Mrs. Mac Millan was with him during the day, in a small confined room, rubbing his limbs and nursing him, and he recovered under the use of opiates and stimulants. 5th, That on the Saturday, when he was convalescent, she was seized with the disease in its most virulent and unequivocal form, and died in ten hours. Now I presume it will not be denied that the epidemic cholera, which was never known in Edinburgh before 1832, and has not been seen in it since 1833, must have some cause or causes of local and temporary existence only. That the lad Mac Millan, who had slept a night at Musselburgh, (then much affected with the disease,) should be seized with it, proves nothing as to the question whether intercourse with the sick has the power of exciting the disease or not. But if that intercourse has no such power, it is plain that his mother, who never left her own close, had no more business to take the disease than any other of the inhabitants of Edinburgh or Leith, and her infection must have been a mere chance. The chances therefore, are, nearly 160,000 to 1 against her being the first person in Edinburgh or Leith who should take the disease, and almost infinite to one against her being infected by it within sixty hours after her son.

"'From the time therefore,' Dr. Alison adds, 'when I was satisfied as to these facts, I have never doubted of the disease having a contagious property, although I have never thought it proved that its extension is to be ascribed to that property alone.'"

"In many of the more isolated cases which occurred during the prevalence of cholera in Edinburgh, the evidence of previous exposure to the infected could not be distinctly ascertained.—(See on this subject Dr. Craigie's able Monograph upon the disease in this city, in the Edinburgh Medical Journal, vol. xxxix. p. 366, &c.)

"In each of the three instances we have next to bring forward, the city of Glasgow formed the infected focus from which the infection was carried."

"*Campbelton.*—In this town, which contains between 9,000 and 10,000 inhabitants, and is situated on the west coast of Argyleshire, there were two separate irruptions of cholera in 1832; the first in April, and the seeond towards the latter end of July. During the first irruption only thirteen cases occurred, ten of which were fatal; and through the kindness of Dr. Macdonald, of Ballyshear, I have been favoured with some notes of them drawn up by Dr. Macintyre of Greenock, who was, at the time mentioned, surgeon to the cholera hospital at Campbelton. The first case is remarkable on account of the latent stage, and of the premonitory diarrhœa. 1. Archibald Witers, aged 28, went from Campbelton to Greenock and Glasgow early in April. He himself confessed, (as I am informed by Dr. Macdonald, and the same, Dr. Macintyre states, was admitted by Witers' mother,) that while in Glasgow he slept in a house where cholera existed In returning home he came by a steamboat to Tarbert, and travelled from thence to Campbelton by land, (a distance of thirty-seven miles,) without entering any house on the road. He reached town on the 10th April. On the 15th he was attacked with diarrhœa, and by the morning of the 17th had also some nausea and vomiting. Dr. Macintyre visited him at 4 o'clock P. M., on the latter of these days, (the 17th,) and found him affected with all the characteristic symptoms of malignant cholera. On the 19th, however, he was convalescent, and had no consecutive fever. 2. Mary Morrison, aged 7, who had been in Witers' house when he was ill, was seized at 7 P. M., on the 20th, with decided cholera, and died in twenty-two hours. 3. Mrs. Morrison, the mother of No. 2, was attacked with the disease at 6 A. M. on the 21st, and sunk in about twenty-one hours. 4. Mrs. Witers, the mother of No. 1, who had attended and nursed her son during his illness, sickened in the afternoon of the 21st, of cholera, and died on the 22nd. This last patient died in the cholera hospital. 5. Alexander Macneil, aged 70, residing in a street about 600 yards distant from that in which Witers' and Morrison's houses were situated, was attacked with cholera symptoms on the forenoon of the 22nd April. 'He had,' Dr. Macintyre remarks, 'been in conversation with one of the hospital attendants the night previous, and had been working, I believe, with Witers on the 15th and 16th, when the latter was suffering under diarrhœa.' Macneil died on the morning of the 23rd. 6. His wife, aged 70, was seized with the disease 12 o'clock noon, on the 25th April, and died after an illness of thirteen hours. 7. A girl, Sinclair, sister-in-law to one of the porters at the hospital, was taken ill on the 23d, but ultimately recovered. 8. Mrs. Christie, aged 38, sickened on the morning of the 28th, and died on the 29th. 9. Her husband, Malcolm Christie, was attacked at 5 A. M., on the 29th, and died on the 30th. 10. Robert Wishart, residing in a house adjoining to that of Christie, was seized at 4 A. M. on the 30th, and died at 8. P. M., of that day. 11. Mrs. Wishart, aged 35, wife of

No. 10, was attacked the same day at 5 A. M., and died next morning, 12. Donald M'Killop took the disease on May 1st, and died on the succeeding day. 13. Fawcett, aged 4, living in the same house with the Wisharts, (Nos. 10 and 11,) was attacked on the 3rd, but recovered. Dr. Macintyre does not state, in the communication which has been put into my hands, whether or not any intercourse, direct or indirect, was traced between the Christies, Wisharts and M'Killop, and those previously affected.

"The thirteen cases that have been mentioned, all occurred within the space of eighteen or twenty days. After the last of them, (Fawcett's) on the 3rd May, no other cases of cholera were seen in Campbelton, till the 28th July, when the second irruption of the disease occurred, and between that date and the 28th October, 98 of the inhabitants were attacked with cholera. No importation of the disease in this second irruption could, as has happened often in regard to the subsequent returns or recurrences of the disease in other places, be distinctly ascertained.

"*Greenock.*—Mr. Turner, surgeon, Greenock, has kindly favoured me with the following facts relative to the first introduction of cholera into that town.

"1. Dow, an elderly fishmonger, belonging to Greenock, went to Glasgow in the latter end of February 1832, and slept in that city in a tenement in which cholera was at that time raging. Next day he came to Greenock labouring under a diarrhœa, which, after continuing for two days terminated in all the more marked and fatal symptoms of confirmed cholera, and the man speedily sunk. 2. Mrs. Black, who officiated as nurse to Dow, took the disease next day, and also died. 3. On the following day Dow's wife was attacked, but recovered.

"4. A fisher boy, the name of M'Millan, who was some hours in company with Dow, and drinking with him on the day he came from Glasgow, and when he was labouring under the premonitory diarrhœa, was seized with cholera that night, and died on the following one in the hospital. 5. Next day this boy's mother took the disease, and died in a few hours. 6 and 7. On the following day his father and brother had also a severe attack of cholera, but their cases did not prove fatal. The disease subsequently spread through Greenock to a considerable extent. The boy M'Millan had been out with his boat in the river, fishing, but with this exception and that of Dow, who had been in the infected house in Glasgow, none of the other persons who have been mentioned had been for a considerable period out of Greenock, and the disease had not been previously seen in that town. In other words, Dow's nurse and mother, M'Millan, his mother, father, and brother, had only had intercourse with a previously infected locality, *indirectly* through the person or body of Dow, who had been, as already stated, exposed to the disease in his lodgings in Glasgow.

"*Doura.*—At the small village of Doura, in Ayrshire, containing 37 families, and 170 inhabitants, not less than 21 cases of confirmed cholera appeared. The first case which occurred was in a young woman, who had, on the 20th February, 1832, travelled on foot with her husband from Springbank, near Glasgow, where the disease was then raging, to Doura, a distance of about twenty or twenty-two miles. She was intending to proceed onwards to Kilwinning, but she was seized with purging and vomiting on the road, and was so ill and exhausted by the time she reached Doura, that she could proceed no farther, and took up her abode in the village, in the house of an acquaintance. She expired the following evening, after having exhibited all the best marked symptoms of cholera, as recognised by the surgeon in attendance, who had seen the disease in India. The stranger was attended by two female villagers, (sisters,) who rubbed her, &c. One of these sisters was attacked with cholera on the 24th, and died after twelve hours' illness. On the 25th, the other took the disease, but recovered. No restrictions whatever as to the intercourse with infected persons, were put in force, and so rapidly did the disease spread, that by the 9th of March, 21 cases in all had occurred among the above mentioned small population.

"In this instance, as in several others which we have mentioned, a person travelling from an infected district, and actually labouring under symptoms of cholera, appeared to carry the disease through a line of healthy country to a distant locality. No case of cholera existed at the time any where near to Doura, and immediately previous to the arrival of this woman, the inhabitants were in the enjoyment in every respect of their usual state of health; yet, within the space of seventeen days after the infected stranger arrived among them, one out of every five individuals in the place was attacked with confirmed cholera; six died of it; and almost every inhabitant was affected in a greater or less degree with diarrhœa. (See Mr. Salmon of Frome's Letter in the Lancet for 1832, p. 182, and also Mr. Moir's Proofs of the Contagion of Malignant Cholera, p. 64.)"

"*Carnwath.*—In the parish of Carnwath, Lanarkshire, containing a population of about 5000 individuals, five cases of pestilential cholera were observed during the prevalence of the disease in this country in 1832-33, and the first of them was imported. Dr. Wilson, who was chairman of the local board of health, has favoured me with the following particulars relative to the history of these five cases.

"The first instance of the disease was observed in the person of a stranger of the name of Waters. This man was a native of Beith in Ayrshire. He was travelling homewards to his native place, asking charity, after having a few days previously left off his employment as a mason in the more eastern districts of the country, where the cholera was raging. It was not ascertained from him at the time whether he had been directly exposed in the east to the contagion of cholera, but he was taken ill with the premonitory symptoms of the disease on the road, at some distance from Carnwath, and when he reached Braehead, (a village in that parish containing about 150 inhabitants,) on the —th of June, 1832, he was *already* labouring under a bowel complaint, and unable to proceed farther. He took up his quarters in Braehead, in a lodging house kept by a person of the name of Telford, and all his symptoms having speedily become more severe and characteristic of cholera, he was sent onwards in a cart by the alarmed villagers, into the adjoining parish of Carstairs. He died either that night or on the following morning.

"The day on which Waters was removed from the lodging house in Braehead, one of Telford's (the lodging house keeper) daughters, and Jean Gibson, cleaned the clothes of the house, and were both taken ill that evening. Gibson died within thirty hours with the most distinct symptoms of cholera; but the girl Telford recovered after a severe attack. At this time two hawkers (a man and his wife) came to Telford's. They both sickened with cholera, the woman recovered, but the man died after a few hours' illness.

"The local board of health adopted every possible measure to prevent the spread of the disease. No other cases of cholera previously or subsequently occurred in Carnwath, or any where within a circuit of country of seven miles extent, at least, around it.

" *Glen.*—This is a healthy little village, situated about two miles south of Falkirk, Stirlingshire, and inhabited by between thirty and forty families of colliers. In April, 1832, eight cases of cholera occurred in it, the two first of which were in individuals who had been exposed to the contagion of the disease in another distant locality. My friend, Mr. Graham of Polmont, who has the villagers under his professional charge, has furnished me with some interesting particulars regarding the history of the disease among them.

" 1 and 2. Robert Anderson and his wife, after spending some nights at Airdrie, (about fourteen or fifteen miles distant,) in a house where some of their relations had died of cholera, returned from thence to Glen on Wednesday, the 4th April. At the time of their arrival were both labouring under the premonitory diarrhœa, and, as was afterwards confessed, they were themselves convinced that they had taken cholera. They kept their complaints, however, as secret as possible, in consequence of the strong feelings of prejudice then existing regarding it, until Sunday the 8th, when Mr. Graham was sent for by the overseer of the mines at the village. The woman was by that time collapsed, and died next night. Anderson himself had the characteristic diarrhœa to a great extent; but being of a strong constitution, he ultimately rallied after lying in a state of collapse for thirty-three hours. 3 and 4. Two of Anderson's children, who had remained at home while their parents were visiting the infected house of their relatives in Airdrie, were seized with distinct, and in one of them severe symptoms of cholera on the 12th. They both recovered. 5. A man, named Benny, was suddenly taken ill with all the symptoms of cholera on the morning of the 10th. He was immediately subjected to active medical treatment, and recovered. Jenckens, another man, was similarly attacked on the evening of the same day, and also did well. Mr. Graham does not state what particular communication the two last persons, Benny and Jenckens, had with the Andersons. 7. A daughter of Jenckens, (No. 6,) was attacked on the 11th: and the 8th and last case occurred on the 15th, in the person of Alexander Brown, who had gone repeatedly to look at Anderson's wife while she was dying.

"*Ferryden and Boddin.*—The following facts with regard to the introduction of cholera into Ferryden and Boddin, two villages in Angus-shire, Scotland, have been drawn up by Dr. Brewster, the brother of the distinguished Sir David Brewster, and clergyman of the parish in which Ferryden and Boddin are situated. I am indebted for the communication of them to Professor Alison.

"The village of Ferryden is placed on the south bank of the South Esk, opposite to the town of Montrose, and contains about 700 inhabitants. The district of country in which it lies, remained altogether free of cholera, when in 1832, and the earlier months of 1833, the disease was prevailing in different parts of the kingdom. In the end of June, 1833, the smack Eagle, from London, arrived at Montrose. Two cases of cholera had occurred amongst the crew during the passage from London, one soon after the smack left that port, and the other off Harwich. As soon as the vessel reached Montrose river, the crew dispersed to their several homes. One of them, Robert Findlay, an inhabitant of Ferryden, carried his clothes and bedding to his house there. A day or two afterwards, two children in the village, who were reported to have been seen tumbling during the preceding day on Findlay's mattress, as it was laid out to the air, were seized with rapidly fatal cholera, and died on the 2d of July; and this, it may be proper to remark, took place at a time when the disease was considered to have nearly or entirely disappeared from Scotland. On visiting Ferryden that day, Dr. Brewster found the mother of the two children labouring under a fatal attack of cholera. The malady subsequently spread through the village, but not rapidly; and during the four weeks it continued, it carried off 27 out of the 700 inhabitants, or nearly one out of every twenty-seven of the residents. It appeared (Dr. Brewster observes in the communication with which I have been favoured) in different parts of the village in succession, and almost uniformly among the relatives, visitors, and neighbours of those who were previously affected. Out of the few cases, he adds, which appeared in Montrose, two were relatives of the sick in Ferryden, whom they had gone to visit there, and were themselves seized with the disease after their return home. The inhabitants of the adjoining district of country in general, carefully avoided all communication with Ferryden, and the disease only appeared in one other part of the parish, viz., in Boddin, a small village on the sea coast, nearly three miles south from Ferryden. Only two cases occurred in this locality, but these two afforded strong corroborative testimony of the contagious property of cholera. Margaret Stott, a young woman, an inhabitant of Boddin, went to visit her sister at Ferryden, and upon returning to Boddin, was seized with the disease, and died in two days. Jean Peterkin, an aged woman, who lived in the house adjoining to that of Stott, and who had not been out of the village, assisted, amongst other things, in putting Stott's body into the coffin, and afterwards washed her bedding. In the course of two or three days she had a fatal attack of cholera. No other person (Dr. Brewster adds) in the village of Boddin, or in the parish, or in the surrounding district, with the exceptions now noticed, was affected by the disease."

In addition to the above important facts detailed by Dr. Simpson in his *brochure*, he has furnished me with the following table, compiled carefully from authentic information, and exhibiting the dates of the arrival of cholera in many places in Scotland. He adds, on the authority of Professor Traill, that cholera never reached the Orkney or Shetland Islands, although it was as far north as Thurso.

A list of several towns and villages in different parts of Scotland which were visited with Asiatic Cholera, showing the date of its appearance in each particular locality.

TOWNS.	DATE OF APPEARANCE.
Haddington, - - - - - -	17th December, 1831.
Edinburgh, - - - - - -	See Dr. Craigie's paper in the Edin. Med. Jour. vol. xlix.
Tranent - - - - - - -	12th January, 1832.
Musselburgh, - - - - - -	19th January, 1832.
Leith, - - - - - - -	26th January, 1832.
Kirkintulloch, seven miles from Glasgow,	21st January, 1832.
Glasgow, - - - - - - -	12th February, 1832.
Paisley, - - - - - - -	13th February, 1832.
Greenock, - - - - - - -	26th February, 1832.
Falkirk, - - - - - - -	About 3d March, 1832.
Doura, near Kilwinning, Ayrshire,	6th March, 1832.
Perth, - - - - - - - -	13th or 14th March, 1832.
Inverary, - - - - - - -	21st May, 1832.
Water of Leith, near Edinburgh, - -	12th March, 1832.
Rothsay, - - - - - - -	23d March, 1832.
Larbert, near Stirling, - - - - -	Before 1st April, 1832.
Fort George, - - - - - -	7th May, 1832.
Dundee, - - - - - - -	23d April, 1832.
Stirling, - - - - - - -	10th July, 1832.
Helensdale, on the confines of Caithness and Sutherland,	About 23d July, 1832.
Portpatrick,[1] - - - - - -	7th August, 1832.
Ayr,[1] - - - - - - -	About 15th August, 1832.
Aberdeen, - - - - - - -	27th August, 1832.

[1] "See some additional dates in my Paper on Cholera."—*Dr. Simpson.*

TOWNS.	DATE OF APPEARANCE.
Cupar, in Fife, - - - - - -	30th August, 1832.
Tain, - - - - - - -	8th September, 1832.
Inverness, - - - - - - -	24th August, 1832.
Dumfries, - - - - - - -	15th September, 1832.
Fort William, - - - - - -	24th September, 1832.
Crieff, - - - - - - - -	2d October, 1832.
Hawick, - - - - - - -	About 20th October, 1832.
Island of Islay, - - - - - -	About 23d October, 1832.
Kelso, - - - - - - -	About 29th October, 1832.
Nairn,[1] - - - - - - -	About 11th August, 1832.
Wick,[1] - - - - - - -	21st July, 1832.

It is exceedingly remarkable how many of the great towns of England either escaped infection altogether, or were visited by only a trifling outbreak of the disease.[2] Up to the 24th of June, 1832, (that is during a period of about eight months since its first appearance at Sunderland,) the total number of cases throughout Great Britain, inclusive of London, amounted to only 14,796, and the deaths to 5432.[3] The disease, it is true, continued in many places to linger long after the above date, and reappeared as an epidemic in some places in 1833 and 1834, but still we are quite warranted in concluding, that on the whole, in Great Britain and Ireland, the cholera did not count 30,000 victims. In Ireland, particularly in Dublin and Sligo, the mortality was much greater than in England, an occurrence which may, perhaps, be accounted for by the bad diet of the Irish lower classes, and the crowded state of their dwellings, it being well known that in the worst quarters of the city, many families reside on the same floor, and frequently more than one in the same room. "In London," says Dr. Elliotson,[4] "the greater part of the people are well fed, better fed than in any other part of the world; they eat more meat, and that flesh is of such quality as scarcely to be found in any other country; besides which, they are better clothed, and more comfortable, and instead of trashy wines they have good sound ale and porter, and malt liquor of all kinds. But in Paris, the water the inhabitants drink is very bad; the people are crowded together, I know not how many families in a house, with little ventilation; the streets are narrow, the houses dirty, and the population live upon what Englishmen consider trash, not roast beef and mutton, but all sorts of dishes made up of bread and vegetables, with a little meat boiled in water to colour it, or give it a flavour; and drink not good beer but thin wine."[5]

[1] "See some additional dates in my Paper on Cholera."—*Dr. Simpson.*

[2] Cholera commenced in Liverpool on the 12th May, and in the mean time had visited Hull, York, Leeds, Manchester, and Warrington.

[3] Medical Gazette, vol. x. p. 400.

[4] Medical Gazette, vol. xii. p. 628.

[5] At the end of this paper will be found a list *of all the towns* in Great Britain where cholera occurred.

Certain it is, no matter how we may attempt to account for it, that cholera was much more destructive in Paris than in London, 385 deaths having occurred in one day, 8th April, 1832, in the former city. Nothing has puzzled and perplexed the continental physicians more than the comparative immunity from cholera enjoyed by England, notwithstanding their predictions, that *there* its ravages would attain to a *maximum*, for they contended, that in the English towns many circumstances would contribute to render the disease more liable to spread, as for example, their very dense population, the extreme poverty and bad diet of the lower orders, and the damp, foggy nature of the climate. Now, I believe, that the reproaches made by foreigners respecting the extreme penury of the lower orders in England are not well founded, at least comparatively speaking, and with reference to the same class of persons in the continental cities; and I am persuaded that in English cities the diet of the poor is superior to that of the continental poor. Indeed foreign physicians have tried their ingenuity to account for the slightness of the ravages of cholera in Great Britain, some attributing the immunity to tea, some to the quantity of meat we consume, and some to the vapours arising from our numerous coal fires; and each of these hypotheses has been met by objections, for the Chinese, the most national tea-drinkers in the world, were wofully scourged by cholera; and the city of Halle, in Germany, the most devastated town of that kingdom, uses nothing but coal for firing. It is to the more substantial nature of English fare, to the superior cleanliness of that nation, and to their living in families separated from each other, that we must attribute their comparative exemption from cholera, an exemption the more remarkable, when we consider that in England, commercial and private travelling between town and town is more rapid, and ten times more frequent than on the continent.

Cholera first appeared in Paris on the 24th of March, 1832, and it has been argued by those who deny the contagious nature of cholera, and its importation from abroad, that in France it broke out suddenly, not on the confines, but in the heart of the kingdom, and consequently, that it must have arisen spontaneously in the metropolis. Before we attach much weight to this argument, we must have very strong proofs that the facts are as above stated; now it is very remarkable, that cholera was officially announced to exist at Calais only eight days after it appeared at Paris, and when we recollect how unwilling the authorities in all seaports of hitherto uninfected nations, have invariably been to acknowledge the existence of cholera, it is not by any means improbable that cholera may have existed in Calais before it broke out in Paris, a supposition confirmed by the report of Arnaud, Moribaud, and Gendrin, who witnessed in Calais, towards the end of 1831, many very violent cases of cholera greatly resembling the Asiatic; nay, even after the cholera had manifestly appeared in Calais, many persisted in declaring that its victims died of common enteritis.

Indeed, according to Moreau de Jonnes, (Lancet, 1832-33, p. 689,) cholera appeared at Calais on the 15th of March, and at Paris on the 24th; so that France cannot be considered as forming an exception to the general rule, that the *disease always appears in seaport or frontier towns, before it makes its way to the centre of any country.* Once arrived at Paris, it spread in every direction. The following observations are from Moreau de Jonnes: "The disease spread by contiguity, as in the other parts of Europe, following lines, of which Paris was the centre, ramifying with the communications through the country. In each department, the time of the irruption was sooner or later after that of Paris, in proportion to the distance from, and the frequency and rapidity of the communications with the capital. Thus the following departments of the east became infected in the following dates, viz:—

Seine, - - -	March 24, 1832.
Seine and Marne, - -	April 2, "
Marne, - - -	" 16, "
Meuse, - - -	" 11, "
Moselle, - - -	" 27, "
Meurthe, - - -	May 4, "
Vosgey, - - -	" 13, "
Hante Saonne, - -	June 16, "

"In the western departments the disease broke out as follows:—

Seine, - - -	March 24.
Seine and Oise, - -	" 28.
Eure and Loire, - -	April 8.
Indre and Loire, - -	" 19.
Deux Serres, - -	" 25.
Vendeé, - - -	July 10.
Charente Inferieure, -	August 4.
Charente, - - -	" 30.

"The degree of rapidity with which the disease spread in different directions is as follows: Cholera appeared in Calais on the 15th of March, 1832, and broke out at Arles on the 17th of September following, having thus, in 186 days, traversed 200 leagues, forming the great diameter of France from north to south. The disease was recognized in Paris, the centre of the kingdom, on the 24th of March; on the 27th of April following, it had spread by contiguity to the department of the Moselle, and on the 11th of May, to that of Finisterre, taking thirty-five days to reach the eastern, and fifty days to arrive at the western frontier of France; having traversed on the one side seventy leagues, and on the other one hundred and twenty.

"Thus the cholera traversed France, from north to south, at the rate of one league in twenty-four hours; whilst from east to west, it required but eighty-five days to travel a distance of 190 leagues, which gives a rapidity greater by one half."

These statements of Moreau de Jonnes, are of the greatest importance. We see cholera introduced probably from England to Calais, and immediately after to Paris, from which it radiated in all directions by slow and varying stages all over the kingdom. The position of Paris, and its daily communication with England, rendered it almost the first prey of the disease in France. Once there, the cholera moved along the different lines of communication in every direction, its route not governed by any of the laws observed by epidemics depending on atmospheric changes; and its gradual progress from Paris, as a centre, towards all parts of the circumference of France, presenting a course obviously opposed to that of such epidemics. The following quotation relative to cholera in Paris is taken from Dr. Simpson's *brochure*.

"*Paris.*—Mr. Velpeau, in an essay on the cholera in Paris, contained in the twenty-ninth volume of the Archives Générales de Medecine, mentions several examples of the contagious propagation of the disease in that city; and we can only consider his testimony to the doctrine of contagion as the more impartial and valuable, seeing that he was one of those medical men who signed the celebrated official document, on the fourth day of the appearance of the malady in the French metropolis, denying altogether its contagious character. 'Out of eighty and odd cases, (he remarks, p. 224,) in this city, the history of which I have noted, there is none the subject of which had not some previous communication, direct or indirect, with other cholera patients.' Among other series of cases he gives the following, (p. 222:) 'A man, aged 55, had remained near two of his friends who were affected with cholera. He was attacked himself, three days afterwards, at his own house, (Rue Vieille du Temple,) and died in eight hours. 2. His eldest son, aged 23, who took charge of his father to the last moment, was attacked next morning, and died in seventeen hours. 3. The mother; 4, next the daughter; 5, then another son, who came from his work to the assistance of his sister, were successively attacked with the disease, but in a less severe form. 6. A child of ten years, who came to visit them, was also seized. 7. An artist living in the flat above was next affected, as well as, 8, his wife; and 9, another person died of the disease in the same house, which (M. Velpeau adds) was not more insalubrious than the neighbouring habitations. The above persons were all (he likewise states) regular in their habits, and in comfortable circumstances.'

"In the surgical ward, St. Jean, of the Hospital La Pitié, cholera (M. Velpeau again observes, p. 225,) did not appear till after the nurse attached to it had been engaged in attending cholera patients in the medical wards. The first person attacked in the ward passed constantly by the bed of the second. The third occupied the bed nearest his, and the servant of the ward was next seized. A fifth, sixth, seventh, and finally an eighth case occurred among the persons lying in the beds nearest those attacked. 9. A young pupil, who, up to that time, had abstained from visiting cholera patients, came to the hospital in the morning. He was affected with cholera that night at *his own house;* and 10, his brother, who lodged in the same room with him, had a fatal attack of it on the following day."

From England cholera soon spread to Ireland; the following dates of its arrival were communicated by Dr. Barker, whose official situation in the Board of Health, gave him the best opportunity of ascertaining the progress of the disease.

PLACES.	DATES OF OUTBREAK OF CHOLERA.
Dublin, ...	22d March, 1832.
Arklow, ...	8th April, "
Banbridge, ...	9th April, "
Cork, ...	12th April, "
Ramelton, County Donegal, .	12th April, "
Naas, ...	13th April, "
Belfast, ...	14th April, "
Warren's-point, . . .	17th April, "
Stranorlar, County Donegal .	22d April, "
Tralee, ...	28th April, "
Galway, ...	12th May, "
Limerick, ...	14th May, "
Waterford, ...	1st July, "
Wexford, ...	21st August, "

It is worthy of remark that Dublin, Cork, and Belfast were affected about four months before Waterford and Wexford. Now a steamer plies twice a week between Dublin and Cork, and Dublin and Belfast, *while there is no direct communication by steam* between Dublin and Waterford, or Dublin and Wexford; and consequently it appears probable, from the dates, that Cork and Belfast were infected from Dublin, while Waterford and Wexford escaped for many months, not being exposed to infectiou from this source. At all events, the fact that Waterford and Wexford should have remained so long without the disease is very remarkable, and if not sufficiently accounted for by their more indirect and less frequent intercourse with Dublin, it may perhaps be explained by their trade with England consisting chiefly of the export of agricultural produce, rather than the interchange of passengers.

We have hitherto followed the route of cholera in the old world; we have now to trace it in the new.

"The disease commenced about the 8th of June, 1832, in Quebec, in boarding houses and taverns in the *Cul de Sac*, a low, uncleanly, and ill ventilated part of the city, crowded with emigrants of the lowest description, with sailors, and other persons of irregular habits."[1]

[1] Vide the official Report of the Board of Health, Quebec Cholera Gazette, p. 72.

Thus we find that cholera appeared in America first at Quebec, just at the season when the spring stream of emigration from England reaches that city. The following account proves that cholera might be thus transmitted.

"The following letter from the surgeon of the British barque Brutus, to the president of the Board of Health of Liverpool,[1] conveys the melancholy intelligence of the cholera having broke out among the passengers, *eight days after* leaving the river Mersey, and which induced the captain to put back. It appears from a statement subjoined to the letter, that between the 27th of May, the period when the first person was attacked, and the 13th of June, the day on which the vessel arrived at Liverpool, 117 cases had occurred, 81 died, and 20 had recovered.

'Sir,

'With the deepest feelings of regret, I have the painful duty to perform of transmitting to you one of the most melancholy and distressing accounts of cholera, which occurred on board the British barque Brutus, bound for Quebec, from Liverpool, with three hundred and thirty passengers. The first case presented itself on the 25th of May, (being the eighth day after we left the river,) in a strong, healthy man, thirty-five years of age; the symptoms were all well marked, the spasms particularly severe; under the usual means of treatment he recovered. The next case was an old woman of sixty, who died in ten hours after the commencement of the attack. The disease continued gradually to increase, (notwithstanding every means having been employed to arrest its progress,) until the night of Saturday, the 2d of June, when we were a good deal tossed about by a heavy sea, and dark hazy weather; it spread to such an alarming extent, that on Sunday, most of the ship's crew being attacked, and having lost some of them the week before, we were obliged to bear up again for Liverpool. It is impossible to describe the scene of misery on the third, fourth, and fifth, people dying in every direction—the greater number of them destitute of the common articles of bed covering. On the sixth, the weather became more favourable, the disease less severe, and the number of new cases diminished, which has since been on the decline.

'I have the honour to be, sir, your obedient humble servant,

'W. W. Thompson, M. R. S. C. in London.'"

"*Brig Amelia.*[2]—On the 19th October, 1832, the brig Amelia left New York (a city in which epidemic cholera at that time prevailed) for New Orleans. The brig had on board her ordinary crew, and one hundred and five passengers, some of whom had the disease *before* sailing; on the sixth day out, the sickness, according to the captain's subsequent official deposition, commenced in the vessel; and in the course of eight days more, or, in other words, by the 31st of October, twenty-four of the individuals on board had

[1] Cholera Gazette.
[2] Dr. Simpson's brochure.

died of it, and several more were labouring under the disease. During the course of this last-mentioned day, (31st October,) the vessel was stranded on the beach of Folly Island, a low and sandy island about twenty miles from Charlestown, and far out to seaward.

"The island was the property of a Mr. Milne, who kept four negroes upon it as permanent occupiers, and used it himself as an agreeable summer retreat. Mr. Milne allowed the captain, passengers, and crew of the brig to take refuge in his buildings. The deputy port physician of Charlestown, Dr. Elfe, was sent down to visit the island, and pronounced the disease which he found there to be cholera. A boat's crew of wreckers who had gone down from Charlestown to the island to attempt to save the vessel and cargo, having returned to the city, one of the men belonging to the crew was there seized with well, marked symptoms of malignant cholera, and died. The rest of this boat's crew of wreckers were ordered back to the island to perform quarantine, and after having embarked, two fell sick, and one died of cholera on their passage down. Two physicians, Drs. Jewey and Pritchard, were sent to the island to afford the necessary assistance, and being worn out by constant exertions, they were relieved in the course of a week by a third medical officer, Dr. Hunt. There were sent down also from Charlestown a clergyman, the man who had nursed the wrecker that died in the city, and a lieutenant and eighteen men of the city guard, the latter being ordered to the island to perform the duty of a *cordon sanitaire*, and to prevent any individuals from leaving the spot. The wreck of the brig was burned on the 8th November. New cases, however, of cholera continued to occur up to the 17th; and it is important to remark, that some of those who were attacked had never visited the brig.

"In this way there were collected upon Folly Island about one hundred and fifty individuals in all; and amongst these there occurred up to the 17th November twenty-three deaths, or sixteen per cent. of the number fell victims to cholera, including twelve of the passengers landed from the brig, six of the wreckers from Charlestown, (not reckoning the one who died in Charlestown, and the other who died in the passage down,) three of Mr. Milne's four negroes, the nurse, and one of the city guard from Charlestown. Of the other seventeen men belonging to the city guard, and whom it was found impossible to prevent from communicating with the passengers dispersed over the island, every one was affected more or less with the symptoms of cholera, with the exception of the lieutenant; and nine of them were reported to have been attacked seriously. One of the three physicians, Dr. Hunt, was attacked on the 17th by the disease, but recovered.

"*Smack Trusty.*[1]—The Leith and London smack Trusty arrived

[1] "The following case of the Trusty has been already imperfectly, and, in several respects, inaccurately stated in Mr. Moir's Proofs of Contagion, p. 71; and in the Cholera Gazette, p. 264. To ascertain as accurately as possible every particular connected with it, I visited last summer the quaratine

at London on the 19th of February, and after remaining in port for fourteen days, sailed again on the 4th March, with ten of a crew, including the captain and mate, and six passengers on board. In London the cholera was then prevailing to a considerable extent, more particularly on the side of the river, and in the quarter connected with the shipping. 1. On the morning of the 6th, the cook was attacked with cholera at sea, and died on the 7th. 2. Another seaman complained of headach when the vessel was brought up in Leith Roads, (a distance of about 400 miles from London,) on the evening of the 8th. This man assisted on the same night another of the crew and a cabin boy to pull ashore the six passengers in the boat belonging to the smack. When he reached the harbour, however, he found himself so unwell as not to be able to return on board, and died of cholera the next morning in the Leith Hospital at 12 o'clock. This was the second case of the disease observed in Leith, the first having occurred about a month previously in a man who had been visiting his infected relations at Musselburgh. 3. The other sailor who landed with him was also obliged to remain on shore, and had an attack of cholera that night, but recovered. 4. On the morning of the 9th, another of the crew of the smack was seized with vomiting and purging immediately after the preventive boat visited the smack in the Roads; and the vessel having been ordered ten miles up the river to the quarantine station at St. Margaret's Hope, he was, when the vessel arrived there about 5 o'clock of the same evening, transferred to the hospital ship Nymphe. The Nymphe (one of the old men-of-war employed as quarantine vessels in the station) had been previously cleared out as an hospital ship to receive a suspicious case of cholera which had occurred on board one of the vessels under quarantine, on the 2d March, but this man had been discharged as well on the 5th. At the time that the sailor from the Trusty was placed in the Nymphe, on the evening of the 9th March, the Nymphe had only two mariners left on board, who had volunteered to act as nurses. On the 11th, two other mariners were joined to these, and on the 16th a fifth was added. The sailor from the Trusty had a severe attack, but continued in life till the 16th. 5. In the afternoon of the 10th, a second sailor was transferred from the Trusty to the Nymphe labouring under cholera: he recovered. 6, 7. On the 11th, two new men were attacked and sent to the Nymphe, both of whom died. One of them was a Leith porter, who had come on board the vessel in Leith Roads, having returned with the boats which landed the passengers. He and the pilot (who had joined the smack

station, and had an opportunity of conversing with one of the nurses who was attacked, and with other persons officially employed there during the existence of the disease. I got access also, through the kindness of Dr Forsyth of Inverkeithing, the quarantine medical officer, to the quarantine official ship journals, in which the state of the sick, the arrival and release of all vessels, the condition of their crews, and all other correlative circumstances, were minutely entered twice a day."—Dr. Simpson's brochure.

near the mouth of the river in Dunbar Bay) having been found on board by the officers in the preventive boat, were obliged to proceed with the vessel to the quarantine station. This porter, Murray, was cut off by the disease after an illness of only twelve hours' duration. 8. On the 12th, another of the crew of the Trusty was attacked and transferred to the Nymphe, but recovered in the course of a few days.

"Thus out of the whole crew of the Trusty, ten in number, one died of cholera at sea; a second on shore at Leith; a third remained there, but recovered: a fourth, whose case proved afterwards fatal, sickened while the vessel lay in Leith Roads. Three others were attacked in St. Margaret's Hope, and sent on board the Nymphe; and of these three one recovered and two died. The porter who joined the vessel at Leith also took the disease there, and died. The three remaining members of the crew, and the pilot, who came on board in Dunbar Bay, had each an attack of diarrhœa.

"Of the *five mariners* who acted as nurses to the crew of the Trusty on board the hospital ship, one was attacked with cholera during the afternoon of the 15th, and died in less than twelve hours. On the 24th, another of them was attacked with nausea, vomiting, purging, and tenesmus, but recovered. On the morning of the 27th, a third is reported in the ship's journal as attacked with the premonitory symptoms of cholera, but is entered as better on the 28th and 29th. On the evening of the day on which the third nurse was attacked, a sailor was sent on board the Nymphe from a second infected vessel that had arrived in the quarantine ground, but up to that day only the men of the Trusty had, with the exception formerly noticed, been on board of her as patients."[1]

Had the Brutus been less severely visited, the captain would, no doubt, have held on to his destined port; and the passengers, for their own sakes, would have spoken of the occurrence of cholera on board their vessel as little as possible, and so the matter would have been hushed up. The occurrence of 81 deaths at sea, among less than 350 persons on board the same vessel, cannot be accounted for, unless on the supposition that the disease is contagious. One such positive fact is worth a volume of negative evidence.

On the 10th of June, 1832, it appeared at Montreal, and here, as at Quebec, it immediately assumed the character of a most destructive pestilence.

The following interesting account[2] of the route of cholera during the first stages of its progress in North America, is from the pen of S. Jackson, M. D., Secretary to the consulting Medical Board of Philadelphia. Dr. Jackson is a non-contagionist, as will abundantly appear from his narrative, upon some of the leading facts of which I may hereafter take occasion to make a few observations. It is worthy of remark that the medical men of America have far outstripped their European colleagues in medical statistics. The

[1] Dr. Simpson's brochure. [2] Cholera Gazette.

weekly, monthly, and annual accounts of diseases, deaths, &c. in each of their great cities have been long published systematically and regularly, and that with a degree of accuracy to which we are strangers. Some of the results of this praiseworthy habit appear in Dr. Jackson's account.

"From the numbers of emigrants, who, about this period, had landed at Quebec, and arrived at Montreal from England and Ireland, a first impression was created, that they had been the means of transmitting the epidemic across the Atlantic. A more close investigation into the facts connected with the commencement of the disease in those cities, served to destroy this supposition. It could not be traced to importation. The emigrants and lower classes of the Canadians were attacked simultaneously in both cities. Numbers of the emigrants were in circumstances eminently predisposing them to suffer attacks of the disease, and they and the lower Canadians were precisely the description of persons most obnoxious to the ravages of epidemic cholera, and such as have been universally observed to be its first victims.

"The lines of communication between the cities of Quebec and Montreal, and the cities of the United States, are by the Richelieu River, Lake Champlain, and the northern canal leading to Troy and Albany; or by the St. Lawrence to Lake Ontario, to Buffalo, and by the Erie Canal leading to Rochester and Albany. It was confidently expected that the disease would penetrate into the United States from Canada by these routes. Along the first, many cases of the disease did certainly occur in the persons of emigrants, but they terminated without its communication to others. On the contrary, the epidemic manifested a decided predilection for the shores of the St. Lawrence, successively attacking the towns and villages along its banks, then following the borders of Lake Ontario, until it entered Lake Erie.

"While attention was directed to the northern and western boundary, supposed to be threatened by the invasion of the disease, it suddenly and most unexpectedly appeared in the city of New York.

"The first case occurred, it is said, on the 24th of June, when a man, a native citizen, residing at the corner of Gold and Frankfort streets, was attacked by the disease. Four cases soon succeeded, the location of which was in Cherry street. The subjects were Irish emigrants, who had arrived in Quebec in the autumn of 1831, and had resided in Albany until the month of May, when they removed to New York.

"On the 27th June, the disease manifested itself in Bellvue Alms-house, distant about three miles from the city. The patient was an aged woman who had not left the house for three years, who had held no communication with the city, and no admission into the ward she occupied had taken place for a month. Several cases immediately ensued in this and the other wards of the house.

The epidemic reached its maximum in this establishment on the 11th July, and terminated on the 4th August.

" In the city of New York, the climax of the epidemic arrived on the 11th of July, from which period it continued very steadily to decline.

" The time that elapsed from the out-breaking of the epidemic at Quebec, and its appearance at New York, is a period of sixteen days, or nineteen at Bellvue Alms-house. The distance between the two cities in a direct line, is four hundred and fifty miles.

" It is to be remarked that all the intermediate cities on the sea-board of the province of New Brunswick and Nova Scotia, of the states of Maine, Massachusetts, and Rhode Island, remained entirely exempt from the epidemic ; and even to the present period, except in Providence, Newport, and Boston, no cases have as yet appeared.

" In this city, the epidemic was much more tardy in its progress than it had been in the Canadas, or in New York. The first decided case of cholera occurred on Thursday, July 5th. A man of the name of Musgrove, residing in the cellar of a house in Filbert street, near Schuylkill Fifth street, was attacked with symptoms of malignant cholera on that day. This man had but lately been discharged from the New Jersey prison ; he had been affected with diarrhœa for two or three weeks previous to the cholera symptoms. The disease proved fatal on Sunday the 8th. The next case was a black man residing in St. John street, Northern Liberties, above Callowhill. He had been employed working on board a ship from England, lying at Pratt's wharf. He was seized with symptoms of malignant cholera the night of Tuesday, July 9th, and died on Friday. This man was perfectly sober in habits ; no premonitory symptoms existed.

" No other cases presented themselves until Sunday, July 14th, when two females occupying a room in a dwelling in Coates street, a few doors above Third, were the victims of the pestilence in its most aggravated shape. Both these females were exemplary in their habits of life, but appeared to be infirm in health. The husband of one of these unfortunates had arrived on Saturday, July 6th, from New York, exceedingly alarmed respecting the cholera. He was taken sick the next day, and died on the succeeding Friday. On Saturday the widow felt unwell, and without advice took grains xvi. of calomel in the evening. She was soon afterwards seized with vomiting and purging, and in the course of the night she sunk into collapse. She died Sunday night. The mother of the deceased husband, on Sunday morning complained of feeling unwell, but without definite symptoms. Having been up with her daughter-in-law during the night, her uncomfortable feeling was attributed to fatigue. She was then going about the house, and had been out on an errand. She was requested to lie down as a matter of precaution, and a small dose of opium administered to her. This was at 8 o'clock in the morning. Dr. Schott, who was in attendance an hour afterwards, went up to her chamber to inquire into her state. He found her lying on the floor; copious dejections of rice-water looking fluid had occurred, and she was in complete collapse: death ensued in the evening. These were the only cases to which the slightest suspicion of communication by contagion could attach; but on the same day a French woman, temperate in habits, about fifty years of age, living in Kensington, beyond the close built part of the town, at the head of West street, was also a victim of the disease. This woman had not been from her dwelling for three weeks; the house is isolated, being surrounded by kitchen-gardens for the supply of the market. She had been affected with diarrhœa since Friday, for which she had dieted, but had taken no medicine: the case proved fatal next day.

"From this time not more than three or four cases occurred, all scattered in different quarters, particularly Kensington, Northern Liberties, and Southwark, until the 27th and 28th July, when the epidemic fairly set in, and cases continued daily to be developed. The disease attained its height in this city on 5th, 6th, and 7th August, since which time it has gradually declined, and appears now to be extinct.

"Taking the 27th or 28th of July as the proper commencement of the epidemic in Philadelphia, there will be a period of twenty-four or twenty-five days intervening between its first appearance in New York, and this city. The distance in a direct line is about ninety miles.

"A comparative view of the population, number of cases and deaths in the cities, which have been brought under observation, presents the epidemic in an interesting point, and exhibits in a clear manner the character it assumed in this city.

Date of Report and Place.	Population.	Cases.	Deaths.	Ratio of Cases to Population.	Ratio of Deaths to Cases.	Ratio of Deaths to Population.
Sept. 30, Quebec .	32,000[1]	5783	3292[2]	1 in 5 1-7	1 in 2½	1 in 10½
" 1, Montreal .	28,000[3]	4385	1853	1 in 6½	1 in 2½	1 in 15 1-9
Aug. 22, New York	140,000[4]	5547	2782[5]	1 in 25⅓	1 in 2	1 in 15½
Sept. 13, Philadelphia	160,000[6]	2314	935	1 in 70	1 in 2½	1 in 173 29-183

"The results of this table show conclusively, that the causes productive of cholera were less numerous in the city of Philadel-

[1] "Permanent population, 27,000; transient population, 5000.—Total, 32,000.

[2] "Protestant grounds, 1244; Catholic cathedral, and cholera grounds, to 25th September, 1574; at St. Roch, 470.—Total, 3292.

[3] "Permanent population, 25,000; transient population, 3000.—Total, 28,000.

[4] "Estimated as remaining by Mr. D. Leslie.—Journal of Commerce, August 8th.

[5] "Report of the Inspector.

[6] "Population within the bill of mortality."

phia than in Quebec, Montreal, or New York, or were so modified as to possess a much less degree of activity. The causes of this result, so favourable to Philadelphia, important in the hygienic history of cholera, and consoling to humanity, as placing this formidable affection to so great an extent under control, it is interesting to investigate.

"The following are the circumstances which, existing more particularly in Philadelphia, may be regarded as influential in ameliorating the violence of the epidemic cause, circumscribing its activity, and diminishing its fatality.

"1. The plan on which the city is built, arranged in hollow squares, separated by wide and paved streets, prevents excessive crowding of inhabitants, procures free ventilation, and gives facility to the means of cleanliness. It is to be regretted that any deviation has been permitted in the original design of Penn, whose sagacity and foresight have been so amply demonstrated in the circumstances of the late epidemic.

"2. The abundant supply of wholesome water placed at the command of the whole community, affords a healthful beverage, and gives the means of the most complete cleanliness, by washing the dirty gutters of the streets, close alleys, and lanes.

"3. The well arranged measures of sanitary police, devised and actively carried into effect by the councils of the city, and the boards of commissioners of the district, and the sanitary committees appointed by them, and by the Board of Health. The measures consisted in a thorough investigation into all existing nuisances, and in their immediate abatement; in a complete system of cleanliness of the city steadily pursued; in the early establishment of numerous local hospitals, provided with ample medical attendance, nurses, and every means applicable to the treatment of the disease; and in spreading before the public early information, derived from the consulting medical committees, of the methods, hygienic, dietetic, and medicinal, best adapted for guarding against the attack of the disease, or to arrest the symptoms on its onset.

"4. A very considerable influence may be attributed to the annunciation made by the mission sent to Canada, immediately on its return, and before the epidemic had commenced its career in this city, of the different periods of the disease, and especially of the existence, in almost every instance, of premonitory signs, and a preliminary stage, with a description of the symptoms indicating its existence. This information was communicated to the public by the sanitary committee through the daily journals of the city, by handbills liberally distributed, and by placards on the corners of the streets. The board of health adopted the same measures, and pursued the same course. In this manner the whole community, before the beginning of the epidemic, were instructed in the most important points in the general knowledge and management of this affection—its commencing period, the premonitory symptoms, its general curability in that state, the necessity of immediate attention and medical advice, and the methods of relief. These facts had been overlooked, and this attention to the instruction of the public were entirely neglected in Quebec, and Montreal, and in New York; from being taken unprepared by the epidemic, earlier than was anticipated, they were not communicated to the public until the measure had been adopted in this city, and when the epidemic there had already attained its maximum of intensity.

"5. The moral resolution, calmness, and perfect freedom from alarm and panic, generally manifested by our citizens, and inspired by a thorough confidence in the efficacy of the preventive means enforced, in the advantages for salubrity of the city, and in its medical resources, contributed in no small degree to diminish the number of cases, and the intensity of the attacks. No stores were closed on account of the epidemic, and not more citizens left the city than usually abandon it every summer. A stranger entering our streets, from the busy throng and cheerful aspect of all he met, would never have suspected the existence of an unusual and a desolating scourge.

"6. The treatment of the disease generally pursued in the city, in the preliminary stage, had most probably no small share in preventing the developement of the disease in innumerable instances. In the lighter forms, it was limited chiefly to diet, rest, tranquillizing doses of anodynes, or mild diffusibles, with occasionally the mildest laxatives or gentle cathartics, conjoined with sinapisms or other rubefacients. The drastic and perturbating cathartics were seldom if at all prescribed, and the stimulant practice but rarely resorted to.

"The foregoing circumstances appear to us as those principally instrumental in producing the favourable results attending the epidemic in this city. As such they acquire a high degree of interest, and afford most instructive lessons as regards the measures of municipal and civil regulation connected with sanitary police.

"In its general features and character, the disease differed in no respect from the many descriptions that have been made since it first attracted attention in Asia, and subsequently in its progress through Europe. It will be unnecessary to make the repetition here; it is, however, important that the fact should be signalized, that during the prevalence of the epidemic, very few persons in the city were entirely exempt from some derangement or disorder of the digestive functions. It is not probably exaggeration to assert, that two-thirds of the population were affected in this manner, which is to be attributed entirely to the epidemic influence. It should also be stated, that in the majority of cases which assumed the decided character of malignant cholera, preliminary symptoms had existed, varying in duration from a few hours to several days. In those rarer instances which were not preceded by any premonitory signs, the subjects were the aged, the intemperate, individuals who had committed some great imprudence in diet, or whose constitutions had been enfeebled, and such cases were generally, if not universally, fatal.

"The disease was not confined to any one portion of the city, but extended to every district. Neither did it progress gradually from one quarter of the town where it first appeared to others, but broke out almost simultaneously in the most opposite and distant points.

"The following table exhibits the number of cases that were reported from the different districts, with the ratio to the population.

	Population.	Cases.	Ratio of Cases to Population.
City, ...	80,458 . .	. 407 . . .	. 1 in 197 7-8
Kensington, . . .	13,320 . .	. 111 . . .	. 1 in 120.
Northern Liberties,	28,932 . .	. 144 . . .	. 1 in 200 11-12
Penn Township, .	11,141 . .	. 55 . . .	. 1 in 202 3-7
Southwark, . . .	20,740 . .	. 251 . . .	. 1 in 82 4-28
Moyamensing . .	6,822 . .	. 198 . . .	. 1 in 39 5-11

"From the above table it appears that the epidemic prevailed with greatest severity in Moyamensing and Southwark. This is to be attributed to the character of the population, rather than to local causes. In both these districts reside the worst portion of our population, and in Moyamensing, especially, there is a dense population, some of whom are of the lowest order and most abandoned habits.

"In the city, though the cases as occurring in different parts, were not kept distinct in the reports, yet it was well known that the larger proportion of them took place in the external limits, especially the western borders, towards the Schuylkill, and the southern extremity, while a very small number only were developed in the central portion.

"The chief mortality of the disease existed in the public institutions. It was much lighter in private practice. The following table exhibits the cases of deaths, as reported in private practice, and the public institutions. The reports, however, do not exhibit the results of private practice in as favourable a light as they really were. A considerable number of physicians in the more respectable practice, reported only the cases that proved fatal or exceedingly severe. They did not return to the Board of Health the lighter cases, which yielded to the operation of remedial measures. The mortality of private practice in the reports, appears, in consequence, to have been far greater than it really was.

" *Table of Cases and Deaths, with the Ratio as occurring in Private Practice, and the Public Institutions.*

	Cases.	Deaths.	Ratio of Deaths to Cases.
Private practice, . . .	1175 . . .	270 . .	1 to 4 3-16
Hospitals, ...	874 . . .	342 . .	1 to 2 5-9
Alms-house, ...	174 . .	92 . .	1 to 1 41-46
Arch street Prison, . .	86 . .	46 . .	1 to 1 20-23

"Had the returns of cases in private practice been complete, the proportion of cases would have been much greater, it would have ranged probably as 1 to 70 or 80, or even more.

"In the hospital practice, the first cases introduced were nearly all fatal. This circumstance is to be accounted for from the universal observation, wherever cholera has prevailed epidemically, that the worst constitutions were the first to suffer attacks. In the commencement of the epidemic, persons first attacked, unaware of their danger, and the nature of the affection, neglect application for aid, and resist the offer of hospital assistance until reduced to a hopeless condition. Besides, misled by the authority of the English and Scotch writers, extensive means had been prepared for warming the patients by heated air, steam, and other means. Experience in a short time proved the pernicious effects of this system. The patients succumbed most rapidly under the exhaustion induced by the profuse watery exhalation from the skin caused by this treatment.

"The disease first appeared in the Alms-house, July 29th; it reached its period of greatest activity on the 8th and 9th of August, gradually declined, and terminated on the 25th of August.

"In the Arch street prison are confined vagrants, disorderly persons, criminals guilty of petty larceny, most of them the victims of low and brutal debauchery, and a limited number of debtors.

"The disease manifested itself on the 31st of July. Cases continued to occur daily, but on the 5th of August the number of cases and deaths suddenly augmented, producing a scene of almost unexampled desolation. In the same room were mingled the dead, the dying, the sick, and the well. The prisoners became frantic with despair, and threatened the lives of the officers and attendants. A number of medical gentlemen, the inspectors and others, repaired to the prison to alleviate the sufferings of these unhappy beings. The vagrants were discharged, the sick were conveyed to the hospitals, and all the prisoners whom it was possible to release were dismissed. The confusion was so great, that a return of the cases and deaths was not made to the Board of Health on that day. By reference to the meteorological table, it will be seen that on the 5th August, the day the disease in the prison acquired its sudden intensity, the barometer had fallen lower than it had been for a month previous, the maximum of the thermometer was at the highest point for the month, and the dew point at the highest elevation. The atmosphere in consequence was light, moist, and oppressive to the feelings. Was this meteorological state of the atmosphere, and the sudden augmentation of the disease, mere coincidence, or were they connected?

"The mortality of the disease in relation to sexes, is shown in the following table. The relation as to cases cannot be ascertained.

"Number of deaths from commencement of cholera to September 1st, per weekly reports of interments, was—

Deaths, 909.	Males, 539.	Females, 370.
Under 20 years.	do. 70.	do. 48.

" *Table of Deaths from Cholera, arranged as to Periods of Life; showing also the Ratio of Deaths from Cholera to the Periods of Life.*

Ages.		Deaths.	Ratio.
Under 1 year		4	1 in 604
Between 1 and 2 years		4	1 503
2	5	30	1 912
5	10	39	1 919
10	15	19	1 188
15	20	22	1 96
20	30	179	1 81
30	40	228	1 60
40	50	159	1 46
40	60	100	1 28
60	70	71	1 102
70	80	47	1 212
80	90	5	1 36
90	100	1	
100	110	1	
		909	

"From this table it results that the earlier periods of life give the greatest exemption from the attacks of the disease, especially the ages from 2 years to 10 years; and that the period of life most prone to be affected, is from 40 to 60 years, and more particularly from 50 to 60 years.

"The ravages of the disease were more extensive in the coloured than in the white portion of the population, in proportion to numbers. The fact is shown in the following :—

" *White Population.*

Nineteen hundred and seventy-seven cases.
Ratio of cases to white population—1 to 74.

" *Coloured Population.*

Three hundred and thirty-eight cases.
Ratio of cases to black population—1 to 41.
Ratio of blacks to white population—1 to 11 4-7.
Ratio of cases of blacks to whole number of cases—1 to 6.

"It has been a common observation by writers on epidemic diseases, that during the prevalence of an epidemic, it appeared to subdue and suppress all other diseases, monopolising to itself, for a time, all the energies of destruction. This observation has been repeated since the days of Sydenham, by whom it was announced, though it has not been supported by statistical evidence.[1] In the present epidemic, although its influence was so extensively felt in the city, the observation has not been sustained. The following table shows very clearly, that during the prevalence of the late epidemic, other diseases continued, not only unabated, but actually augmented, causing an increase of mortality independent of that produced by cholera. During the months of June, July, and August of this year, the deaths from the diseases generally prevalent, exceeded those of the corresponding months of last year, 425. It is to be remarked, however, that the diseases in which the augmentation of the mortality was the greatest, are those congenerous with cholera, viz. gastric, enteritic, febrile diseases, and inflammations. All those diseases appear to have derived an increase from its presence. It is also to be observed, that scarlet fever, instead of yielding to the sway of cholera, was actually augmented.

"*Table*[2] *showing the prevailing Diseases independent of Cholera; what influence it exerted over them; and the rate of their Mortality.*

DISEASES.	1831.				1832.			
	June.	July.	Aug.	Totals	June.	July.	Aug.	Totals.
Consumption, . .	35	41	33	109	44	52	73	169
Convulsions, . . .	18	26	29	73	28	29	39	90
Cholera Infantum . .	45	132	82	259	25	134	157	316
Diarrhœa and dysentery,	18	28	49	95	15	47	83	145
Fevers, ...	17	24	35	76	31	35	65	131
Scarlet fever, . .	5	29	10	24	23	17	14	54
Inflammations in general,	32	19	26	77	28	43	29	100
Inflammations in the chest, ...	16	10	8	34	16	15	7	38
Inflammations in the abdomen, ...	16	9	18	43	12	28	22	62
Dropsy in the head, .	22	22	29	73	5	33	23	61
Do. in the chest,	2	4	6	12	2	4	3	9
Do. in general, .	6	12	11	29	3	10	9	22
Debility and decay, .	28	33	29	90	16	45	8	89
Apoplexy, . . .	9	8	4	21	4	8	7	19
All diseases, (still born deducted,) . . .	294	467	490	1251	369	785	1431	2585
All diseases, (malignant cholera deducted,)	294	467	490	1251	369	689	618	1676
Excess in mortality of 1832, ...					75	318	941	1334
Excess after deducting mortality from cholera, ...					75	222	428	425"

[1] This opinion is also supported by Villermé, who says, that during the cholera epidemic in Paris, other diseases became more rare. I prefer Dr. Jackson's view of the case, as agreeing with my own experience during the cholera epidemic in Dublin in 1832 and 1834.

[2] "For this table I am indebted to Dr. Emerson."

Why the cholera, *if an imported disease*, should have broken out nearly simultaneously in Quebec and Montreal, is very easily accounted for, since both are the receptacles of British and other foreign emigrants; and on the same principle, we must explain its appearance so soon after at New York, where, no doubt, it arrived by a separate importation from Europe, a circumstance which will prevent us from feeling the same surprise with Dr. Jackson, that between Quebec and New York *all the intermediate cities on the seaboard escaped*, at least for a few months. This is analogous to the exemption of Waterford and Wexford during several months that cholera raged in Dublin and Cork. I have published Dr. Jackson's Report unabbreviated, because it is intended to be conclusive against the theory of contagion; while it, in my opinion, contains strong internal evidence of a contrary tendency. The great number of cases which occurred in the Alms-house and Arch street prison, seems to me to furnish a conclusive argument in favour of its contagiousness; and Dr. Jackson admits that it arose among the lower orders of emigrants both in New York and Philadelphia; but as I do not wish to entangle myself in a protracted discussion of this question, I shall now resume the account of the progress of cholera. In the United States it spread far and near, as might be expected from the wonderfully rapid and frequent intercourse that takes place all over the Union; but except in the condensed population of the chief seaports, its ravages were not great. It is curious to observe how little Philadelphia suffered in comparison with Montreal, Quebec, or New York; no doubt because its population is less condensed, and live in families more separated from each other. In making this observation, I do not mean to undervalue the power of predisposing causes, such as poverty, bad diet, intemperance, &c., which prevail more in the latter cities than Philadelphia. Still, comparing America with those European and Asiatic countries which suffered most, the only constant difference we can discover is, that the separation of families is much more complete in the United States than in any other country except England; and to this difference, consequently, we are justified in referring for an explanation of the remarkable fact, that England and the United States fared better than other countries, notwithstanding their acknowledged superiority, above all in the facilities of internal communication. A wish to be brief forces me to conclude the subject of the cholera in North America, with the following list of places, and the dates of its arrival in each.

Albany, ...	3d July, 1832.
Troy, ...	16th July, ,,
New Brunswick, ...	July, ,,
Rochester, ...	July, ,,
Baltimore, ...	August, ,,
Washington, ...	August, ,,
Boston, ...	August,[1] ,,

[1] I am not certain of the dates of its first appearance where the day of

Cholera did not reach South America at all, a fact explicable by the great length of the voyage from the infected countries, which reason also protected the Cape of Good Hope, the West Indies, and New Holland. It is a curious fact, that New Holland, for the same reason, has hitherto been free from measles, scarlatina, and hooping-cough, although the colony is fifty years old. We must now return to Europe; and first with respect to Portugal. It appears from the following editorial paragraph in the Medical Gazette,[1] that the disease was imported. "The London Merchant Steamer sailed from England for Oporto, on the 25th December, 1832, and arrived at the mouth of the Douro on the 1st January, 1833, having lost seven persons on her passage by cholera. The troops which she took out, with General Solignac, landed immediately at Foz, about two miles to the west of Oporto. By a letter from a medical gentleman of that city, which we have lately seen, it appears that cases of the disease occurred at Foz, on the road to, and in Oporto, before the 15th of January; and we know from other authorities, that it has since spread to *Coimbra* on the south, and *Vigo* on the north."

Mr. Lardner, a very intelligent surgeon, and formerly a pupil of mine, has written a very interesting paper on the progress of cholera in Portugal.—Lancet, 1834-5, p. 314. He is a decided non-contagionist, but his facts seem to me to be strongly corroborative of the doctrine of contagion. Among other admissions, the following is almost conclusive. "Lisbon was not visited by cholera for a considerable time after Aveiro; which fact may give the contagionist a lift, for during the siege there existed no direct communication by water between Oporto and Lisbon. The Miguelite batteries would not allow a ship to enter the Tagus, and Donna Maria's ships kept a strict blockade outside the bar." The epidemic took six months to travel slowly by land from Oporto to Lisbon. Had the communication by sea between those two ports been open, no doubt it would have reached Lisbon sooner: in America how quickly it extended from one seaport to another. It is a remarkable circumstance, and one which ought to have great weight in the discussion respecting the contagiousness of cholera, that *cholera has in no recorded instance appeared in any place sooner than the ordinary modes of communication might have brought it from some infected station.* Again, it can easily be proved that *the rate at which cholera travels varies with the rapidity of that communication.* A few weeks were sufficient to transport it from the ports of Britain more than three thousand miles across the Atlantic to Canada, while it took six months to creep along the interrupted line of communication between Oporto and Lisbon. The following dates refer to Portugal, Spain, and Italy. I regret that I have not ascertained more numerous and accurate *data* respecting its pro-

commencement is not mentioned; but in all the above places the cholera prevailed during the above months.

[1] Vol. xii. p. 123.

gress in these countries, but what I have been able (in my hurry) to lay my hands on, will perhaps prove sufficient for my present purpose, which is only to map out the route and march of the main body of the disease. From the preceding observations it will appear, 1st, that cholera has had no fixed rate of progress; 2d, that it has spread in every direction, sometimes traveling northwards, sometimes southwards, at other times east or west, its route being determined not by the points of the compass, but by the great lines of internal and international communication.

Oporto, ...	3d January, 1833.
Aveiro, . . .	3d February, "
Coimbra, . . .	March, "
Vigo, . . .	March, "
Lisbon, ...	15th June, "
Havana, . . .	26th Feb., "
Drammen, (Norway,) .	1832. "
Christiana, . . .	29th September, 1833.

Cholera never got to any other West Indian islands, nor to British (fomerly Dutch) Guiana, Demerara, nor any of the embouchures of the great South American rivers, Amazon, Orinoco, or La Plata—[Dr. Gilgeous]—though the soil and climate, with the immense tracts of inundated and swampy lands, would there seem most favourable to its developement.

Cholera spread extensively in France in summer:—

Marseilles, ...	Spring, 1835.
Toulon, ...	Ditto, "
Mexico, (frightful,) . .	Summer, July, 1832.

In September, 1835, (Lancet, vol. for 1834-5, p. 782,) "the cholera had nearly ceased its ravages in the south of France, and took a south and easterly direction along the countries bordering the Mediterranean Sea. It has penetrated into Piedmont in spite of the strictest precautions, and now prevails with more or less intensity at Nice, Coni, Livorno, Genoa, Florence." From this extract we do not learn the dates of its arrival at the above places, but they were probably according to their respective distances from France. The kingdom of Naples was not infected until a still later period: at Naples, probably, September, 1836. It attained the maximum at Naples on the 22d November, 1836; Algiers, 14th October, 1837; Bona, September, 1837.

To trace it accurately, its secondary routes and dates of reappearance should be made out; it would then be found to have returned often on its steps.

Thus in September, 1837, Marseilles was attacked for the third time, while in same season of the year 1837, it reappeared also at Berlin, Prague, and Danzig.

It is worthy of remark, that cholera began at Naples, which carries on a perpetual commercial intercourse with Marseilles, about a year before it commenced in Rome! August, 1837. The disease travelled southwards in the north of Italy, setting out from France; northwards in the south of Italy, starting from Naples.

An interesting question here arises, whether cholera is likey to become a permanent resident in this country. Its history indicates that it will not; for although cases of Asiatic cholera are now and then met with, they are by no means so violent or intense as formerly; and their comparative unfrequency may be judged from the fact, that but 460 deaths from cholera took place in England and Wales during the six last months of 1837, while other diseases formerly introduced from abroad, but which have become thoroughly naturalised in Great Britain, present a very different result. Thus in the half year the deaths from

Small-pox were	5,811.
Measles	4,732.
Scarlatina	2,520.

Sir James Clark, physician to her majesty, has interested himself much in obtaining information for me respecting the progress of cholera in Great Britain; and has on this occasion, as on many others, displayed a most praiseworthy zeal for the promotion of medical science. To him I am indebted for maps of Scotland, England, and Ireland, constructed specially for my use, and in them are marked, with the greatest accuracy, all the places where cholera appeared. These maps I had intended to publish, but found that the expense would be very considerable, and far beyond what could be borne by a periodical; as a substitute for the maps, I have composed a list of every city, town, or village attacked by cholera, in Great Britain; and have arranged the names in counties beginning in the north of each kingdom, and setting down the counties, as we proceed southwards, in an order arranged (in each successive set) from west to east. This list will enable any of our readers to construct the maps for himself with great ease and accuracy. The numbers in the list refer, I believe, to the order of succession in which the disease arrived at each place respectively. If this be so, the value of the table will be still greater. Sir James Clark has most kindly promised to procure the precise dates for every place as soon as possible, and I shall not fail to publish them in the March number of this Journal.

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Rush,	79
Malahide,	16
Portmarnock,	80
Baldoyle,	32
Howth,	10
Santry,	63
Clontarf,	12
Hollywood,	65
Castleknock,	75
Glassnevin,	33
Finglass,	66
Chapelizod,	33
Palmerstown,	155
Clondalkin,	4
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Adare,	96	Innishannon,	66
Loughmore,	68	Ballymartle,	48
Castle Connell,	47	Millstreet,	150
Limerick,	30	Kanturk,	73
Abingdon,	154	Buttevant,	16
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Pallasgreen,	170	Mallow,	22
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The maps from which the preceding tables have been constructed furnish, even on a cursory examination, some very interesting particulars. In Scotland nine tenths of the extensive regions north of the Clyde, and popularly termed the Highlands, escaped, and the parts which were visited form two leading groups, the smaller situated at either side of the eastern embouchure of the Caledonian canal; the larger including the country immediately north of the line joining the Firth of Forth and Firth of Clyde.

Now there is here an evident connection between the visitation and the chief routes of commerce and communication, a fact rendered still more striking by the total immunity from cholera which the whole of the western Highlands enjoyed, there being no infected locality between Inverary and Cape Wrath. Again, the Mull of Cantire escaped, with the exception of Campbelton, a seaport possessing a frequent steam communication with Glasgow. In the Lowlands, the greatest number of infected places occurred in the vicinity of the great line of communication connecting Edinburgh, Glasgow, and Greenock, and near the English borders, particularly towards the eastern extremity, not far distant from the county in which cholera first appeared in England. A very striking circumstance is the freedom from cholera enjoyed by the Western Isles, (Hebrides,) and all the western ports of Scotland, while so many of the eastern ports were affected. Here the exemption cannot be attributed to any comparative salubrity of climate, and freedom from low swampy tracts of country, and river courses, but to the manifest facility which the coast trade on the eastern side of the Caledonian peninsula afforded to the transmission of the disease. Many similar deductions might be made from an examination of the map of cholera in England and Ireland, but want of space prevents me from entering into further particulars.

I cannot conclude, however, without noticing the curious and remarkable fact, that the country, which of all others most abounds in swamps and pestilential miasmata, I mean the western coast of Africa, escaped the visitation of cholera altogether; not a single town on the Atlantic shore of Africa was visited. Sierra Leone, and all the low, half-inundated but thickly inhabited countries in the embouchures and deltas of the Gambia, the Niger, and the Zaire, escaped. Contrast this immunity with the ravages the cholera made in all the Mediterranean seaports of Africa, where the soil is comparatively dry and sandy, and the inference is obvious.

THE END.