

## **On certain abnormalities of the bones / by Arthur E. Durham.**

### **Contributors**

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ON CERTAIN  
ABNORMAL CONDITIONS OF THE BONES.

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PART I.

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BY

ARTHUR E. DURHAM, F.R.C.S., F.L.S., &c.,

ASSISTANT SURGEON TO, AND LECTURER ON  
ANATOMY AT GUY'S HOSPITAL.

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FROM GUY'S HOSPITAL REPORTS,

1864.

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ON  
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THE BONES.

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BY ARTHUR E. DURHAM.

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SOME diseases are especially interesting on account of their frequency and obvious practical importance, others seem rather to attract attention because they are so rare and (when met with) appear so curious. But it is manifestly desirable to become acquainted, as far as we can, with every form of disease that may possibly present itself, as well as with those forms which actually occur most frequently. Moreover, striking instances are not wanting in which cases and specimens, long regarded as mere pathological curiosities, have been found to possess important practical bearings when advancing knowledge has led to the recognition of their true significance. I need, therefore, offer no apology for devoting the following few pages to the discussion of some points in connection with those remarkable conditions of the bones which are called respectively (and not inappropriately) Mollities Ossium or Osteomalacia, and Osteoporosis, especially that form of the latter which, when affecting the head, has sometimes been designated Hyperostosis Cranii. Each of these conditions is very rare, at any rate in those advanced stages in which alone, in the present state of our knowledge, it can be recognised. Each (the latter especially) has been accidentally discovered after death in many instances in which its presence had never been suspected, much less accurately diagnosed, during life; and further, there is, I believe, a very intimate relation, in point of succession, between the two conditions to

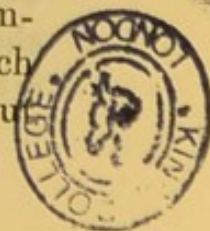


the existence of which, as far as I have been able to ascertain, attention has hitherto been but very imperfectly, if at all, directed. Before entering upon the discussion of the general history of these diseases, however, I would venture to ask attention to the details of a few interesting cases hitherto unpublished.

## MOLLITIES OSSIUM.

I am indebted to Mr. Hilton for permission to publish the following case, and to his dresser, Mr. J. J. Phillips, for the particulars with which he has kindly furnished me. This case, I think, fairly illustrates the usual origin, progress, symptoms, and termination, of the most severe form of progressive softening and absorption of the bones.

CASE 1.—S. W—, a respectable married woman, æt. 45, was admitted into Charity Ward, Guy's Hospital, under the care of Mr. Hilton, on the 23rd of November, 1863. She had come of healthy parentage; her father had been dead only a year at the period of her admission, and her mother was still living. Of her thirteen brothers and sisters nine were alive and well, and of the four who had died none suffered from any hereditary or constitutional disease. She herself was always somewhat below the standard height, but up to the commencement of her present malady had enjoyed uniformly good health, although she had been subject from time to time to considerable privations. She had worked hard as a laundress, and consequently had been frequently for long hours in bad atmosphere; *otherwise*, she does not appear to have been exposed to cold and damp to any noteworthy extent. She had resided for many years in the immediate neighbourhood of Ludgate Hill. She had borne four children, all whom, at the time of her admission to the hospital, were alive and apparently healthy; the eldest being twelve years of age, the youngest about four. After the birth of the last-mentioned child she very soon became again pregnant, and about three years before admission she was delivered, after a very long, lingering labour, of a full-grown but stillborn child. When sufficiently recovered from her confinement to leave her bed she was suddenly seized with such severe pain in both heels that she was quite unable to pu





either foot to the ground. The pain gradually extended up the legs; both lower extremities became œdematous, and the abdomen ascitic. By the end of seven weeks the pain was so far alleviated, and the swelling so far diminished, that she managed to walk about; but she remained in a low state of health, and the pain never entirely left her. In the course of two years the pain again became very severe; it was felt in both lower limbs throughout their whole extent, but seemed especially to cross, as it were, from one hip to the other.

In October, 1862, while attempting to dress herself, she fainted, and fell from the edge of the bed on which she was sitting to the ground. A medical man who was called in, stated that the right thigh-bone was broken, and advised her to go to some hospital. She accordingly obtained admission into St. Bartholomew's, where she remained five months. A long straight splint was applied to the outer side of the injured thigh and kept on for a month. No reparative action took place. About a month after her admission, while the bed-clothes were being changed by the nurse, the left femur gave way. She did not feel the bone crack; it seemed merely to bend, as if it were not strong enough to support the weight of the limb. During the remainder of her stay in the hospital the limbs were kept in as good position as practicable by means of pillows.

In March, 1863, she left St. Bartholomew's, hoping to be able to do a little needlework at home. She found herself, however, quite unable to do anything of the kind. She was confined absolutely to her bed, overpowered by severe pain and general weakness. Deep-seated aching pain soon attacked the upper extremities also, especially the left; and one bone after another gave way, in each instance bending rather than breaking. The left humerus followed the femora, then the bones of both legs, then the right humerus. The thighs could be moved into almost any shape or position, and much suffering was occasioned by their frequent accidental displacement. In this miserable state the poor woman remained, until, her house being required by the London Chatham and Dover Railway, she was brought by the officials to Guy's Hospital, packed in a box especially made for the purpose.

On admission (November, 1863) her condition was most



pitiable; she was much emaciated; almost every part of her body was more or less deformed, and her sufferings from pain, and excessive weakness were manifestly very acute. Her hair was of a dark-brown colour, as also were her irides. There was no arcus senilis. The head preserved its normal form, but the malar bones were very prominent. The superior maxillary bones were soft, yielding readily to pressure. The inferior maxilla was much firmer. The teeth were tolerably good, and did not appear to be at all softened. Mastication gave rise to considerable pain, and at best was only imperfectly accomplished. The chest was much deformed, especially on the left side, from softening and falling in of the ribs. Some idea of the deformity presented by the lower part of the body may be obtained from Plate I. The skin generally was more or less scaly, and on the legs especially was almost ichthyotic in appearance. There was no manifest indication of any visceral disease. Her appetite was tolerably good; thirst always considerable, at times intense; pulse normal in frequency, but feeble; respiration not hurried. She did not complain of headache nor of pain in the back. The perspiration was free, always probably rather in excess, and at times very profuse; it did not possess any peculiar odour, nor was it noticed to stain the linen in any remarkable manner. The urine, when passed, was of a pale-straw colour, not quite clear, alkaline in reaction, but *not* ammoniacal, and of specific gravity 1015. On standing over-night a whitish sediment, composed chiefly of phosphate of lime was deposited, and an iridescent pellicle of triple phosphate appeared on the surface. An abundant white precipitate, soluble in nitric acid, insoluble in acetic acid, was thrown down on the addition of oxalate of ammonia. Nitric acid, when added, caused no precipitate, nor did it give rise, even after very long standing, to the remarkable reaction noticed by Dr. Bence Jones\* in a somewhat similar case. The urine preserved about the same character throughout.

She was ordered to take half an ounce of lime-water in milk with a drachm of syrup of poppies three times a day; also two drachms of syrup of the phosphate of iron in water three times a day after her meals; six ounces of wine, and such

\* 'Transactions of Royal Society,' 1848.



food as she could take. For some days she continued apparently in much the same state, her appetite being tolerably good. She complained of intense pain in the extremities (particularly the lower), brought on by the slightest motion, continuing for an hour or two, and then partially subsiding.

On 19th December she was ordered to take, instead of the before-mentioned medicines, a teaspoonful of bone powder in cod-liver oil thrice daily. It was found, however, that the lime salts were not assimilated to any extent, for during their administration the quantity of lime carried off in the urine was proportionately increased. The cod-liver oil, moreover, made her sick. These medicines were therefore discontinued.

About the latter end of December the greatest pain was in the left upper extremity, the bones of the whole of which were soft, and gradually becoming more and more bent.

On the 7th January, 1864, she was ordered to take fifteen minims of the tincture of the sesquichloride of iron in infusion of quassia three times daily; her wine was increased to eight ounces, and a little brandy was also given from time to time.

On the 14th January a considerable quantity of florid blood and some coagula were passed from the bowels; the hæmorrhage continued during the next day, and then ceased. Gallic acid and infusion of roses were freely administered. The general decline of the patient, which hitherto had been gradual, and marked by no special indications or symptoms, now became very rapid. She presented much the appearance of a patient in the last stage of hectic fever. Day after day she appeared manifestly weaker. Her respiration became more and more gasping, hurried, and difficult; and on the 19th January she died, apparently from simple inability to breathe longer, on account of the extremely soft and yielding condition of the ribs. The muscles of respiration at each effort seemed rather to bend the ribs than to expand the chest. During the latter days of her life her head was the only part which at all retained the natural form. The chest was much distorted, the spine somewhat curved. The extremities were all, with the exception of the right forearm, more or less bent and twisted.

At the post-mortem examination no disease of any of the



viscera was discovered. The brain appeared firm and healthy. The heart was natural, its muscular tissue not obviously degenerated. The lungs were sound, and less congested than might have been expected, considering the mode of death. The liver was not unusually fatty. The alimentary canal appeared healthy throughout. There was no ulcer nor internal pile in the rectum, but this portion of bowel was enormously distended by fæces. No further explanation was found of the hæmorrhage which had occurred shortly before death. The kidneys were apparently normal, except that one contained a small calculus in a pouch connected with its pelvis. The subcutaneous tissues were œdematous, and contained a quantity of altered fat.

All the bones examined had undergone, to a greater or less extent, those remarkable changes in appearance and texture which are characteristic of true mollities ossium. They could without exception, be cut by the knife, and for the most part with great ease.

The shafts of the long bones were affected to the greatest extent. When cut into by the knife they seemed to consist of a soft, red, greasy mass, breaking down easily under the fingers, not unlike liver in appearance, but more gelatinous in consistency, enclosed in a sheath of thickened and somewhat altered periosteum. The extremities of the bones, almost without exception, retained externally a shell of bony material, but internally presented the same appearances as the shafts.

The bodies of the vertebræ seemed eaten out, as it were, into large cavities, filled with a soft red substance similar to that in the long bones. The transverse processes and laminae, as also the ribs, clavicles, and sternum, were similarly affected. All of these, though much hollowed out, retained some bony material. The pelvis was not notably distorted; its bones, however, had undergone considerable softening. The skull presented, when cut, a very peculiar appearance. It was considerably increased in thickness, red in colour, and so far homogeneous that no distinction was visible between the tables and diploe. In texture it somewhat resembled softened pasteboard. The basilar process was flattened out in such a manner as made it appear to have altered its relation to the foramen magnum. The sutures could scarcely be traced.



Several small portions of bone were kept, and are now in the museum. Representations of some of them, drawn to the natural dimensions, are given in Plate II.

These drawings necessarily convey but a very imperfect idea of the curiously abnormal appearance of the recent specimens. Still, however, the remarkable thinness of the remaining external shells (figs. 1, 4) of bone, the almost entire absence of true cancellated structure (figs. 1, 2, 4), the attenuation of the articular cartilages (figs. 1, 2, 4), the fusion, as it were, of the semilunar cartilages with the head of the tibia (fig. 1), and the partial fibrous ankylosis of one condyle of the femur to the corresponding tuberosity of the tibia (fig. 2), are tolerably well shown, as also are the "excavated" appearance of the bodies of the vertebræ (fig. 5), and the thickening and unnatural uniformity in substance of the calvarium (fig. 3). In the recent state the cavities, small and large, in all the bones, were filled with soft, or even semifluid, greasy material, varying in colour in different parts from yellow to dark red, and similar to that already described as replacing the shafts of the long bones.

I have very carefully examined, both chemically and microscopically, the several portions of bone which were preserved. The results of my examination, although, for the most, agreeing with those obtained by previous observers, seem in certain respects to suggest ideas as to the possible course (if not as to the essential nature) of mollities ossium, somewhat, perhaps, in advance of those hitherto maintained. These results, however, and the ideas suggested, can be more conveniently discussed at a future page.

I am indebted to Dr. Gull for the particulars of the following case:

CASE 2.—Some few years ago Z—, the wife of a medical man, began to suffer with gradually increasing weakness and pain in the dorsal region, associated with more or less deformity, somewhat resembling that produced by ordinary antero-lateral curvature of the spine. She consulted Sir B. Brodie, who told her she need be under no anxiety; the deformity had probably existed a very long time—most likely from girlhood—and would not get worse. She herself was satisfied that the



deformity was of recent origin; and, after a time, finding her weakness increasing, and her deformity becoming more manifest, she went to Dr. Gull for further advice. At the period of her first visit she was about fifty-four years of age, rather under the middle stature, and apparently in feeble health. She had had a large family, and had ceased to menstruate a year or two. She had suffered much from various causes of mental anxiety, but not from privation, nor any unusual exposure to cold or damp. She complained of great general weakness, and inability to hold herself upright, or exert herself in any way. Her deformity was remarkable, but difficult to describe. The spinal column in the dorsal region seemed bowed backwards and to one side; the ribs were flattened laterally and projected anteriorly. Her whole appearance conveyed the idea of a general softening and yielding of all the bones entering into the formation of the thoracic parietes. She did not complain of pains in her limbs, and the long bones were very little, if at all, affected. She suffered a great deal from headache. As the malady progressed her head seemed to sink down between her shoulders. There was no evidence of any visceral disease. The urine was not particularly examined; at any rate, no peculiarities in it could be remembered. From the period of her first visit to her death, which occurred in somewhat less than a year, she was seen from time to time by Dr. Gull, as well as by Sir B. Brodie, who was much struck by the difference between the actual progress of the case and that which he had at first anticipated. The thoracic deformity rapidly increased. The spine became more and more bowed; the head sank lower and lower between the shoulders; the ribs seemed to pass more and more one over the other; and the sides of the chest became more and more flattened, until the appearance was presented of a general collapse or squeezing in of the whole upper part of the body. At length the patient died, literally because she could breathe no longer. For a short time before death there had been some bronchitis, but not to such an extent as would have proved fatal under ordinary circumstances.

CASE 3.—In the year 1837 the body of a woman was brought from the workhouse to the dissecting-room of Guy's



Hospital, where it was discovered that she had been the subject of mollities ossium. The pelvis,<sup>1</sup> femur,<sup>2</sup> tibia and fibula,<sup>3</sup> are preserved in the museum, and afford good illustrations of the disease under consideration. The following particulars of the case are quoted, or condensed, from the account given in the 'Museum Note-Book,' No. 2, page 33:

It was ascertained, on inquiry at the workhouse, where she had lived for seven or eight years, that the patient, having been a very active little woman, had been employed for some time as helper in the house, and in the fulfilment of her duties had been in the habit of "lifting and carrying considerable weights." About four years before her death "her strength began to fail, and from that time she complained of constant pain in the lower extremities." At a subsequent period she also complained of pain in the upper extremities. She became gradually weak, and by the end of a year she was scarcely able to walk. It was also noticed that her back was beginning to be unnaturally bent. In the course of another year she had become quite helpless and confined to her bed. For several months her urine was observed to be "very thick, like thin gruel or flour mixed with water," to deposit a sediment, and to become "very offensive to the smell soon after emission." During the last year, or year and a half, of her life her spine appears to have become much curved. She was noticed to be "always bent towards the right and forwards, with her legs slightly drawn upwards, the left leg inclining over the right." Sight, hearing, and voice, remained good up to the time of her death. There was nothing peculiar about the "evacuations from the bowels."

On examination in the dissecting-room it was found that the exterior of the skull was less resisting than usual, and internally "the whole base, including (the superficial parts of) the petrous portions of the temporal bones, was decidedly soft, allowing an incision of nearly a line in depth to be made with ease. The bones of the internal ear, however, appeared quite as hard as usual, nor did the interior of the petrous portions seem to have been altered in density." In the dorsal region the spine was extremely curved towards the right side, "a por-

<sup>1</sup> See Specimens 1124<sup>90</sup>, (2) 1134<sup>74</sup>, 75, (3) 1212<sup>82</sup>, and Drawing No. 8, 'Catalogue Pathological Collection, Guy's Hospital Museum,' vol. i, p. 8.



tion of it being compressed in the deep groove between the sides of the vertebræ and the internal aspects of the ribs."

"The pleuræ (on the right side) were adherent, and the lung consolidated by compression. No tubercles were observable in the lungs. The heart appeared healthy, excepting that its fibres were paler and softer than usual." The arteries were similar in condition to those of aged persons. The sciatic nerve was very much enlarged (on which side is not stated, nor whether on both; no relation, therefore, can be made out between this peculiar condition of the nerve and the nutrition of the parts supplied).

Almost "any part of the skeleton could be cut with an ordinary scalpel, either transversely or vertically." The ribs could all be bent by very slight pressure, and very easily broken.

The humerus, also, was easily bent, and broken by the hands alone, "without any great effort."

The pelvis also was soft and bent by the weight of the body. It is accurately described in the 'Catalogue of the Museum' (p. 85) as "presenting the peculiarities produced by mollities ossium; the acetabula have been thrust upwards, the spine downwards, and the pubes forwards; the opening of the pelvis is thus much narrowed, and of a heart-shape, the pubes being rostrated."

On section the shafts of the long bones, which had undergone the most extensive softening, were found to consist of "thin diaphanous shells" of bony material, in some parts scarcely thicker than "common writing-paper," and hardly any were more than one-twentieth of an inch in thickness, except in the neighbourhood of certain fractures, to be presently described. The cancellated structure was "not bony and crisp, as usual, but soft and membranous."

The lower half of the left femur showed, perhaps, the least deviation from the normal state. The outer shell of bone was rather thinner and less dense than in health, but much denser and harder than that of any of the other bones of the same extremity. The interior was occupied by an opaque, thick, jelly-like substance, yellowish or brown in colour, and, at first sight, apparently homogeneous. By means of a probe, however, branching filaments, which appeared to consist of the endosteum and blood-vessels of the cancellated tissue, could be



raised out of the mass. Minute scales of bones were noticed adhering to the membranous filaments. The articular cartilages appeared healthy.

The left femur and the right tibia and fibula had been fractured during life. No successful attempt at bony union was manifest. There were no signs of active change in the surrounding soft parts. There did not appear to be any increased vascularity about the fractured ends themselves. The periosteum around them, however, was much thickened for the space of about two inches; and a new "deposit" of bony material had taken place upon the old shells, whereby their substance was increased to an average thickness of three lines for an inch or so from the point of fracture. The new bony deposits, like the old shells, were soft and spongy.

The museum of Guy's Hospital contains several specimens illustrating mollities ossium besides those obtained from the subjects of the cases above related. None of them, however, require any detailed description in the present paper, although they deserve a passing notice. Two<sup>1</sup> were taken from the body of Sarah U—, whose case is fully recorded in Mr. Solley's well-known paper in the twenty-seventh volume of the 'Medico-Chirurgical Transactions.' Two<sup>2</sup> others were taken from the body of a man who had been under the care of the late Mr. Bryant, of Kennington. "When first seen, this man had the bones of his legs bent and broken; the clavicles were out of place, and had formed false joints; the humeri were very brittle and easily broken."<sup>3</sup> No further particulars are given.

There is also in the museum the skeleton of a sweep<sup>4</sup> said to have been the subject of mollities; but there is no history, and the nature of the disease is doubtful.

To proceed now to the more general consideration of the causes, symptoms, and phenomena of mollities ossium, Litzmann—whose treatise on the subject,<sup>5</sup> with the exception,

<sup>1</sup> Specimens No. 1004, 1004<sup>89</sup>. Presented by Mr. Solley.

<sup>2</sup> Specimens 1160<sup>64</sup>, 1160<sup>65</sup>.

<sup>3</sup> (Museum) Note Book, p. 48.

<sup>4</sup> Specimen 1000<sup>30</sup>.

<sup>5</sup> 'Die Formen des Beckens, insbesondere des engen Weiblichen Beckens, nach eigenen Beobachtungen und Untersuchungen, nebst einem Anhang über die Osteo-



perhaps, of Beylard's, is, I believe, in many respects, the most complete yet published—has collected and analysed 131 cases. I have, as far as I have been able, referred to the original details of these cases, and, with a few somewhat doubtful exceptions, cannot do otherwise than accept them as genuine examples of the disease in question. In addition to the number quoted by Litzmann, I have been able to collect the particulars of 14 other cases, making a total of 145.

Of the 145 patients, 13 only were males and 132 females.

Of the females, 91 were first affected during pregnancy, or very shortly after childbirth.

The symptoms of the disease first appeared in 10 patients only, 7 females and 3 males, under 20 years of age, and in 12 patients over 50. The great majority began to suffer when between 25 and 35 years of age.

The bones of the pelvis are stated to have been affected in 133 cases.

"	"	spinal column	"	"	98	"
"	"	thorax	"	"	71	"
"	"	lower extremities	"	"	59	"
"	"	upper extremities	"	"	47	"
"	"	head	"	"	35	"

In 33 cases only are all the bones of the skeleton stated to have been affected.

In the vast majority of the 91 cases described as commencing more or less directly in connection with pregnancy, the first symptoms manifested themselves in or about the pelvis and lower part of the spine. In 73 of these cases the disease was absolutely confined to the bones of the trunk, and in a very great many cases there is no evidence of any other than the pelvic bones having been affected. How far such cases as these last are to be regarded as examples of true mollities may fairly be questioned. We may defer inquiry upon this point, however, to a more convenient period; for the present, I would only say, once for all, the statistics given must be taken for what they are worth, not as absolutely reliable, for many of the cases are very imperfectly reported; some being narrated only, or, at any rate, especially, in reference to obstetrical difficulties produced by the special

malacie,' Berlin, 1861. The "Appendix on Mollities Ossium," translated by Dr. Matthews Duncan, appears in the 'Edinburgh Medical Journal,' vol. vii.



deformities of the pelvis; and, in many, certain parts only of the skeleton appear to have been examined—those parts, that is to say, in which fractures or flexions indicated the existence of the disease.

In the majority of the cases not immediately connected with pregnancy or childbirth, and in some of the worst of those that were, the symptoms first, or at any rate very early, manifested themselves in the lower extremities.

As to the precise cause of this remarkable malady we know absolutely nothing. All the indications at present afforded us are negative rather than positive. Even as to the more general causes we are almost equally in the dark, so little agreement does there appear to exist between the earlier histories of different cases. Among the sufferers have been persons of originally the most different temperaments. A very large proportion are stated to have been of perfectly healthy parentage. Many, it is true, resided in unfavorable localities, but many others did not. Many had been subject to considerable privation, but others appear to have been well clothed and well fed. Some attributed the origin of their sufferings to their having slept in damp sheets,<sup>1</sup> or in cold humid situations,<sup>2</sup> or to their having worked in wet and exposed localities.<sup>3</sup> Many appear to have suffered from privation, damp, and cold, conjoined, as was notably the case with the numerous patients at Sottegem, in Flanders,<sup>4</sup> mentioned by Hoebecke, upon several of whom the Cæsarean section was performed; but many others suffered from none of these influences, much less from all conjoined. Some few (six only) were known to have had syphilis; but no evidence of any such taint appears to have been obtained in the very large remainder of the recorded cases.

Tuberculous disease is noted as having been very rarely met with; so rarely, indeed, that Beylard expresses his opinion that “an antagonism seems to exist between tubercle and mollities ossium.”<sup>5</sup> Important visceral disease has been dis-

<sup>1</sup> Howship, ‘*Trans. Med. Chir. Soc. Edinburgh,*’ vol. ii.

<sup>2</sup> Gosselin, quoted by Beylard, *op. cit.*

<sup>3</sup> Stanski, ‘*Recherches sur les Maladies des Os,*’ Paris, 1852.

<sup>4</sup> Hoebecke, ‘*Mém. et Obs. pratiques de Chir. et Obstet.,*’ Bruxelles, 1840.

<sup>5</sup> Beylard, *op. cit.*, p. 33.



covered on post-mortem examination in but few instances, and detected during life in fewer still. In no instance was the disease found of such a nature as to offer the slightest explanation of the morbid conditions of the bones, or of the peculiar symptoms therewith associated, beyond that afforded by the bones themselves.

In eight instances the patients were insane. In all, with the single exception of the first case recorded by Mr. Solly,<sup>1</sup> the bones became affected *after* the symptoms of insanity were fully established. But in the remaining 137 cases the mental faculties do not appear to have been impaired, not even in those of the cases in which the cranial bones were extensively softened. In a very great many instances, however, the patients had suffered long and severely from lowness of spirits, anxiety, fear, or grief.

One indication as to the direction in which the general, if not the particular, cause of the disease is to be sought, and one only, as far as I have been able to make out, is given in common by each and every one of the fully reported cases. In the histories of all, without exception, mention is made of the existence of some influence or other, or of some combination of influences, well known to be capable of producing great general depression of the nervous system. In many instances, moreover, such influences appear to have been in operation with or without intermission for long periods. Severe privation, and anxiety associated with precarious means of existence—long continued exposure to cold and wet—pregnancies too frequently repeated, with miscarriages or difficult labours—mental distress, profound melancholy—and all the other circumstances above alluded to—however much they differ in other respects, agree at least in this, that they, one and all, have a tendency to depress, exhaust, and even to paralyse for a time, the powers of the nervous system, and consequently to injuriously modify, to a greater or less extent, those nutritive processes upon which the maintenance of the whole body depends. It certainly appears difficult to understand why the bones should be, or seem to be, especially affected by any such general cause, and undergo more manifestly than other parts destructive changes, without compensatory reparation. But it

<sup>1</sup> In 'Med.-Chir. Trans.,' vol. ix, p. 438.



must be borne in mind that bone is among the least highly vitalized of the tissues, and certainly the least highly vitalized of all in connection with which a comparatively abundant vascular supply is ready to promote absorption, and in other ways to assist destruction as well as repair. Nay, further, the very formation of bone is, not without reason, regarded by some as a downward step, and ossification as an expression, or at any rate as a manifestation, of degeneration. Now, if this view be correct, it is not difficult to conceive that, under certain morbid conditions of the general system, destructive changes would become more rapidly, and notably manifest in those tissues in which degenerative processes had already commenced, or become established. In connection with this point it is worthy of note also, that under altogether different circumstances, as for example, from the influence of continued pressure, we find bones degenerating and becoming absorbed more quickly and manifestly than the softer parts, which are composed of more highly vitalized tissues.

On the whole, it seems probable that mollities ossium is to be regarded as a particular expression, as it were, of a general morbid condition of the system, rather than as a special disease of the bones themselves. But in the present state of our knowledge we cannot accurately describe and define any such general morbid condition, much less explain why it should give rise to the remarkable phenomena and symptoms associated with it.

A great many different hypothetical explanations of the special pathology of mollities have been suggested by different authors. All, however, that I have hitherto met with are, to my mind, unsatisfactory in the extreme. For I find, without exception, that the hypothesis which fulfils tolerably well the requirements of some cases cannot possibly be made to accord with the phenomena of others, even if it be not absolutely negated by them.

Morand,<sup>1</sup> I believe, was the first who supposed an "acid diathesis" to be the starting-point of the malady. Several subsequent writers have repeated this hypothesis, slightly modifying it in various ways. Phosphoric and lactic acids

<sup>1</sup> See Beylard, *op. cit.*, p. 227. 'Histoire de l'Acad. Roy. des Sciences,' 1753, pp. 114 and 541.



have each in turn been fixed upon as the immediate agents in the bone-softening process. C. Schmidt<sup>1</sup> found excess of phosphoric acid and lactic acid in combination with lime in the fluid contained in the interior of the bones of a patient who suffered from mollities. The fluid had an acid reaction. The patient, a young woman, was taken ill about the period of her confinement, "evidently in consequence of deep grief." Schmidt suggests the idea that the sugar of milk in the system may by some chemical change have given rise to the production of the lactic acid which was found. He does not, however, clearly make out whether the presence of lactic acid was the cause or the consequence of the altered condition of the bones. The probability, I think, is that the latter was the case; for lactic acid does not appear to have been discovered in the blood, nor in any other parts of the body than the diseased bones; and it does not seem improbable (as suggested) that the lactic-acid fermentation may have been set up in the sugar of milk contained in the blood, by contact with the changing morbid materials of the affected bones. C. O. Weber<sup>2</sup> supports the same view, and further suggests that the lactic acid serves to convert the comparatively insoluble *tribasic* phosphate of lime of normal bone into the comparatively soluble *bibasic* phosphate. Unfortunately, this hypothesis is inconsistent to an extent altogether inexplicable with the facts of many carefully observed cases; and even if it were not, it is obvious that the presence of lactic or any other acid must be regarded as a phenomenon, not as a cause—a something itself to be explained rather than an explanation—of the essential nature of the malady under discussion. Regarded simply as one of the phenomena of mollities ossium, the presence of lactic acid is important and interesting. It is, however, as already intimated, by no means a constant phenomenon, and has often been expressly sought and not found. For example, Professor H. Frey<sup>3</sup> was unable to detect any trace of lactic acid in the bones of a subject he very carefully examined. Virchow,<sup>4</sup> in a case

<sup>1</sup> "Knochenerweichung durch Milchsäurebildung;" Wöhler und Liebig, 'Annalen de Chemie u. Pharmac.,' Bd. lxi, pp. 329—335. Quoted by Litzmann, op. cit.

<sup>2</sup> 'Ossium Mutationes Osteomalacia Universali effectæ,' C. O. Weber, Bonn, 1851.

<sup>3</sup> 'Mon. f. Geburtsk.,' Nov., 1862. Quoted in 'Med.-Chir. Review,' April, 1863.

<sup>4</sup> Quoted by Litzmann, op. cit.





which came under his observation, so far from discovering any acid, found that the contents of the diseased bones possessed a strong alkaline reaction. Lehmann,<sup>1</sup> however, distinctly states that he has known cases "in which some of the bones of a patient affected with osteomalacia exhibited an acid reaction (as the femur and tibia), whilst others (as the ribs and pelvic-bones) showed no trace of the presence of acid." If more extended investigations should confirm this statement of Lehmann, and show that at one particular period in their process of change the bones contain acid, and at other periods do not, the inconsistency which at present exists between the results obtained by different observers would be explained; and some further light might be thrown on this obscure subject. This would be especially the case if it should be found that in association with such changes in chemical reaction, the bones present other equally well-characterised and constant changes in their physical condition and chemical composition.

Another very different hypothetical explanation has been suggested, to the effect that, there being in pregnant women a large "demand for calcareous salt for the osseous system of the fœtus," the bones of the mother must be proportionately ill-nourished. In support of this hypothesis the observations of Leuchs<sup>2</sup> are quoted. He states that "hens having a deficiency of lime-containing nourishment either lay eggs without chalky shells, or they produce them at the expense of their own proper osseous system; their bones become soft, the animals can no longer stand, get bent together, and die." These observations are most unquestionably very interesting; but it is difficult to understand how the hypothesis founded upon them can be made to apply to cases of mollities ossium occurring in men, or in women, who have never been pregnant!!!

M. Stanski<sup>3</sup> attributes the origin of mollities ossium to a vitiated condition of the blood.

Proesch<sup>4</sup> considers an alteration of the periosteum and endosteum to be the primary cause of the disease.

<sup>1</sup> 'Physiological Chemistry,' translated by Day, vol. iii, p. 29.

<sup>2</sup> 'Journal f. Pract. Chemie,' Bd. xxv, Heft 1, referred to by Litzmann, op. cit., Trans. 'Edinburgh Medical Journal,' vol. vii, p. 552.

<sup>3</sup> 'Recherches sur les Maladies des Os désignées sous le nom d'Ostéomalacie,' Paris, 1851.

<sup>4</sup> 'Archives Générales de Méd.,' 1835.



Lobstein<sup>1</sup> suggests that the phenomena depend upon an increased activity of the absorbent vessels, due, probably, to a more energetic innervation.

Mr. Curling<sup>2</sup> speaks of mollities ossium as a form of "eccentric atrophy of the bones," "the result of defective nutrition, and not of increased activity in absorption."

Mr. Solly<sup>3</sup>, on the other hand, considers that this is "an active disease, not a mere atrophy." He says further, "I am led to believe that it is of an inflammatory character. That it commences with a morbid action of the blood-vessels, which gives rise to that severe pain in the limbs invariably attendant on this disease, but more especially in its commencement, and exhibits itself after death by an arterial redness of the part. The absorbent vessels are at the same time unnaturally excited, and the earthy matter of the bone is absorbed and thrown out by the kidneys."

It would be very easy to add many others to the number of different opinions already quoted. But it is needless to do so. Where there is room for such difference of opinion, it is obvious that very little is known. It is equally obvious that, before any satisfactory explanation can be given of the causes and nature of the malady we are discussing, further investigation is absolutely necessary. In the present state of our knowledge on the subject it is useless attempting any new hypothesis.

But however difficult, or even impossible, it may be to ascertain the precise cause or causes of mollities ossium, and to arrive at any sound conclusion as to its essential nature, there is comparatively little difficulty in recognising the existence of this disease, at least in its more advanced stages, during life, and in tracing to a certain extent, after death, the progressive changes that may have taken place in the bones.

In the earlier stages the symptoms, though tolerably constant, are somewhat obscure, and perhaps not absolutely distinctive; but when the malady has made any considerable progress they become well marked and unmistakable.

The first symptom of mollities, as shown by the history of almost every case, is pain, more or less peculiar in character, always deep-seated, and greatly increased by pressure or motion;

<sup>1</sup> 'Traité d'Anatomie Pathologique,' t. ii, quoted by Beylard, op. cit.

<sup>2</sup> 'Med.-Chir. Trans.,' 1837, vol. xx.

<sup>3</sup> Ibid., 1844, vol. xxviii.



sometimes coming on suddenly and with extreme severity, sometimes commencing vaguely and insidiously, and gradually becoming almost insupportable; sometimes wandering, at other times fixed for a period to some particular spot, and subsequently spreading to other parts; sometimes intermitting, at other times unceasing. In some cases the pain is described as having been "dull" and "aching" in character, in others "burning," "piercing," or "tearing." In the majority of cases the pain appears to have been first felt in the lower half of the spine, the pelvis, and loins; but in some it commenced in the feet, knees, or other parts of the lower extremities. It is curious to note how, in the records of case after case, the patient is said to have suffered from "rheumatic pains" for a considerable time, or to have been suddenly seized with "rheumatism." Still more curious is it to observe how, apparently in consequence of such expressions, certain authors have been led to consider mollities ossium of "rheumatic origin." Without at all doubting the existence of a malady properly called rheumatism, one cannot help being struck by the frequency with which "rheumatism" and "rheumatic pain" are employed as mere terms, and simply mean pain, the cause or origin of which has not been made out.

Associated with the pain there has always been noticed on the part of the patient, at a very early period of the malady, a feeling of general lassitude and disinclination to do anything. This feeling has increased more or less uniformly until it has ended in actual inability to make any exertion whatever.

The next set of symptoms to appear have, as a rule, been those more or less directly associated with the softening and absorption of the bones. Thus, diminution of stature, some deformity or other of the spine or pelvis, or some fracture or curvature of one or other of the long bones, has been noticed to occur, in different order of priority in different instances. Such indications of the nature of the case have, as a rule, gone on multiplying in number and increasing in extent from time to time during the remaining lifetime of the patient. Associated with the earlier periods of softening of the bones, (and probably arising from a reflex influence exerted through the nerves upon the muscles), has constantly been noticed another remarkable symptom, viz., an uncertain, feeble gait, and continual fear of



falling. General feverish symptoms do not appear to have been frequently met with during the earlier stages of the malady, but have invariably supervened towards its termination. In no case, however, could the patient be said to have suffered from acute inflammatory fever, the symptoms being always of a low, and occasionally of an intermitting, type.

In almost all the carefully reported cases it is noted that the urine contained a quantity of lime salts very considerably in excess of the normal standard, or, at any rate, some indication is afforded that such was the case.

In its earlier stages mollities ossium is liable to be mistaken for "rheumatism," diseases of the spinal cord, or certain of the more common affections of the vertebral column; and the more so inasmuch as all often appear to arise from similar general conditions. It is necessary, therefore, in dealing with obscure cases, to bear in mind the possibility of the existence of this disease, however rarely it may actually occur. Perhaps if it were more frequently thought of, it might be more frequently discovered.

The pain of mollities ossium is more deeply seated, more evidently in the bones, than that of "muscular rheumatism;" and when it occurs in the neighbourhood of joints, it is not associated with the swelling, heat, and redness, which more or less constantly characterise "articular rheumatism." It is, moreover, more persistent, and less readily yields to treatment, and it is accompanied by a feeling of weakness, and that fear of falling already referred to, which are seldom, if ever, met with in rheumatism.

The general symptoms of mollities, the seat and character of the pain, the peculiar gait and carriage of the body in walking, the absence of any loss of sensation in the lower extremities, the absence also of any difficulty in passing the urine or voiding the motions, serve to distinguish this malady from those affections of the spinal cord, giving rise to certain other symptoms which might render diagnosis difficult. It is important, however, to bear in mind the possibility of the spinal cord being pressed upon, or otherwise interfered with, during the softening and sinking together of the vertebræ, and of there thus arising a combination of the symptoms of mollities ossium and damaged spinal cord.



The general symptoms, again, and the character of the deformities which arise, serve, if attentively considered, to distinguish mollities ossium affecting the vertebral column from any of the ordinary forms of spinal disease. But that a mistake may be made, even by the most experienced, is shown by the second case I have recorded above. The deformities of the spine produced by mollities have almost invariably been found to be exaggerations of the normal curves, or, at any rate, to be much more general than those abnormal curvatures more frequently met with. In no case has anything like *angular curvature* been found, nor have abscesses in connection with the diseased vertebræ ever been discovered.

It is scarcely possible that any difficulty can arise in distinguishing true mollities ossium from that softening and fragility which occur in connection with cancerous growths or deposits in the bones.

I would only further remark, in connection with this part of our subject, that mollities ossium ought never to have been confounded, as it has been, and still appears to be, in the minds of some, with rickets on the one hand, and senile fragility of the bones on the other. In rickets the primary cartilages have never become properly ossified. In senile fragilitas ossium the animal matter of the bones appears to be absorbed as rapidly, if not more rapidly, than the earthy constituents, and none of the characteristic general symptoms of true mollities are present.

Mr. Solly,<sup>1</sup> in his valuable paper already referred to, has rightly insisted on these distinctions. I would, however, suggest that the specific name he has proposed for the disease under consideration would be more fully descriptive and accurate if it were written "*mollities ossium rubra, flexilis, et fragilis*," instead of simply "*rubra et fragilis*." Flexibility conjoined with fragility, rather than simple fragility, appears to be the distinguishing character of the bones in this disease.

A minute examination, whether microscopical or chemical, reveals peculiarities in the intimate structure and composition of the affected bones as striking, and as characteristic of mollities ossium, as are the more general and obvious phenomena and symptoms already described. The differences which

<sup>1</sup> Op. cit.



exist between the results obtained, and published by various careful observers, appear to me for the most part either to be simply differences of interpretation, or else to have arisen from the fact that different bones, or bones in different stages of the disease, have in the several cases been selected for examination.

In the following résumé of the results of my own microscopical examination of various portions of bone taken from the subject of the first case recorded above, I have ventured to arrange the appearances observed in, what appears to me, their natural order of succession. Further investigation, however, may perhaps render the correctness of this arrangement doubtful; for though I have carefully examined, I may say, some hundreds of specimens, I am still far from having succeeded in making out satisfactorily all the various shades of change through which the bony tissue must pass in its downward progress from the hardness and solidity of health to the dissolution and absorption of disease.

The different stages described were exhibited by specimens taken from different bones, or from different parts of the same bone. All sections were cut with a sharp knife; none were ground, or subjected to any such rough, destructive treatment.

The portions of bone at my command have not afforded opportunity for proper investigation of the changes in the vascular supply which may well be supposed to precede or to accompany the changes in the bone-tissue itself; but, from what I have been able to make out, I am led to the belief that an increased quantity of blood is present in the bones, at any rate during the earlier stages of the disease; but whether as a cause or consequence there is no evidence to show. In the later stages of the disease the minute vessels in the affected bones appear to become more or less highly congested and dilated; in still later stages to degenerate, and in some instances to rupture. Shreds of what appear to have been blood-vessels, free blood-corpuscles more or less natural in appearance, others variously altered or broken up, and blood-colouring matter staining the general débris, are to be found readily enough, and to a very considerable extent, in the interior of most of the cavities in the diseased bones. The increased size of the larger blood-vessels which supply the



affected bones is, to a certain extent, rendered evident by the dilatation of the grooves, canals, and foramina, through which they pass. This dilatation of grooves, &c., is strikingly exhibited by those for the meningeal arteries in the interior of the calvarium I have been especially examining.

The first indication I have seen in the bone structure itself of the commencement of the disease is that, I believe, which is afforded by a peculiar alteration in the general appearance of the "bony-matter." This alteration may constantly be observed in sections taken from the least affected bones. It is comparatively easily appreciable, particularly when the sections are examined by polarized light, and compared with similarly prepared specimens of normal bone. The "bony matter" is seen to be more opaque and less uniform in appearance than natural; sometimes, even, it is irregularly granular. The semi-translucency and apparent homogeneity of material presented by healthy bone are lost to a greater or less extent. And the idea is suggested that some disunion, as it were, must have taken place between the component elements of the "bony-matter."

Next, the lamination of the affected bones becomes less distinct, and the semi-opacity and irregularly granulated appearance of the bony matter become more pronounced. The laminae, especially the innermost ones, of the more perfect Haversian systems, appear to get more or less fused together; the lacunae (or bone-corpuscles) become wider; some of the canaliculi increase, others diminish in calibre. I have not been able to find evidence of any new formation of bone-corpuscles, nor am I satisfied of the truth of the frequently repeated statement, that in bones affected with mollities the bone-corpuscles are "more numerous than usual." On the other hand, I have little doubt that Mr. Dalrymple<sup>1</sup> is correct in his opinion that, although "at first sight the bone-cells appear more numerous than is natural," this is "due to the approximation of the cells to each other, by reason of their mutual enlargement," and he might, I think, have added, to the absorption of intervening material.

Next, the earthy matter becomes entirely separated from the animal matter of the innermost laminae, and more or less com-

<sup>1</sup> 'Dublin Quarterly Journal,' vol. ii, p. 91.



pletely absorbed. Consequently the Haversian canals are seen to be surrounded by a comparatively clear and transparent ring of animal matter, from which the normal earthy constituents have been separated and carried off.

Next, the rings of animal matter are disintegrated and absorbed. Meantime the earlier changes described are going on in the surrounding laminae. Their bony material loses its normal appearance; their lacunae or corpuscles enlarge to a greater and greater extent; their canaliculi also enlarge and shorten, or become apparently obliterated; and, finally, the disintegration and absorption of their earthy and animal matters is in turn accomplished.

The same process is continued until the regular Haversian systems are all more or less completely destroyed; and, as a general effect, the bone assumes a hallowed-out, porous, or somewhat sponge-like appearance. Pores more or less circular in outline, or minute irregular spaces formed by the conjunction of two or more pores, represent in position, the previously existing Haversian systems. These pores and spaces are separated from one another by the few concentric laminae that remain, and by those irregular laminae which may be seen in almost every bone to fill up, as it were, in the normal condition, the interstices between the more perfect Haversian systems. A good idea of the appearance presented by a portion of bone in this condition, when seen by a low power (two-thirds-inch object-glass by Smith and Beck) is conveyed by Plate IV, fig. 2. A portion of normal bone from precisely the corresponding part of a healthy skull, and magnified to exactly the same extent, is represented, for the sake of comparison, in fig. 1. The contrast between the two is striking. In fig. 2 it is easy to recognise the enlarged and enlarging Haversian canals surrounded by comparatively transparent laminae of animal matter, and to trace out the manner in which the larger spaces were probably filled up, in the healthy condition, by two or more Haversian systems that have already disappeared. In one or two spots the irregular laminae alone remain. In no part of the specimen is the lamination anything like so obvious as in normal bone; nay, indeed, its vestiges can be traced only with great difficulty, or not at all. Fig. 3 represents a small portion of another specimen much more highly magnified. In this



figure the peculiar alterations in shape, size, and general appearance, exhibited by the lacunæ (or bone-corpuscles), and the enlargement of some canaliculi, and the disappearance of others, are very beautifully shown. Some idea also is conveyed of the irregular and very delicate fibrillated appearance which the animal matter, deprived of its normal earthy associates, in some places presents when examined by a high power. The lacunæ, as a rule, appear empty. In some, however, I have seen distinctly enough the so-called nuclei.

Lastly, the irregular laminæ (or portions of bone which fill up the spaces between the regular Haversian systems) in their turn undergo similar processes of destructive change, until nothing is left of the original bony fabric but a delicate network of fibres and shreds of membrane, here and there dotted by minute fragments of undestroyed bone or adherent particles of amorphous earthy matter.

The processes of change which take place in the cancellated tissue are similar in character to those which have thus been more particularly described as witnessed in the compact tissue of the bones. If the cancelli be thought of as very large Haversian canals or spaces, and the trabeculæ as flattened-out instead of concentric laminæ, the application of the description is manifest. I think, however, that the various stages, at any rate the earlier ones, can be best made out in the compact tissue. Destruction has generally advanced too far in the medullary portions of the bones before opportunities of examination are obtained. In all cases, as already indicated, the effects of the disease are earliest manifested in the cancellated structure, and gradually extend thence from within outwards. The endosteum-lined portions of the bones are the first, the periosteum-covered portions the last, to suffer.

The changes in the compact tissue can be best investigated by means of thin sections cut with a sharp knife; those in the cancellated tissue by means of small portions of the trabeculæ carefully picked out, and very gently washed free of the adhering fat, &c.

Now the process of disintegration appears to go on much faster than that of absorption; for a large quantity of débris, organic and inorganic, is always to be found helping to fill up the spaces which would otherwise be left vacant by the de-



struction of the osseous tissue. Mixed with this débris are the contents, more or less altered, of blood-vessels which, having been previously distended, have finally ruptured, partly, perhaps, in consequence of the destruction of their natural firm support. The earthy débris is for the most part represented by very minute molecules, more or less irregularly aggregated together; the animal débris by shreds of membrane, ill-defined fibres, cell-like bodies, and fat, either free, as oil-globules, or contained in ill-developed or degenerated fat-cells. The precise way in which fat is formed during the chemical disintegration of the gelatigenous constituents of bone we do not know; but we do know that fat is one of the commonest products of the taking-to-pieces, as it were, of the various higher organic constituents of the body. Where degeneration outruns absorption, excess of fat is almost always to be found.

Mixed also with the débris are to be found many proper "marrow-cells," some of them more or less altered in character.

Thus, and of such constituents for the most part, if not entirely, is made up, I believe, the peculiar greasy, yellow, red, or brown material which occupies the place of the destroyed bones, and fills the cavities of those which are still in the earlier periods of the disease. Cells with or without nuclei and nucleoli, and cells with or without tails—or what might be described as such—are, doubtless, occasionally to be found in greater or less abundance; but there is nothing distinctive about them, as far as I am able to judge. The vast majority of cell-like bodies I have met with in the cavities of the diseased bones have seemed to me to have been formed by the coalescence of the histolytic molecules rather than by any proper process of cell development. This remark especially applies to what have been described as "laminated amyloid" corpuscles.

The bones from a case of mollities ossium, however far the disease may have progressed, yield no evidence of anything like "malignant cell growth."<sup>1</sup>

<sup>1</sup> I cannot leave this part of my subject without referring the reader for further information to the details of the careful examinations made by Messrs. Birkett, Rainey, and Simon, appended to Mr. Solly's paper (already quoted), as well as to Mr. Dalrymple's contribution to the 'Dublin Journal,' vol. ii, on "The Microscopical Characters of Mollities Ossium."



To proceed now to the results obtained by the chemical examination of the bones affected by mollities.

A great many analyses, qualitative and quantitative, of bones affected with mollities ossium, have been made from time to time. The particular results published do not precisely agree in any two cases, and in some instances differences are shown, which at first sight appear very striking. All the several records of analyses, however, which I have been able to collect, agree in indicating certain general conclusions as to some of the chemical phenomena of mollities. The differences shown are evidently due, for the most part, to the fact that the specimens selected for examination were, in the several cases, in different stages of the disease. Indeed, the analysis in each case may be considered as illustrating the extent to which the particular bone had become affected, rather than as proving the chemical composition proper to bones in general in mollities ossium. Each step in the downward progress must necessarily be associated with concomitant degrees of change, which may be rendered more or less evident by chemical as well as by physical examination. Further, other discrepancies in the results obtained doubtless depend upon differences in the methods of analysis adapted by different experimentalists.

The following are the results of two analyses of different parts of the calvarium from the subject of the first case recorded in the present paper. For purposes of comparison the results of the analysis of healthy bone are placed in the third column.

	Occipital bones (mollities ossium).	Frontal and por- tions of squamous bone (mollities ossium).	Occipital bone, normal (Von Bibra <sup>1</sup> ).
Phosphate of lime . . . . .	41.53	39.19	57.66
Carbonate of lime . . . . .	?	evidently present	8.75
Carbonate and phosphate of magnesia	2.92	5.80	1.69
Chloride of sodium, &c. . . . .	—	—	.63
Phosphate of iron . . . . .	.70	.21	—
Insoluble matter . . . . .	.40	—	—
Organic matter, cartilage, fat, &c.	45.55 54.45	45.20 54.80	68.73 31.27
Total . . . . .	100.00	100.00	100.00

<sup>1</sup> Von Bibra, 'Chemische Untersuchungen über die Knochen und Zähne des Menschen und der Wirbelthiere.'



The differences between the various published analyses of bones affected with mollities having been alluded to, and the probable explanation of such differences suggested, it seems to me needless to quote the particular figures of the analyses themselves. Suffice it to say, that the most complete, and at the same time, most reliable I have been able to find are those given by Dr. Rees<sup>1</sup> (who, in 1839, analysed the bones of the subject of the third case in the present paper), Bostock,<sup>2</sup> Proesch,<sup>3</sup> Boguer,<sup>4</sup> Lehmann,<sup>5</sup> and C. O. Weber<sup>6</sup> and Von Bibra.

The general conclusions indicated by the various analyses referred to, and further supported by my own, are as follows.

First. The relative proportion of inorganic to organic constituents is much less in bones affected with mollities ossium than in normal bones. The degree of diminution varies with the extent to which the disease may have progressed in the particular bone examined.

Secondly. The relation which the organic and inorganic constituents bear to one another is more or less changed. In normal bone there is reason to believe that a perfect chemical union exists between the mineral and animal elements. But in bone affected by mollities it appears to me that a special process of chemical disunion, as it were, must take place concomitantly with the physical disunion of which I have already spoken. At any rate, I have found that the earthy matter is much more readily dissolved out of such bone than out of normal bone. Sometimes even a certain quantity can be washed out by water alone, without the aid of acid. In healthy bone the constituents are combined. In bone affected by mollities they seem rather to be mixed.

Thirdly. Both animal and mineral constituents are severally changed to a greater or less extent in character and composition, as well in relative proportion and mode of association. The animal constituents consist of more fat and less

<sup>1</sup> 'Guy's Hospital Reports,' 1839, vol. iv, p. 191.

<sup>2</sup> 'Med.-Chir. Trans.,' vol. iv, p. 38.

<sup>3</sup> "De Osteomalacia," 1835; 'Archives Générales de Médecine.'

<sup>4</sup> Valentin, 'Repertorium,' 1842, p. 394.

<sup>5</sup> Schmidt's 'Jahrb. der ges. Med.,' Bd. xxxviii, S. 280.

<sup>6</sup> Op. cit.



nitrogenized matter than is found in normal bone. The fat is more liquid, free to a greater extent, less confined by cell-membrane, and contains, probably, no phosphorus.<sup>1</sup> The nitrogenized matter is so far altered in character that in the earlier stages comparatively little gelatin or chordin is to be obtained by the ordinary processes, and in the later stages none at all. The solutions obtained from portions of the calvarium I have especially examined did not gelatinize to the slightest degree on cooling, and gave no precipitate with either the mineral acids, alcohol, or the prussiates of potash, although an abundant precipitate was thrown down by tincture of galls. The mineral constituents vary very much in the nature and relative proportion of the substances of which they are made up. In normal bone the carbonate and phosphate of lime are found to preserve a tolerably constant relative proportion. This is far from being the case in bones affected by mollities. In such the normal proportion of carbonate to phosphate is, as a rule, much diminished. There are, however, some exceptions recorded; for instance, in the analysis given by Proesch<sup>1</sup> of a dorsal vertebra, the proportion of carbonate to phosphate is increased to a remarkable extent. The figures given are—phosphate of lime, 13.25; carbonate of lime, 5.95; salts, .90; cartilage, 74.64; fat, 5.26. No explanation is offered of this extraordinary proportion of carbonate. Besides such differences in the relative proportions of carbonate and phosphate of lime, there appears reason to believe that a particular difference in composition exists between the phosphate of lime, of normal bone and that of bone affected by mollities.<sup>2</sup> Thus much, and little or nothing more, has hitherto been determined respecting mollities ossium, as regarded from a purely chemical point of view. Very many points remain to be investigated, and certain of the results already obtained require further confirmation, or such criticism and explanation as further investigation alone can give. But, after all, when we consider the extreme complexity, heterogeneity, and ever varying character of the structures submitted to analysis, how coarse and clumsy appear even the most delicate and refined processes yet devised! And, again, when we con-

<sup>1</sup> Lehmann, vol. iii, p. 29.

<sup>2</sup> *Op. cit.*

<sup>3</sup> See C. O. Weber, *op. cit.*



sider that each tiny particle of any bone we are examining may be in a different condition to that of almost every other particle, and possess a correspondingly different composition, how utterly unsatisfactory and apparently worthless do those figures seem to become which represent only the bare quantities of earthy salts and animal matter contained in ten or twenty grains' weight taken from the bone and pounded up together. At best, such figures can represent only an average, and that an unfair one, of the composition of a great number of particles of bone in different conditions and differently constituted. By way of illustration I may refer to the sketch (Plate XI, fig. 3) of the section of a small portion of the calvarium already so often referred to in the present paper. At the spot indicated by letter *b* the bone, or what remains of it, is so soft as to yield to the very slightest pressure, even of the finger. By letter *a* is indicated a roundish, tolerably well-defined spot, about one fifth of an inch in diameter, where the bone is so hard as to be cut with a sharp knife only with considerable difficulty. Now, portions of bone taken from the spot *b* and submitted to the most careful chemical examination under the microscope show no evidence of the presence of carbonate in their composition, while portions taken from the spot *a* and similarly treated yield abundant bubbles of carbonic acid. Further, at *b* the proportion of mineral constituents, taken altogether, is manifestly extremely small, while at *a* the proportion cannot be much, if any, less than that met with in normal bone. Scattered throughout the bone I have examined are many such spots of extreme variation, and often in close proximity to one another. Similar notable variations might, doubtless, be discovered, if looked for, in the substance of the bones obtained from other cases. And if so, we may fairly ask, what importance can be attached to any row of figures which must necessarily include in one statement the respective analyses of an uncertain number of certainly very different portions of bone all added together?

We may now turn to the consideration of certain other and more practical points in connection with our subject.

The prognosis in advanced cases of *mollities ossium* must, unfortunately, and in the present state of our therapeutical knowledge inevitably, be almost always fatal. In the earlier



stages, however, there is reason to believe some good can be effected.

Obvious improvement or cure is stated to have occurred in 22 cases out of the 145 already quoted. And in several instances which ultimately proved fatal (as, for instance, in Mr. Howship's well-known case<sup>1</sup>) the progress of the malady appears to have been temporarily arrested.

In 18 out of the above-mentioned 22 cases, however, the origin of the disease is clearly stated to have been more or less immediately associated with pregnancy or the puerperal condition; and the pelvic bones alone, or the pelvic bones and the lower part only of the spine, were affected.

The issues of several cases on record are not given.

In 108 cases a fatal termination is reported. And in almost every instance the cause of death was clearly connected, directly or indirectly, with the softened or deformed condition of some or other of the bones.

In several cases (as, for example, in the two first reported in the present paper) the immediate cause of death appears to have been asphyxia, arising from the circumstance of the muscles of respiration bending the ribs, &c., instead of dilating the chest. In other instances, after having suffered from "slow fever," sometimes accompanied by diarrhœa, sometimes by obstinate constipation (dependent upon the inability of the abdominal muscles to assist defecation), the patients are said to have died of "extreme exhaustion." In 48 cases the patients died from causes immediately associated with labours rendered difficult by deformities produced by the disease. In 33 of these cases Cæsarean section was performed. Different expedients were resorted to in other cases to accomplish delivery.

Among the cases in which recovery is stated to have taken place there are, perhaps, none more striking than two recorded by Beylard.<sup>2</sup> Both these cases came under the care of M. Trousseau. In each the progress of the malady was well marked. Each recovered health under the combined influences of rest, warmth, good food, and cod-liver oil; although, of course, the striking and characteristic deformities remained.

<sup>1</sup> 'Edinburgh Medico-Chirurg. Trans.,' vol. ii, p. 136.

<sup>2</sup> Op. cit, pp. 266—274.



In both, the pelvis and the spine were the parts most strikingly affected. In one, the femora also became deformed.

There does not appear to be any reason to doubt the possibility of cure in such cases. As long as the walls of the thorax are sufficiently firm for the purposes of respiration, and the bones of the spinal column are prevented from injuring the most vital parts of the cord—as long also as the patient is free from the dangers of an unnaturally complicated labour—it is difficult to understand how any mere softening of the bones can lead to a fatal result. And as far as the general processes of nutrition are concerned, however they may have become perverted, and whatever special expression, as it were, their perversion may have assumed, we know of no reason why they should not be induced to return to their normal course, provided only that time be given by the warding off of death, and favorable conditions be supplied. The favorable conditions manifestly required in the treatment of mollities ossium—as, indeed, in the treatment of almost all other chronic perversions of the nutritive processes—are mental ease, bodily rest, good food, good air, warmth, with such medicaments as cod-liver oil, iron, and quinine.

In the treatment of rickets it is by no means impossible that the administration of lime-salts may be of service; but in mollities ossium there are already more lime-salts in the body than can be retained, and to give more only throws additional work upon the excreting organs.

Granting, then, that mollities ossium is not an absolutely incurable malady, the questions naturally arise, how does the process of cure affect the softened bones? in what way does it become manifest? what changes in appearance and structure ensue? and what are the final results? The bones I have been examining seem to me clearly to indicate the direction in which the answers to these and such like questions are to be sought. But, before entering into particulars on these points, I would very briefly direct attention to some of the more general features of certain other abnormal conditions of the bones, which I proposed to myself to discuss in the present paper more fully than I now find my limits will permit.



OSTEOPOROSIS, OR POROUS HYPEROSTOSIS, ESPECIALLY OF THE  
BONES OF THE SKULL.

Scattered through the pathological collections in different museums are to be found a number of bones, principally skulls, which are thickened to a very remarkable extent, and so altered in texture and composition as to present a most curious general appearance. Such bones appear almost universally to have been met with accidentally. Some have been found in churchyards, some in dissecting-rooms; in no instance, as far as I have been able to ascertain, is there any satisfactory history on record of any case in which this peculiar condition has been found after death,—much less has it ever been diagnosed during life. In some instances a few particulars only, of very little value, have been made out by careful inquiry after the accidental discovery of the abnormal conditions of the bones. In the great majority of these instances the patients appear to have been insane, or, at any rate, of weak intellect. Such was the case with two of the subjects, portions of whose skulls are preserved in the Guy's Hospital museum. Such also was the case with two other subjects, whose remains are represented by sundry specimens in the museum of St. Thomas's Hospital.

The bones alluded to are all of them very much thickened, and in some instances to an enormous extent. In the skulls the sutures are obliterated, the diploe more or less completely absent, and the grooves and foramina for the blood-vessels very greatly increased in size and number. But beyond these points of general resemblance we find that these bones may be easily arranged in an apparently natural consecutive series, or rather, as I think I shall hereafter be able to show, in two such consecutive series. In the first of these series the bones are more or less uniform in structure. They are comparatively spongy, light, and somewhat disposed to crumble under pressure. Their general appearance has not inaptly been compared to that of dried mortar. All such conditions may properly be included under the name of porous hyperostosis. In the second of these series the bones are extremely hard, dense, and heavy, but, like those of the first series, they have a certain rough irregularity of texture. The several varieties of



this series may be included under the generic term sclerotic hyperostosis. Both series, or rather certain members of both series, are represented in the museum of Guy's Hospital. The skull, a portion of which is shown in Pl. III, fig. 1, drawn to the natural dimensions, may be regarded as typically illustrating the first series. And that from which fig. 2 in the same place is taken affords, I think, a fair example of the second series. Now, it is, I believe, generally considered by the few who have paid any attention to this subject, that the dense heavy condition is related by succession to the light porous condition, and that the transformation is effected by a process of what has been termed "consecutive induration" (Rokitansky). It seems to me, however, after the most careful examination, that it is probable, rather, that, although processes of "consecutive induration" unquestionably go on in each, yet nevertheless the two series are really distinct, and represent the more or less perfectly cured conditions of different diseases. The soft mortar-like series illustrates, I believe, the changes which ensue when the progress of *mollities ossium* has been arrested, and a more or less successful attempt at repair and the re-establishment of normal nutrition has been set up. The dense and hard series, on the other hand, similarly illustrates, I believe, the cure of rickets under certain particular circumstances and conditions. Into the full discussion of these propositions, however, space does not permit me at present to enter, but I propose to return to the subject in a future number, and adduce satisfactory evidence in support of what I have here suggested.

With regard to the transition of bones softened by *mollities* into the porous form of hyperostosis, the evidence seems to me very strong, and may briefly be stated as follows. In *mollities* the bones become, as we have seen, distended and sponge-like in their general structure. In the skull the diploe disappears, and the tables become thickened; the sutures are more or less obliterated, and the grooves for the blood-vessels enlarge. All these alterations remain, and some of them become more pronounced in porous hyperostosis. Indeed, if a portion of skull affected with *mollities* be slightly macerated and dried, and then compared with a similar portion from a skull affected with porous hyperostosis, a very striking general similarity in



appearance is at once seen to exist between the two. It seems, to the unaided eye, as though the mollities-bone did but want the addition of a little more earthy matter and a little more general firmness and resistancy to make it exactly resemble the other. And on examining certain portions of the respective bones under the microscope the resemblance is still further illustrated. In Plate IV, fig. 6, a very accurate representation is given of the appearance presented under a low power by a section taken from the skull affected with porous hyperostosis figured in Plate III, fig. 1; and by its side (Plate IV, fig. 7) is an equally accurate representation of a section taken from the hard spot in the skull affected by mollities, the situation of which is indicated by *a* in Plate II, fig. 3. It is needless to describe in words the points of resemblance between these two specimens; they are very obviously, as well as very faithfully, shown by the drawings referred to, and still more strikingly illustrated by, fig. 5, Plate IV. This figure represents a small portion of the porotic bone more highly magnified; it is drawn to the same scale as figs. 3 and 4 on the same plate. A comparison of these figures shows at once how closely in general arrangement, shape, and size, the lacunæ (or bone-corpuscles) and canaliculi of the porotic bone resemble those of the bone affected with mollities, and in what precisely similar respects in both cases these structures differ from the corresponding ones of healthy bone.

It seems impossible to resist the conclusion that at the point indicated by *a* (fig. 3, Plate II), and at several other like spots in the different parts of the bone, a process of repair had actually commenced, which, had the life of the patient been prolonged, might have extended throughout the whole softened bone. Further, that if such a result had happily occurred there would have been brought about a condition of skull more or less closely resembling that which we have been speaking of as porous hyperostosis. That the spots alluded to indicate the presence of a process of repair, and are not mere portions of hitherto unaffected bone, is rendered evident, not only by their microscopical appearance, but by their position. They are, as far as I have seen them, in every instance, in parts of the bones which ought to be occupied by diploe, and where, therefore, no such dense spots would be found in normal bones.



*Description of the Plates illustrating Mr. Durham's paper on  
Certain Abnormal Conditions of the Bones.*

PLATE I

Represents the habitual position of the lower part of the body of Sarah W— (the subject of Case 1) during the greater part of her stay in Guy's Hospital.

PLATE II.

*Fig. 1.* Shows a section through the outer, *fig. 2* through the inner, condyle of the left femur, and corresponding portion of the head of the tibia. The thinness of the articular cartilage is shown especially in *fig. 1*, in which also the fusion of one of the semilunar cartilages with the articular cartilage is represented. In—

*Fig. 2* is shown the commencement of a fibrous ankylosis between the femur and tibia.

*Fig. 3.* Shows somewhat diagrammatically the exact thickness of a portion of the frontal bone. The entire absence of diploe is indicated. The somewhat circular spot indicated by *a* was remarkably hard as compared with the rest of the bone; the spot indicated by *b* as remarkably soft.

*Fig. 4.* A section of the upper part of the humerus.

*Fig. 5.* A section of two of the dorsal vertebræ.

All these figures are drawn to the natural dimensions, from bones from the body of Sarah W—.

PLATE III.

*Fig. 1.* From a portion of skull to be placed in the museum of Guy's Hospital, to illustrate the appearances presented in porous hyperostosis cranii.

*Fig. 2.* From a portion of a skull in the museum of Guy's Hospital, to illustrate the appearances presented in sclerotic hyperostosis cranii.





## PLATE IV.

- Fig. 1.* Section of normal occipital bone.
- Fig. 2.* Section of occipital bone affected with mollities, cut from the same part and in the same direction as the above, and drawn to exactly the same scale.
- Fig. 3.* Another portion of the specimen from which *fig. 2* was taken, very much more highly magnified. The alterations in the size, shape, and general arrangement of the lacunæ and canaliculi, characteristic of mollities, are well shown, especially when the figure is compared with—
- Fig. 4,* which represents a small portion of normal bone from the corresponding part of a healthy skull.
- Fig. 5.* Represents the appearance presented by a portion of the skull affected with porous hyperostosis (figured in Plate III, *fig. 1*), magnified to precisely the same extent as *figs. 3* and *4*.
- Fig. 6.* A larger portion of a section from the frontal bone of the same skull (porous hyperostosis), magnified to a considerably less extent, for comparison with
- Fig. 7,* which represents a corresponding section from the spot *a*, in the frontal bone of the skull affected with mollities. See Plate II, *fig. 3*.

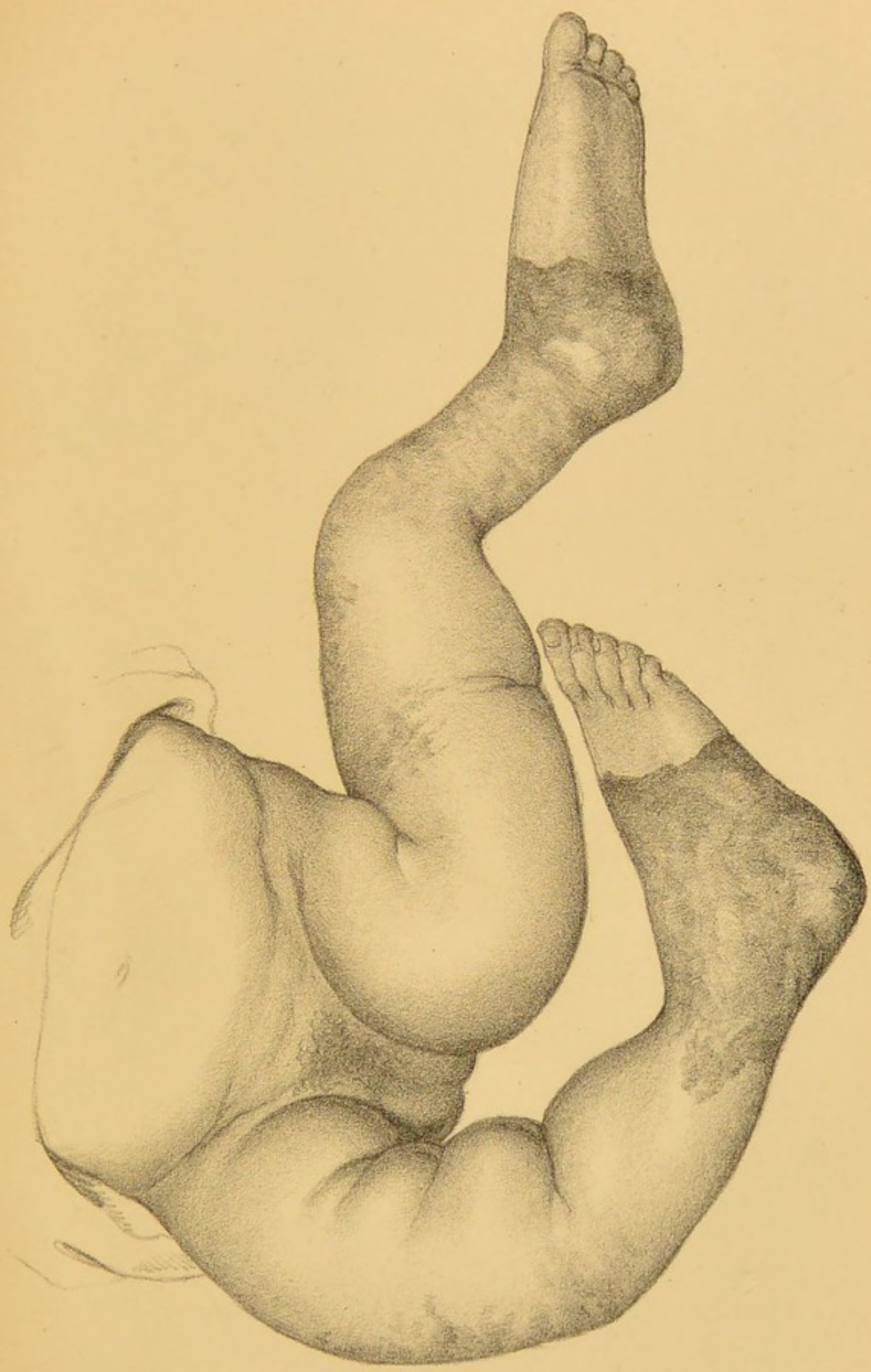
Figures 1, 2, 6 and 7, were traced on the stone from photomicrographs taken by myself.

Figures 3, 4 and 5, were traced from sketches made by aid of the camera lucida.

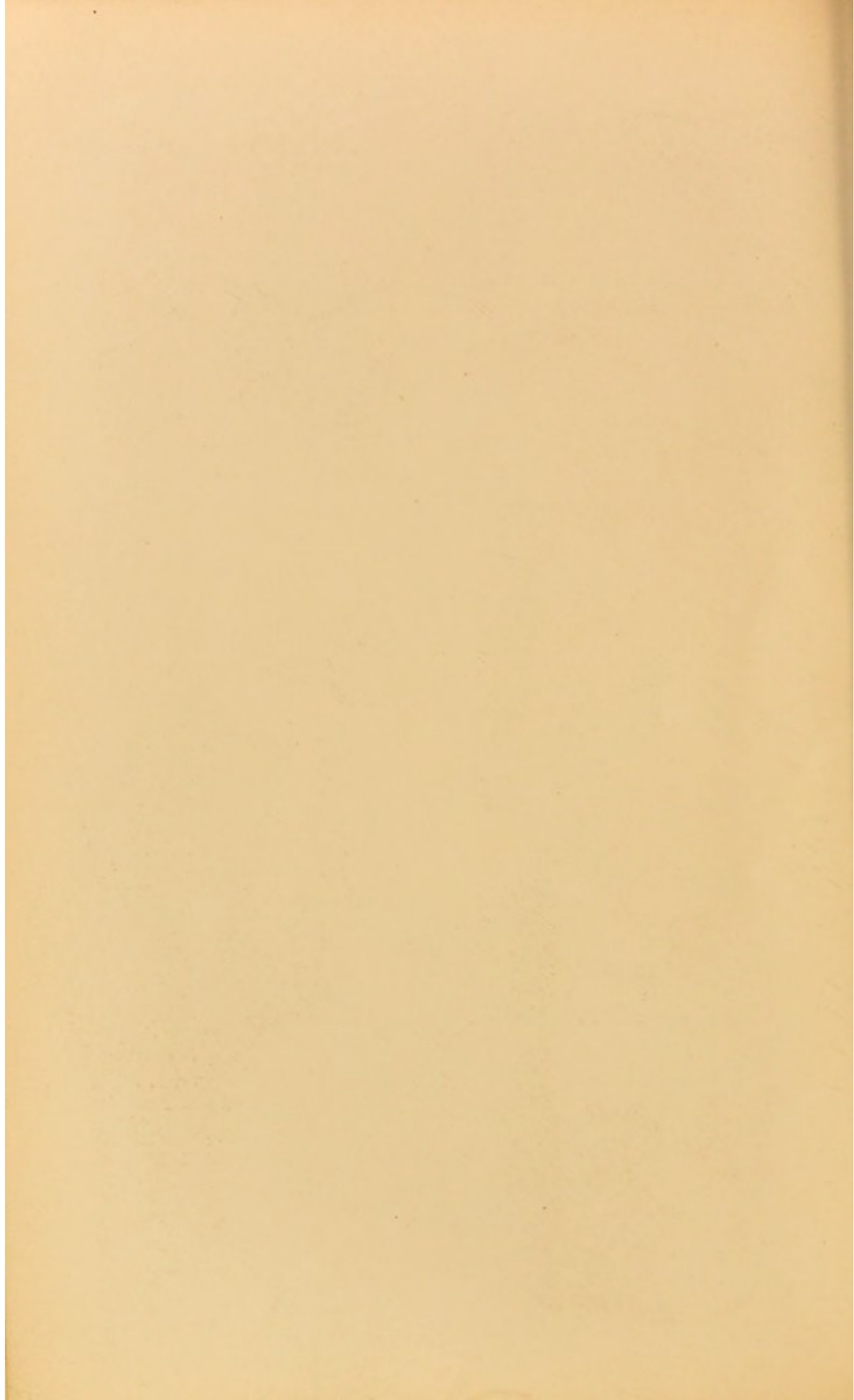
The exact scale has thus been preserved in all instances.

All the figures were most minutely finished from the objects themselves, under the microscope, by Mr. Tupper, who has faithfully copied, not only the lacunæ, but even the individual canaliculi.

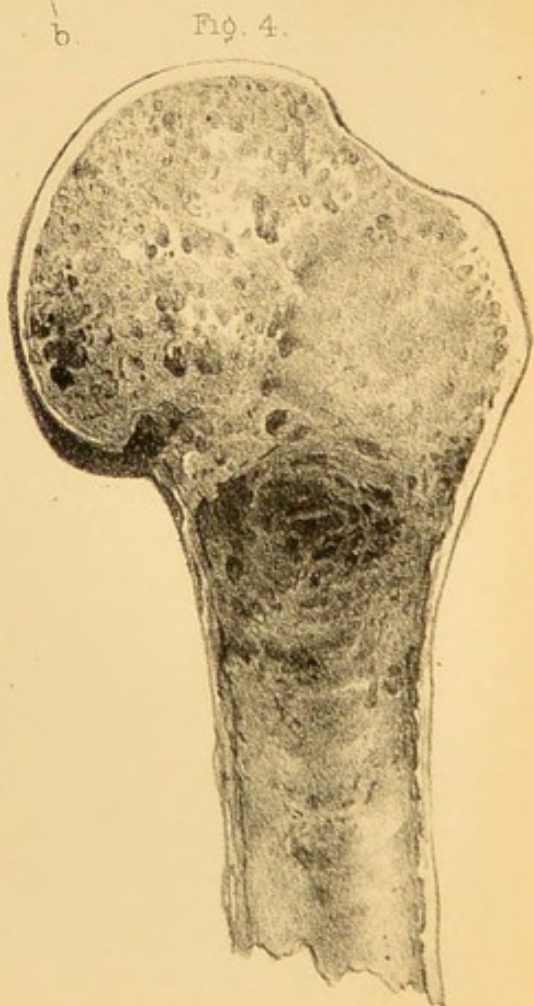
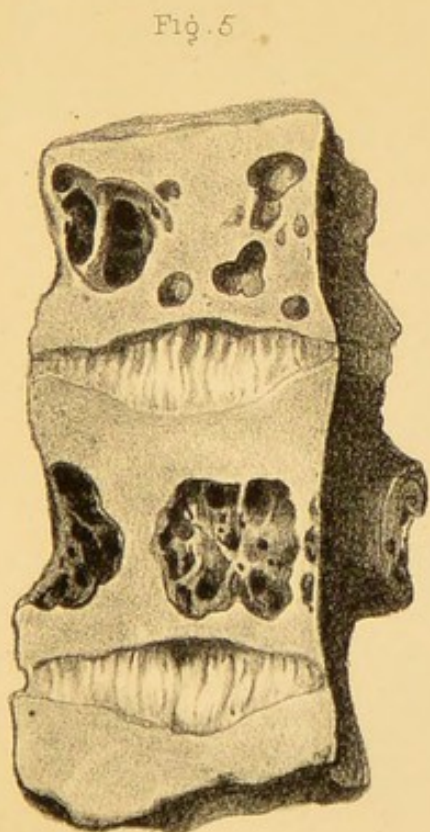
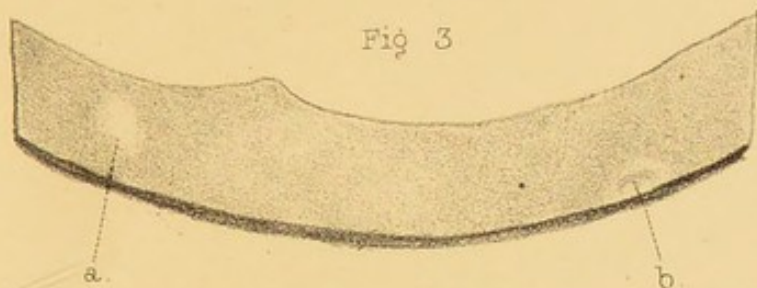
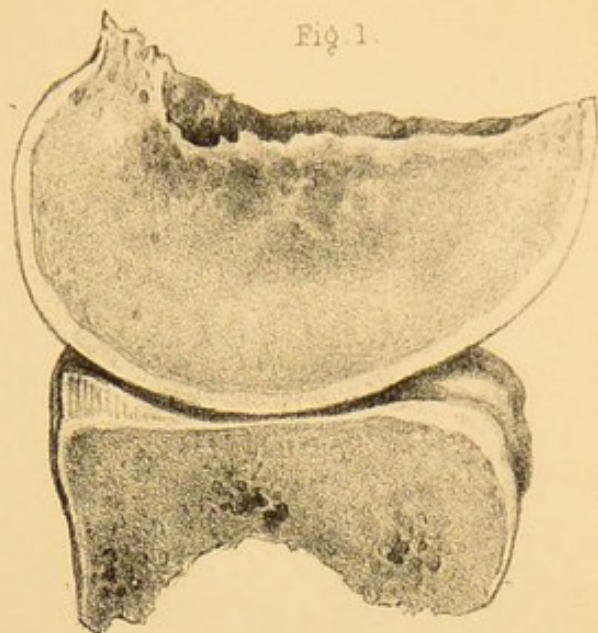
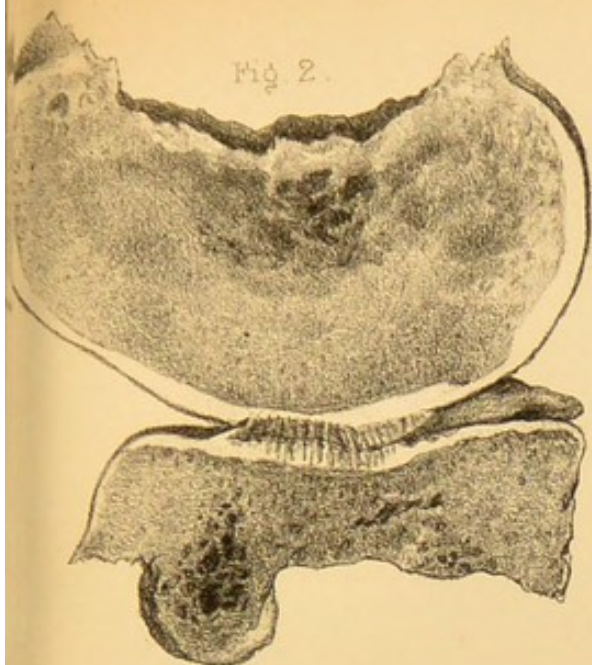














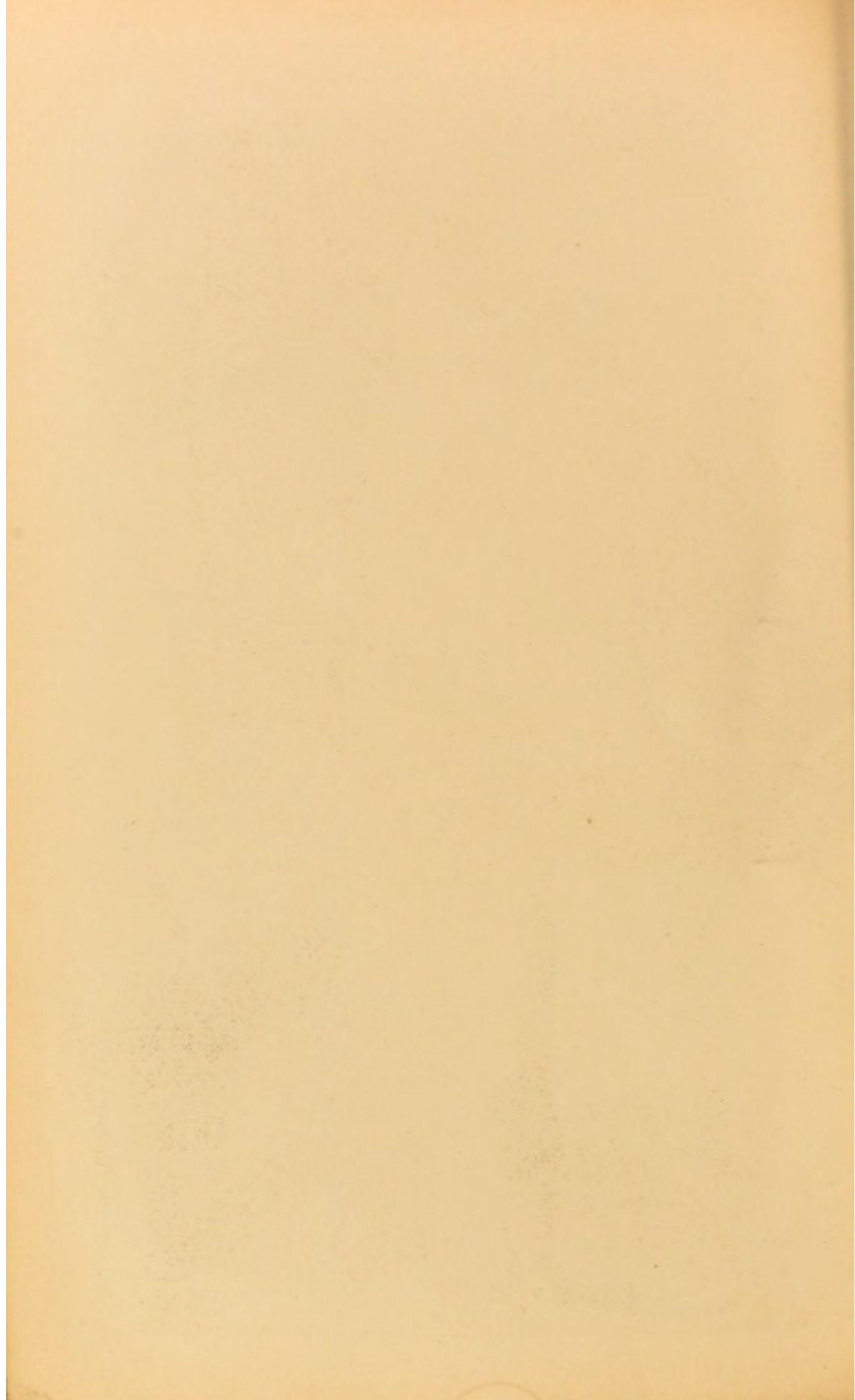




Fig 1.

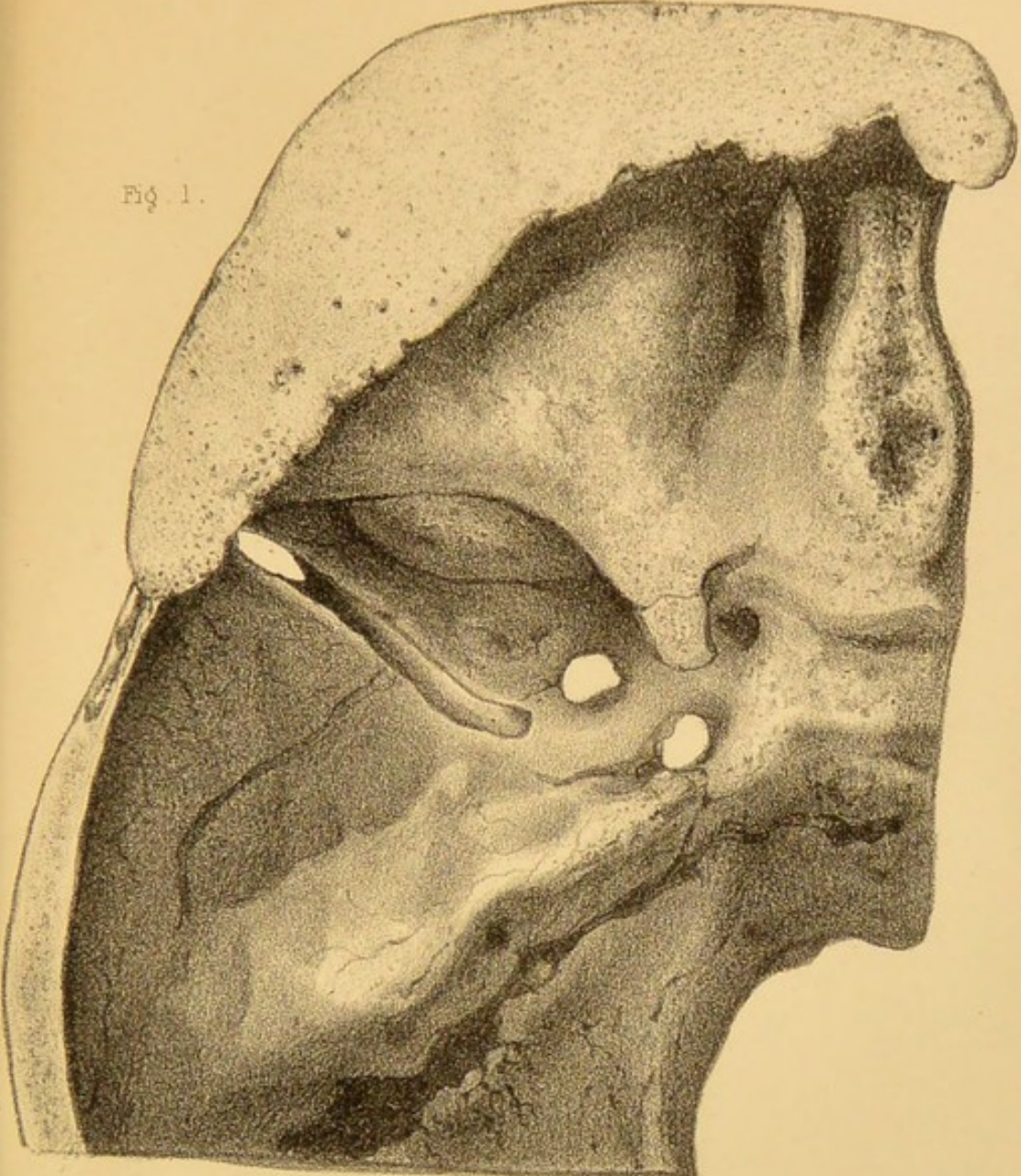
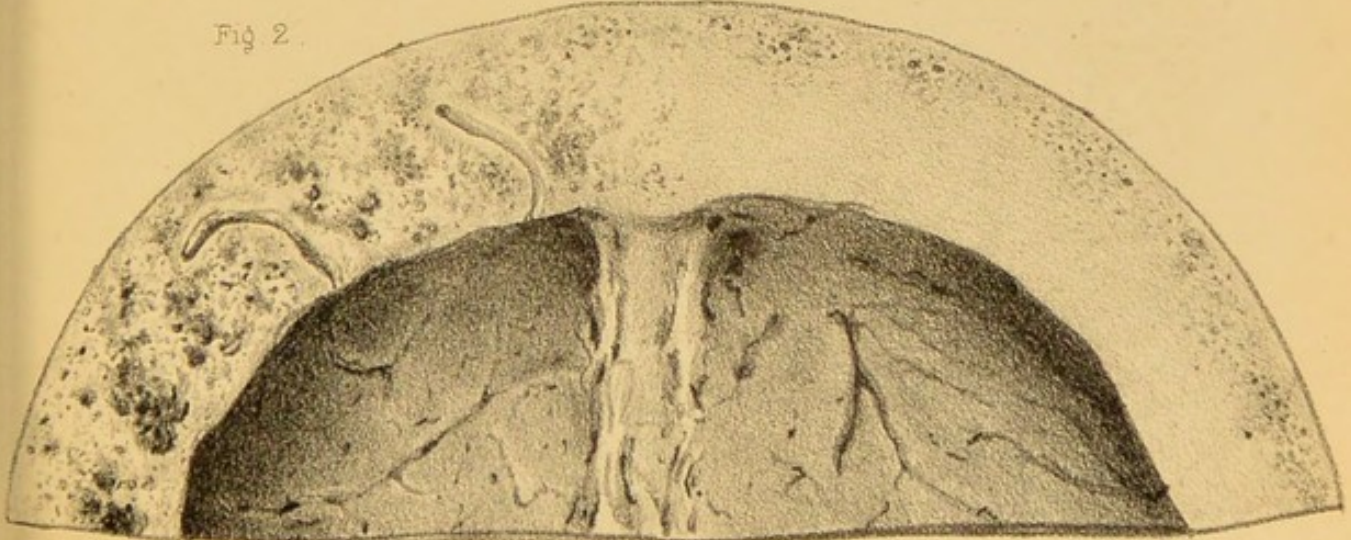


Fig 2.





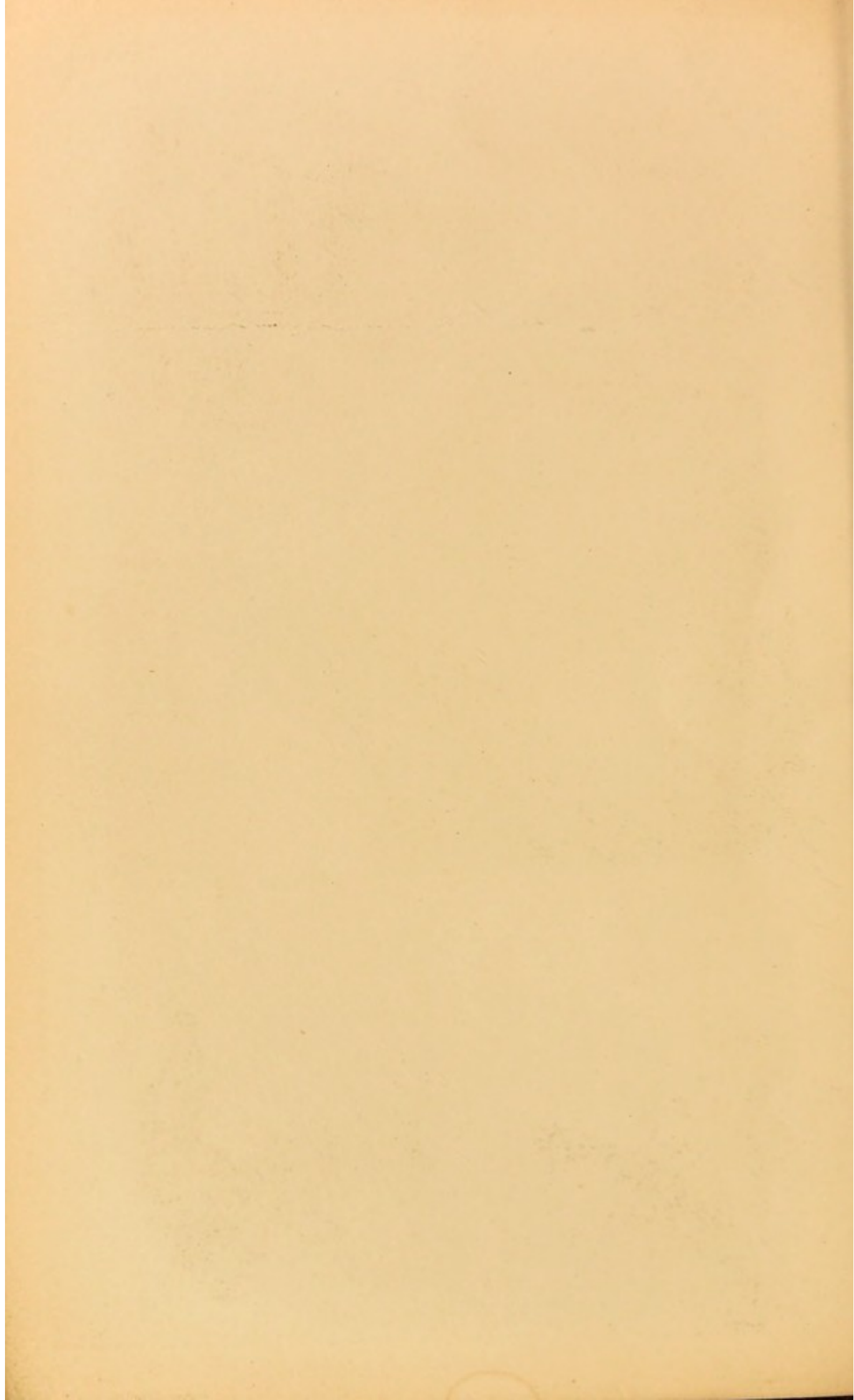




Fig. 1.

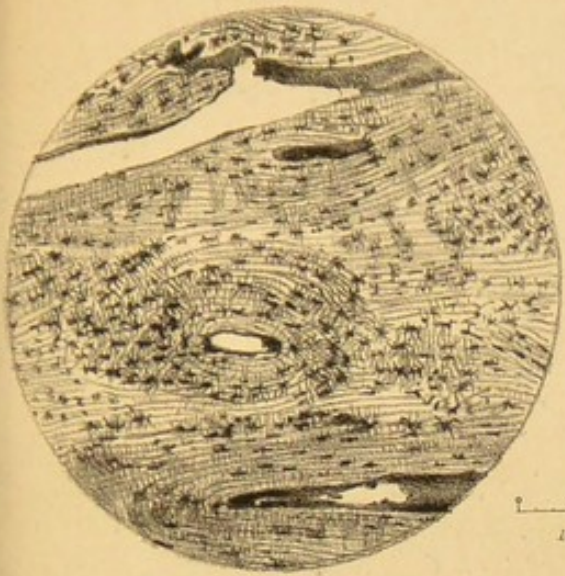


Fig. 2.

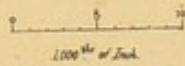
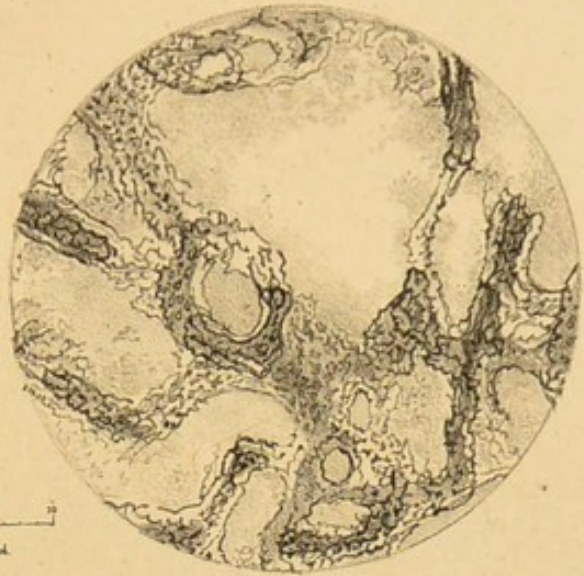


Fig. 3.

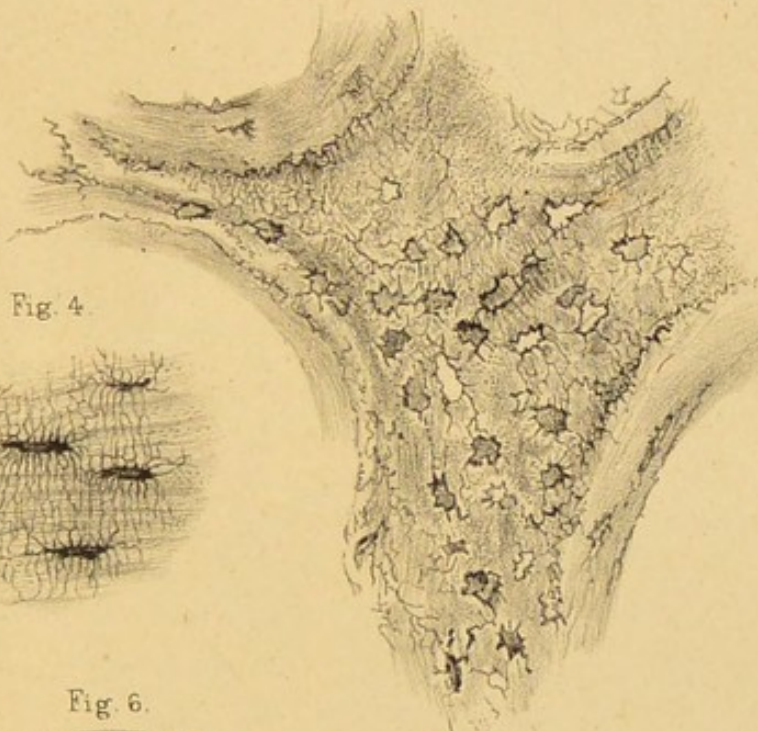


Fig. 5.



Fig. 4.

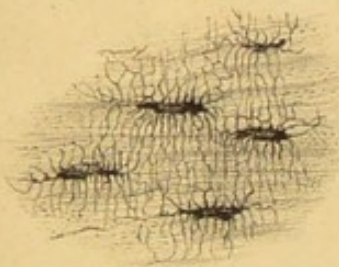


Fig. 6.

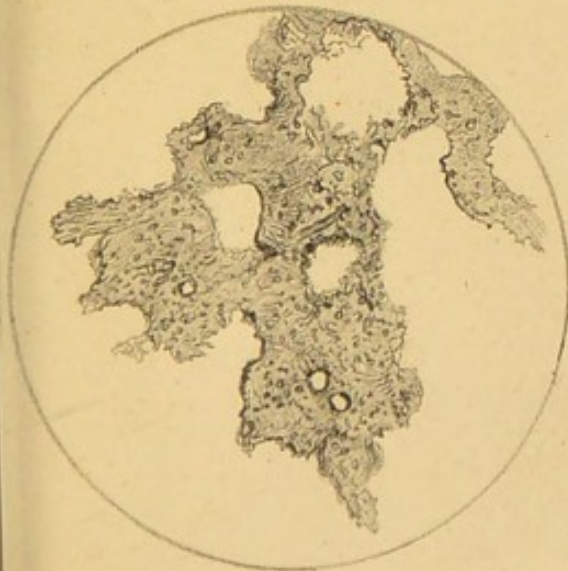


Fig. 7.

