Mr. W. H. Power's report to the local government board on an outbreak of "fever" that proved to be trichinosis on board the reformatory school ship "Cornwall".

Mr. W. H. Power's Report to the Local Government Board on an Outbreak of "Fever" that proved to be Trichinosis on board the Reformatory School Ship "Cornwall."

George Buchanan,
Medical Department,
March 15, 1880.

This inquiry was directed by the Local Government Board at the request of Mr. Secretary Cross, to whom application had been made (30th October 1879) by the School Ship Society for investigation of an alleged outbreak of "fever" on board their ship "Cornwall."

This outbreak, it was stated, had occurred about a month before, and was the second prevalence of "fever" on board within a period of four years. At the end of 1875, indeed, nearly 50 per cent. of the boys had been affected with what was held to be enteric fever. In regard of this outbreak, and also at the request of Mr. Secretary Cross, an inquiry was in March 1877 ordered by the Local Government Board. It was to have reference to the sanitary condition of the "Cornwall," and to a suggestion that the health of the boys had suffered from the outflows of metropolitan sewage at Crossness and Barking. Mr. Netten Radcliffe conducted this inquiry, but for various reasons, was unable to complete it. A memorandum by him presented to the Board on the subject is dated May 1878.

The "Cornwall" lies at moorings in the Thames off Purfleet. Formerly, as an 80-gun ship, her complement consisted of 800 officers and men. As a reformatory school ship she has at no time accommodated more than 318, boys and officers. At the date of the recent outbreak the numbers were 262 boys, and 15 officers. The age of the boys ranged from 12 to 20 years.

The outbreak of 1879.—Up to mid-September the health of the boys had during a long period been satisfactory. For many weeks no boy, except one accredited with incipient phthisis, had been more than a very few days on the sick list, and the entries appearing on this list referred only to minor ailments and to casualties. On *Tuesday*, 23rd September, seven boys reported themselves to the medical officer of the ship for the sick list and were admitted to the sick-bay. Setting aside one trivial case, six boys suffered thenceforward from an illness that lasted 18 days in a fatal case, and 26, 37, 38, 42, and 88 days in cases that recovered. Next day, 24th September, two boys reported themselves to the doctor; one of them was only slightly ill for a few days, the other was confined to bed 28 days. By the 29th of September 10 other boys had come on the sick list. Except one who had symptoms of pneumonia, and was ill 38 days, none had marked objective symptoms, and all of them seemed well in a few days. On *Tuesday*, 30th September, and *Wednesday*, 1st October, six boys came under treatment. Three of them had illness lasting 18, 18, and 29 days; the ailments of the others appeared trivial. Between 3rd and 6th October nine boys, and on 11th October one boy came under the doctor. All, except one who suffered several weeks from jaundice, were out of sorts a few days only. From *Tuesday* 14th, to Thursday, 17th October, six boys came under treatment. Five of them were ill for 18, 18, 31, 35, and 67 days respectively; one only proved a trivial case. On Tuesday, 21st October, one boy, and on 23rd October another boy came under treatment. The former was ill 14 days, the latter had no decided symptoms. This was the last case up to the time of the inquiry. In all, therefore, there were 43 cases of some sort or degree of sickness. They may conveniently be divided into the more serious and the less serious attacks. In all 18 boys suffered from decided, most of them from serious, illness, and one of them died on the 18th day of his disease. Twenty-five other boys were slightly ill, most of them for a few days only; and some of these 25 may not, it was thought, have been ill at all, but owing to panic may have imagined themselves possessed of symptoms of the sort described by boys who really suffered. There can be no doubt that all the serious cases, and some of the slighter ones as well, had a disease which was properly described as a "continued fever." In most instances the symptoms were clearly indicative of enteric disturbance, and in some cases there were in addition persistent diarrhœa, rose-coloured spots on the abdomen, and hæmorrhage to a greater or less extent from the bowels. From these data the outbreak was regarded as one of enteric fever, presenting perhaps an unusual number of abortive cases, and as possibly complicated by malingering.

Q 843. 100.—4/80. G. 12. E. & S.

On occurrence of the outbreak prompt measures were taken for isolation of the boys attacked. In the absence of any proper hospital accommodation in connexion with the ship, the boat-house at Purfleet, belonging to the vessel and situated on the jetty by which access is gained thereto, was at once cleared of its contents and prepared for reception of the sick. By 26th September it was fitted as a temporary hospital, and on that day seven cases were transferred to it. Subsequently, cases as they arose, whether severe or trivial, were removed to this boat-house. On 1st October, arrangements having been made for their reception, 10 boys were removed to the Seamen's Hospital, Greenwich, and on 6th October another batch of four boys. With the single exception of a case of jaundice, none of the boys removed to Greenwich had any notable illness; consequently 13 of the 14 were returned to the "Cornwall" after a week or 10 days each in hospital. During the progress of the outbreak a plot of ground at Wennington, 1½ miles from the ship, was acquired by the School Ship Society for hospital purposes, and hereon was erected an iron building to which were removed on 7th November all patients from the boat-house capable of bearing the journey. On 11th November, the occasion of my first visit to the "Cornwall," one boy only remained in the boat-house. This boy had then been ill 50 days, and presented, on such examination as was bearable by him under the circumstances, conditions usual to persons who have suffered many weeks from fever.

This was the history as presented to me at the beginning of my inquiry; and I at once set myself to search for causes of enteric fever.

In seeking for such causes regard was had to circumstances of a kind that experience has suggested might be concerned with enteric fever, and that may have affected (*a*) the ship's company collectively, or (*b*) particular boys, or groups of boys, and through them perhaps other persons. It was seen that if such circumstances failed to explain the occurrence of the disease, inquiry would have to be directed into the influence of articles of food hitherto not recognised as capable of producing enteric fever.

I. *a*. Under the first head the evidence obtained proved negative. *Water* could be excluded for the reason that the water consumed on board was from the Purfleet reservoir of the South Essex Water Company, within the area of which service no prevalence of enteric fever was heard of. Such risk of contamination of this water as was formerly incurred during transit to the ship has been got rid of since the outbreak of 1875 by establishing, by means of a hose attached to a chain cable, direct communication between the mains of the water company and the water tanks on board: to this new method of water conveyance no suspicion attached. *Milk* as an agent of infection was altogether out of question. None of the boys on board under any circumstances partook of milk. *Sanitary Circumstances of the Ship.*—Herein nothing was discoverable suggestive of conditions likely to favour recrudescence of the disease of 1875, or to foster recently imported infection. Most of the structural and other alterations recommended after the last outbreak by the Port Medical Officer had been long since adopted, and the ship throughout appeared to be clean, well ventilated, and wholesome. Notably the arrangements and regulations respecting excrement disposal were, especially as regards the boys, of such sort as to render highly improbable any fostering or dissemination of infection of excremental outcome. It is true that two officers' closets on the main deck forward (which have been retained notwithstanding the Port Medical Officer's recommendation for their removal) are from their proximity to the sick-bay objectionable; but no evidence was forthcoming suggestive of their having had concern with the outbreak. *River Circumstances.*—In regard of possible influence of river-borne sewage, bathing and swimming of the ship's company in the river, and washing of decks with river water, received attention. As to bathing, all hands bathed for the last time for the season on the 15th August. Only boys learning to swim, some 24 in number, continued their lessons until the 8th September. Bathing seemed to be excluded as a factor in the outbreak from the circumstance that the interval between the occasion of the last bathing and the date of the outbreak, a period of upwards of five weeks, far exceeded any known limit of the incubation period of enteric fever. On the other hand swimming, though not thus excluded, was set aside from the fact that one only of the 24 boys learning to swim was included in the first group of sufferers by the outbreak. Washing, or rather sluicing of decks with river water could not, as a possible cause of the outbreak, be excluded: but on the other hand, there was nothing whatever to show that it had, in fact, any influence for harm. And so with any emanations there may have been from the river itself, or from the foreshore.

I. *b.* The second stage of inquiry, having to do with the circumstances of particular individuals and groups of individuals, required, beside other information more or less easily attainable, minute and accurate knowledge of the inner life on board the vessel. Thus it came about that I attempted to live over again, as it were, on shipboard the weeks preceding the outbreak. In doing this I was assisted, in a way and to an extent which I cannot describe, by the Captain Superintendent, who throughout a tedious inquiry rendered me unwearied assistance. By this method a mass of evidence concerning the boys was got together. It had to do with boys who escaped as well as with boys attacked, and much of it, as was inevitable, proved in the end irrelevant. Before proceeding to deal with the matters investigated it will be convenient to state in a tabular form, for future reference, some of the data obtained in regard of the boys attacked.

SUCCESSION of "FEVER" CASES on the "CORNWALL." [Severer cases in Roman type; slight or doubtful cases in italics.]
The intervals of the table show Monday nights.

Date of going on Sick List.	Name and Age.	Date of Removal from Ship.	Duration of Illness to Convalescence. (Days.)	Watch.	Mess.	Division.	Position of Sleeping-berth.	Last on Leave before Outbreak.
September 23	Harry Sims, 15	September 28	88	Starboard	15	13th	Lower deck, right forward	No leave.
" 23	Henry Wheeler, 16	September 28	37	Port	17	16th	abaft main hatch	"
" 23	Joseph Braidshaw, 16	September 26	38	Port	3	4th	Middle " abreast main hatch	"
" 23	Arthur Brawnlis, 16	September 26	26	Starboard	15	11th	Main " forward, ship's side	"
" 23	Charles Beaumont, 15	September 25	42	Starboard	15	5th	Lower " abaft main hatch	July 22-25.
" 23	Richard Pierce, 16	September 25	18—died	Starboard	15	13th	" " right forward	No leave.
" 23	*Alfred Peck, 16*	*October 1*	*10?*	*Port*	*17*	*12th*	*Lower " forward, ship's side*	*August 2.*
" 24	Edward Davis, 16	September 26	28	Port	3	4th	Middle " abreast main hatch	September 26, 1878.
" 24	*Henry Dashwood, 16*	*October 1*	*8?*	*Port*	*6*	*10th*	*Lower " abreast hatch, forward*	*April 12.*
" 26	*George Brace, 16*	*October 1*	*5?*	*Starboard*	*6*	*9th*	*opposite magazine hatch*	*May 27.*
" 27	*George Meir, 15*	*October 3*	*6?*	*Port*	*5*	*6th*	*Middle " abreast fore-ladder*	*April 10.*
" 28	Arthur Marks, 16	On board throughout	38	Starboard	19	17th	Lower " abaft main hatch	December 27, 1878.
" 29	*James Justice, 16*	*October 1*	*?*	*Starboard*	*3*	*3rd*	*Middle " abreast model*	*June 30.*
" 29	*Alfred Jardine, 15*	*October 1*	*?*	*Starboard*	*9*	*9th*	*Lower " hatch forward*	*June 30.*
" 29	*Alfred Hardley, 15*	*October 1*	*?*	*Port*	*9*	*10th*	*" " forward*	*June 8.*
" 29	*Edward Bonenell, 15*	*October 1*	*?*	*Port*	*9*	*10th*	*" " abreast hatch, forward*	*April 26.*
" 29	*John Leader, 15*	*October 1*	*?*	*Port*	*9*	*12th*	*" " amidship*	*May 6.*
" 29	*Joseph Childs, 16*	*October 1*	*?*	*Starboard*	*10*	*7th*	*" " opposite main hatch*	*No leave.*
" 29	*Henry Rose, 15*	*October 1*	*?*	*Port*	*6*	*4th*	*Middle " " opposite main hatch*	*May 14.*
" 29	*William O'Hara, 16*	*September 29*	*?*	*Port*	*3*	*4th*	*" " abaft cabins*	*August 28.*
" 30	*George Saunders, 15*	*October 1*	*?*	*Port*	*19*	*4th*	*Lower " opposite magazine*	*No leave.*
" 30	*James Kift, 16*	*September 29*	*8*	*Port*	*8*	*10th*	*" " opposite main hatch*	*" *
October 1	Henry Salmon, 16	October 3	18	Port	11	8th	Middle " "	September 14-18.
" 1	Charles Speer, 17	October 2	18	Port	4	4th	" " "	7-11.
" 1	William Pull, 15	October 2	29	Starboard	15	9th	Lower " magazine hatch	April 16.
" 3	*George Lawrence, 13*	*October 3*	*?*	*Starboard*	*8*	*4th*	*abreast main hatch*	*No leave.*
" 3	*W. Spice, 13*	*October 3*	*?*	*Port*	*20*	*13th*	*abaft cabins*	*" *
" 3	*J. Mitchell, 13*	*October 3*	*?*	*Port*	*20*	*13th*	*" " " *	*" *
" 4	*George Norman, 17*	*October 3*	*?*	*Starboard*	*8*	*6th*	*Middle " abaft " *	*June 8.*
" 5	*Alfred Inge, 15*	*October 9*	*?*	*Port*	*3*	*13th*	*Lower " abaft cabins*	*No leave.*
" 6	Frederick Simmonds, 16	October 6	38	Starboard	20	5th	" " opposite main hatch	May 28.
" 6	*William Mowbry, 16*	*October 16*	*?*	*Starboard*	*5*	*1st*	*Middle " abaft cabins*	*July 2.*
" 6	*Albert Ferris, 16*	*October 16*	*?*	*Port*	*?*	*2nd*	*" " " *	*May 31.*
" 6	*Daniel Holland, 16*	*October 15*	*?*	*Port*	*11*	*12th*	*Lower " forward*	*April 19.*
" 11	*Henry Rogers, 14*	*October 11*	*6*	*Port*	*4*	*6th*	*" " abreast officer's cabins*	*May 26.*
" 14	Edwin Brice, 16	October 15	31	Port	3	10th	Middle " opposite magazine hatch	May 31.
" 14	James Howes, 14	October 15	35	Starboard	17	13th	" " under main hatch	July 4-9.
" 14	Henry Wenn, 15	October 14	67	Starboard	9	9th	" " opposite magazine hatch	May 30.
" 16	*William Brooks, 14*	*October 16*	*?*	*Starboard*	*12*	*2nd*	*Middle " abaft " *	*July 23.*
" 17	Frank Bowler, 15	October 17	18	Port	12	16th	Lower " under main hatch	No leave.
" 17	James Hopcroft, 15	October 19	18	Port	8	18th	" " abaft " *	" *
" 21	George May, 13	October 21	14	Port	17	12th	" " forward	August 4-6.
" 23	*Frederick Kingrose, 14*	*October 24*	*8*	*Starboard*	*7*	*7th*	" " *opposite main hatch*	*No leave.*

The boys on board the "Cornwall" are divided primarily into two watches, port and starboard, of equal strength; and are also classed in messes which are 20 in number in all. A third sort of grouping of the boys, in 18 "divisions," has reference to seniority and to sleeping quarters. The watches, each on alternate days, are employed on the work of the ship, seamanship-instruction, &c.; the watch not on duty being at school. On one afternoon in each week, Wednesday, all hands go ashore for recreation—cricket, football, and the like. The messes, each numbering 12 or 13 boys, have reference only to meals, and all meals are taken on the middle deck. Except at meal times boys of the same mess do not necessarily associate together. The sleeping berths, which are allotted without reference either to watches or messes, are with few exceptions on the middle and lower decks. Inmates of the sick-bay and wet-a-beds alone sleep on the main deck.

Data of the sort furnished by the table were studied with reference to the domestic life on board the ship here glanced at, but they did not for a length of time afford any clue to the outbreak. Of the many directions in which inquiry was pushed without result, some of the chief are as follows:—

Nothing could be discovered leading to suspicion that any groups, large or small, of boys could have been infected while *on shore* for amusement or exercise; and, beyond a somewhat heavy incidence of the early outbreak on a particular mess (an incidence that could not it was thought be usefully considered until other questions had been exhausted), no sort of grouping led to any suggestion about the origin of the disease *on the ship*.

Importation of infection to the ship by any individual boy seemed to be excluded. None of the boys early or severely attacked had been from the ship for many weeks previous to the outbreak. As regards new comers, in July seven, in August four, and in September two boys were admitted to the ship. One only of these 13 came under the doctor within two weeks of admission. He had slight diarrhœa on July 7th, 8th, and 9th. Short "leave" to boys who have been six months on board is often accorded, but only on written assurance by the friends to whom the visit is to be paid that their households are free from sickness. In the 12 weeks ending 23rd September 78 boys had leave, in no case exceeding five days. One only of the 78 came on the sick list within two weeks of his return. He suffered from "stomach derangement and debility" on July 24th, 25th, and 26th, after which he returned to duty.

Importation of infection by visitors was considered. Visitors to the ship, notably "old boys," are very numerous. In the month of August alone, 42 old boys (14 of them on one day, 21st August) visited the ship. Old boys and other male visitors use (if they require to do so) the closets in the "heads"; females use the private closets. It has been already noted that spread of infection by means of the closets on board appeared altogether unlikely. Inquiry is made of all visitors to the boys as to infection at their homes before they are received on board.

In the laundry arrangements no suggestion as regards importation or dissemination of the disease was afforded. All clothing of the boys is washed on board, in water from the domestic supply, on Mondays and Thursdays, and each boy does his own washing. Clothing and bed linen of sick cases were during the outbreak disinfected at the boat-house and then taken to Purfleet to be washed.

Particulars respecting the dates of reception on board of new clothing and bedding, and the distribution of such articles to boys individually or in groups, afforded no clue to the outbreak.

II. It was not until the foregoing lines of inquiry had been exhausted, that inquiry as to possible influence of food in producing the outbreak could be usefully made: for we have no knowledge of dissemination of enteric fever by constituents of food other than water and milk. In connexion, however, with the question of food of the boys, certain circumstances that had throughout the inquiry been borne in mind began to attain prominence. These were, the fact that the food supplied to and cooked for the boys was distinct and separate in all respects from that of the officers, who escaped illness; that the incidence of the first outburst of disease had been exceptionally on mess 15; and, that the more serious cases arranged themselves in groups which were attacked mainly on *Tuesdays* or *Wednesdays* at weekly or fortnightly intervals. Thus in seeking among articles of food for a heretofore-

unrecognised agent in the propagation of enteric fever, there existed no primâ facie ground for suspecting one kind of food more than another, unless one could be found capable of fulfilling certain assumed conditions of the problem requiring solution. These conditions were, that the article of food should have come into use about the time of the outbreak ; that it should have been consumed by the boys alone, and chiefly in the first instance by boys of a particular mess or messes; and that it should have had opportunity of operating weekly for two successive weeks, and then only after the lapse of a fortnight. Considerable hesitation was felt as to the validity of the conditions assumed as requiring fulfilment. For the heavier incidence of the outburst on mess 15 was not so decided as to be beyond the range of mere chance, and the assumption of operation of the cause of the outbreak on certain Tuesdays was based on one class of cases only, the graver ones, as probably being in their incubation more constant than the others. Obviously, too, all articles of food provided solely for the boys would equally fall under suspicion, if the fact of boys alone being attacked were exclusively considered. But notwithstanding objection to seeking hypothesis to fit hypothesis, investigation in the above sense was undertaken, for the reason that unless this was done inquiry could not proceed further.

Exceptional food of the boys first received attention, and herein was found a circumstance that seemed of possible significance. Pierce, the boy who died, received, as boys were in the habit of doing, a present of food from home, shortly before his illness. This food consisted, it was thought, of cake alone, which he probably shared with his mess (No. 15), and other comrades. By this means might have been brought about (if the cake was infective) some of the earlier features of the outbreak ; though all the conditions of the problem would not thus be satisfied. The question was therefore left for, if necessary, future consideration.* Inquiry respecting the regular diet of the boys extended to all articles of food used on board, the days of the week on which they were habitually consumed, and the dates on which articles of food other than fresh meat and vegetables (which were received day by day) were received on board. As regards meals, breakfast and supper offered no hint as to the cause of the outbreak. Neither meal varied in any way suggestive of relation with the grouping of cases observed in the outbreak. Dinner, however, seemed to suggest a clue. The animal food of the boys, though varied day by day (fresh meat four times a week, and cheese, suet pudding, and salt meat each once), was the same every Sunday, every Tuesday, every Wednesday, every Thursday, every Friday, and every Saturday ; but on *Mondays* could vary. Monday was, indeed, always a boiled *salt meat day;* but the *sort* of salt meat consumed on Mondays differed from week to week. As a rule it was alternately salt beef and salt pork; now and then it happened that either one or the other constituted dinner on *successive* Mondays ; and occasionally a dinner of the one was supplemented to some extent by the other. Salt beef, therefore, and salt pork came under suspicion, for either of them might by this method of consumption have been related to the grouping of the graver cases on or about certain Tuesdays; and further, it was ascertained that a fresh cask of each came into use shortly before the outbreak. Suspicion of this sort once aroused settled naturally on pork. Not indeed on account of so-called typhoid fever of the pig (which is not known to be transferable to man), but for a wholly different reason. It occurred to me that if pork had had to do with the outbreak, some of that (224 lbs.) of the cask newly taken into use *might have been trichinised, and that the disease, therefore, from which the boys suffered might not have been enteric fever at all, but trichinosis.* It will be observed that a theory of trichinosis seemed exactly to fit the conditions assumed as requiring fulfilment. A newly broached cask of pork came into use shortly before the occurrence of the outbreak. The pork was consumed by the boys alone. Portions of the pork not thoroughly well cooked might form but a small proportion of a total dinner for the boys, and might therefore have been consumed on particular days within the limits of one or two messes, and thus (if such portions happened to be infected with trichina) the incidence of the severer cases on a particular mess or messes might have been brought about. Again, pork might very well have been consumed on two successive Mondays, and after that not until a fourth Monday, and thus the specialties of the time-distribution of cases, notably the peculiar grouping of the graver attacks, might be accounted for ; while the great diversity of duration of illness would be quite intelligible. Trichinosis, in its incubation period, and in the duration of the illness resulting from it, has been known in outbreaks of the disease upon the Continent to vary

* Toward the close of this inquiry, and after the above was written, the Captain Superintendent ascertained that Pierce's present comprised, besides cake, in all probability animal food. The further consideration of the subject which thus became necessary will be given later on (page 9).

very greatly. Probably the persons who have eaten most largely of trichinised flesh, or who have eaten it in a condition most nearly approaching a raw state, suffer soonest (sometimes within 24 hours) and most severely from trichinous disease. Many persons who have certainly partaken of trichinised flesh, but who have done so sparingly, or in a fairly cooked state, have escaped the disease altogether, or have had merely trifling illness of undefined commencement and end, and occurring many days, even some weeks, after the infective meal. Other evidence, too, seemed to support the theory. It was now ascertained that the use of pork on board the "Cornwall" had, owing to misgiving as to the wholesomeness of such food, been discontinued shortly before the cessation of the outbreak; further, it was learned that the pork in question was "American pork," exceptionally obtained from a firm in Bristol; and more, that it consisted solely of "belly pieces," and therefore of parts of many pigs, and of those parts most likely to be infested with trichina.

The theory of trichinosis was accordingly put to the test of further inquiry: but no confirmation of it was at first to be found. Inquiry (1) respecting the actual consumption on particular Mondays of the pork in question, (2) the pathological condition of that pork, and (3) the clinical records of the cases attacked by illness failed, for various reasons, in attaining any other than a negative result. (1.) As to pork the cook's books, though showing day by day the consumption in kind and in amount of each article of food used by the boys, failed to distinguish between salt beef and salt pork. These were habitually classed together as "salt meat," 96 lbs. of which were entered as having been consumed each Monday in September and October. Thus the precise Mondays in these months on which pork had been consumed, and that Monday in October on which it had been last eaten, could not be determined. Again, (2) microscopical examination of small portions, in each instance, of pieces of pork remaining in the "harness cask,"* and believed on board to have formed part of the contents of the cask that had come into question, failed to find any trichinæ. (3.) Detailed examination of the clinical records of the cases of illness failed in like manner to establish or to refute the theory. Few notes, except those relating to temperature, pulse, and respiration, had, owing to stress of work during the outbreak, been taken, and these by themselves afforded no ground for a conclusion. The temperature curves (when I had formulated the notes in charts) showed that beyond doubt many of the boys had suffered from continued fever; but as to the precise nature of that fever they gave no definite information. In several instances, and notably in their inception, these curves differed considerably from the temperature curves of enteric fever; but how far they (or any of them) corresponded with the temperature curves of fever resulting from trichinosis I had no sufficient means of judging. The pulse records of the cases did not in their relation to the temperature curves appear altogether suggestive of enteric fever.

It will be observed that this study of the clinical records of the cases, though it failed to elicit information directly suggestive of trichinosis, failed to a like degree to support a theory of enteric fever. Attempt was therefore now made, in conjunction with the medical officer of the ship, to recover by inquiry of the boys themselves and of their attendants more extended particulars of the clinical history of the cases attacked. By this means, and with help of leading questions, it was ascertained that if the outbreak had been one of trichinosis, certain symptoms, usually described as characteristic of that disease, had not been prominent. Notably "sudden swelling of the face, particularly of the eyelids, at an early stage of illness" had not, except perhaps in one or two instances, been noticed.† No obvious "painfulness and immobility of the arms and legs with œdema and contraction of the muscles" could, except doubtfully in a single instance, be heard of. Again "œdema of the feet, legs, and thighs toward a later stage of illness" had not, except in one case, existed. General "anasarca of the trunk" had been altogether absent. But nevertheless it became apparent that though in no single instance had all the symptoms referable to trichinosis been present, still in several cases one or more symptoms that might have belonged to that disease had existed, and in other cases such symptoms seemed obscurely hinted at. Further, in some half dozen instances, there had been jaundice of an anomalous sort. Upon the whole it did not seem that trichinosis could, from this clinical history, be set aside; though evidence affirmative of it was, thus far, wanting. On the other hand, these new details left me unconvinced that the outbreak had

* The "harness cask" is that containing brine, into which odd portions of the salt meat taken from the original casks await consumption. The amount of meat that finds its way into the harness cask probably varies a good deal.

† The symptoms here put in inverted commas are quoted from Dr. Thudichum's account of the diagnostic points of the disease.—(Seventh Report of Medical Officer of Privy Council, pp. 379–80.)

been enteric fever; and this, notwithstanding the occurrence in certain cases, of symptoms more or less diagnostic of that disease. As the questioning of the boys and of the ship's staff proceeded, it became, indeed, increasingly evident that a large proportion of the fever cases might be more safely ranged under some general name, such as "simple continued fever," than under the specific name of enteric fever; and it was observed, too, of the less febrile cases that they, like the more febrile, were accompanied by pain in the belly and nausea, with, though commonly without, looseness of the bowels.—In taking this view of the outbreak, I found myself in much accord with the Medical Officer of the ship, who, except for some few cases, would from the beginning have been disposed to avoid a name that implied a certain knowledge of the pathology of the disease.

It was now, upon reaching this point, that it came to be pretty clearly seen that an outbreak, characterised as this one was in the bulk of its cases, by "simple continued fever" with gastero-enteric disturbance, might just as well have been related to trichinosis as to enteric fever; the fact of certain of the graver cases of the outbreak, taken collectively, presenting most of the symptoms characteristic of enteric fever, seeming to lose significance beside the circumstance that these very same cases presented, collectively, many symptoms that might be referable to trichinosis. So that, at this stage of inquiry it had become obvious that need for *direct* evidence respecting the nature of the outbreak had become imperative, and in this sense I reported to the Medical Officer of the Board.

Two methods were indicated whereby direct evidence might be brought to bear on the subject of inquiry. One, microscopical search for trichinæ in portions of muscle excised from patients who had recovered; the other, exhumation and pathological examination of the body of the single fatal case of the outbreak. The former course did not commend itself; for microscopical examination of living muscle is practicable only within somewhat narrow limits, and failure to find trichinæ by this method, while not necessarily disproving trichinosis, would in no sense afford evidence of enteric fever. On the other hand exhumation and pathological examination of the body (with the large facilities thus procured for microscopic examination of muscles) of the boy who died might be trusted (if decomposition had not too far advanced) to decide between trichinosis and enteric fever. Further, this course had the additional advantage of dealing with what was in effect a test case of the outbreak. The case in question was that of the boy Pierce, who was one of the first group of sufferers attacked on September 23rd. He in particular exhibited symptoms (persistent diarrhœa, copious eruption of rose-spots, and even free hæmorrhage from the bowels) believed at the time to be those of enteric fever. In addition, he, in dying on the 18th day of his illness, appeared to be the subject of bowel perforation.

Application was therefore made by the Board to the Home Office for an order for exhumation of the body of Pierce. An order being granted conditionally on consent of the friends of the boy being first obtained, and on the understanding that the exhumation and necessary re-interment of the body should be carried out under the auspices of the Sanitary Authority of the district in which burial had occurred, I set myself to procure this consent and to make the requisite arrangements. This having been done, the examination of the body took place on the 6th December. With the consent of the Board, Dr. Cory (who had previously assisted in microscopic examination of the pork) was associated with me at the necropsy and in the pathological investigations which followed.

It was hardly expected that post-mortem examination of the ordinary kind would, two months after burial, afford much information. It was thought that detailed pathological examination of certain viscera and tissues would be needed before a conclusion could be arrived at. At the necropsy, however, it was found that decay had not so far advanced as to obscure certain first indications which, while they did not point to trichinosis, went far to negative the notion of enteric fever. The body, though much decomposed externally, fairly retained its normal proportions. There was no œdema of the feet, limbs, or trunk. Internally the effects of decomposition were less manifest; the various viscera were easily made out, and so far as naked-eye appearances went, were not much changed. Beyond enlargement of the spleen, which was double the normal size, there was nothing suggestive of enteric fever. There was no peritonitis, nor any evidence of perforation. The peritoneum generally was clear, shining, and free from lymph or adhesions. No enlargement of the mesenteric glands could be discovered. The stomach, intestines, some of the other viscera, and portions of various muscles were reserved for further and more exact examination.

Further examination was carried out conjointly by Dr. Cory and myself. I think it right to put on record minute technical details

respecting this examination, for the use of future inquirers. First, as to enteric fever. Very careful examination of the stomach and intestines failed to find any trace of ulceration, or (allowing for decomposition) of any change in the intestinal glands such as is usual in enteric fever. Moreover, the bowels, as tested by water, proved throughout intact. In a few places the bowel was discoloured internally, as if by injection of the mucous membrane subsequently altered by decomposition; but there was no appearance among the decomposed bowel contents of the presence of blood in any considerable quantity. More thorough examination of the mesenteric glands than had before been practicable revealed a few only enlarged, and none were bigger than peas. The other organs afforded no evidence for or against enteric fever. It thus appeared, after detailed examination of the viscera habitually implicated in enteric fever, as had appeared from the original necropsy, that with all allowance for decomposition, no such anatomical changes as are characteristic of enteric fever toward the end of the third week of its duration were to be found; and the conclusion now seemed warranted that whatever had been the nature of this boy's fatal illness, it certainly had not been enteric fever.

This conclusion was more than confirmed by the results of microscopic investigation, conducted with reference to trichinosis. In the very first specimen examined, a few fibres from one of the abdominal muscles, was found a *wandering and living trichina;* and further search revealed the presence of these parasites in most of the muscles examined.* Although tolerably abundant, the trichinæ could not be said to "infest" (in the common sense of the word) any of the muscles, except perhaps the diaphragm, and in none of them had the parasite reached the stage of encapsulation. Except the first found, no trichinæ exhibited active movement, and comparatively few had attained, as had that one, their full growth as muscular parasites. In specimens of this sort the internal structure and organization were under a high power ($\frac{1}{12}$) readily made out, the parasites having altogether resisted decomposition, and most of them having probably died only a short time before examination. The smaller, not fully grown, muscular trichinæ, on the other hand, had seemingly all long since died. Their outline had become indistinct, their interior granular, and their structure could not be made out. Many were found broken up. Examination of the decomposing contents of the small intestine failed to find any parent trichinæ, but by scraping the under surface of the folds of mucous membrane of the bowel, brood trichinæ in considerable numbers were obtained. These had apparently all died, and their structure could not satisfactorily be made out.

Doubt could no longer exist that this boy died from acute trichinosis. Not only was the presence in his body of the actual parasite demonstrated, but the results of microscopic examination pointed to the parasites as having played a very active part in the production of his illness, and were indeed precisely such as might have been anticipated in a case of early death from trichina disease. Death took place in this instance on the 18th day after appearance of symptoms, at a period that is too short to have allowed of universal migration of brood trichinæ, and insufficient also for the attainment of full growth in the muscles of any but early migrants. At the same time the period was not nearly long enough to have sufficed for the full evolution and encapsulation of many (if, indeed, of any) muscular parasites.†

Demonstration such as this of the nature of the fatal illness in what has above been termed a test case of the outbreak, was in effect demonstration of the nature of the outbreak itself. It will be remembered that the evidence adduced indicated that the cause (whatever that might have been) which produced this boy's illness, produced also the illness (so far as that was specific) of his shipmates; that his case, in that it formed one of the first and most severely attacked group of sufferers taken ill on 23rd September, was representative of the earliest and intensest operation of that cause; and that it was representative also, and in a high degree, not of the anomalous but of the *enteric* class of cases; of those, namely, whereon diagnosis of the outbreak had been in the first instance based, and in regard of which a theory of trichinosis had appeared at one time well nigh untenable. Under the circumstances it was deemed unnecessary to

---

* No trichinæ were discovered in the heart. This organ was found to be small, its walls thin and flabby, and its muscles more decomposed than any examined. Possibly during life the heart had been severely trichinised (seeing that brood parasites, if conveyed by the venous blood, would encounter it first of all the muscles) though subsequently the parasites had migrated from it. Encapsuled trichinæ in the cardiac muscles are almost unknown.

† It is here assumed that migration to and growth and development of the trichinæ within the muscles practically ceased with the death of their host. The circumstance that any living trichinæ should have been found in this boy's muscles two months after burial proves merely the extraordinary vitality of the parasite. But on these aspects of the subject, see Appendix A. to this Report.

proceed by vivisection of muscles of recovered cases to seek further and corroborative evidence as to the nature of the outbreak.

There now remain to be considered the circumstances under which trichina disease became conveyed to the boys. In this connexion must be noted a suggestion, made for the first time while this report is in progress, that *the ship's* pork had not been the *source* whence the trichinæ had been derived. It was ascertained by the Captain Superintendent that Pierce, the boy who died, had, among other things, in the present of food received from home shortly before his illness, a piece of fresh roast pork. This present of food (at the time thought to have been cake) has been already referred to on p. 5 of this report, where it is stated that although all the features of the outbreak could not be accounted for on the assumption that the food brought to Pierce was infective, still the illness of Pierce and his mess (No. 15), and other comrades attacked early in the outbreak, might possibly be so explained. Accordingly inquiry was made concerning this present of pork, with a view of ascertaining what concern it might have had in the commencement of the outbreak. Considerable doubt existed in the first place as to the date on which this present of food was received; the evidence of some (and perhaps the most trustworthy) witnesses, fixing it at the end of August (three weeks to a month before the outbreak), that of others placing it at a much earlier period. The mother herself, who once only, she says, made her son a present of pork, thought she had done so shortly before the Bank holiday in August. Accounts, too, varied as to the amount of pork constituting the present; but upon this point perhaps the mother's statement is to be relied on. It was to the effect that she purchased, at 8*d.* per lb., 1¼ lbs. of loin of pork on a Saturday, and after dining on it with her daughter on Sunday, took the remainder to her son on visiting him on the following day. Neither she nor her daughter suffered subsequently from any illness. The pork was, she stated, well cooked, for the reason that she had an especial distaste for under-done pork. Of other witnesses on this point, some confirmed while others dissented from this statement. On one point only of the subject were the various witnesses unanimous: whatever may have been the quantity of the pork, the date of its reception, and the amount of cooking it had undergone, all agreed that Pierce consumed most of it himself. Two boys only could be found who acknowledged having tasted the pork, and neither of them was included in the list of sufferers by the outbreak. The members of Pierce's mess (No. 15), who were especially questioned on this subject, one and all denied having tasted the pork, and few of them were aware that Pierce had had any. It thus appeared that of the first sufferers by the outbreak, none excepting Pierce had partaken of the particular pork in question; and that of those, including the mother and sister, who had consumed that pork, none, again excepting Pierce, had suffered by the outbreak. Probably, therefore, this pork had no concern whatever in causing illness on board the "Cornwall."

The foregoing alternative having been disposed of, it seemed inevitable that the "American pork" on board the "Cornwall" was the source whence the trichina disease had been derived; and an attempt was now made to learn how it had happened that the method of cooking salt meat on board the vessel had failed to destroy the infectivity of the pork; and incidentally evidence was sought as to the extent to which the implicated pork (consisting of pieces from various animals, in two or more casks) might have been affected with trichina disease. Cooking salt meat on board the "Cornwall" is effected by boiling it 3½ to 4 hours; a process that seemed at first sight not unlikely to secure cooking of the meat, and one which has, so far as I could learn, commonly to a great extent achieved its object—the meat being spoken of as stripping easily from the bone. But when the details of the process come to be considered, cause appears for questioning the uniformity of cooking obtained by this method. Salt meat is cooked on board *in bulk:* 96 lbs. of beef or pork, as the case may be, are packed in a covered galvanised iron vessel of size just sufficing for the meat and the necessary water; the latter, when the meat is added to it, being nominally at boiling point.* The iron vessel with these contents is then placed over the central fire area of a stove of the "kitchener" type; and is assumed to be retained there from 8.30 a.m. until 12.30. Once only, it is said, during that period is the vessel interfered with for the purpose of adding more water.† Now, it will not be disputed that meat thus cooked on a large

* Plunging meat into water that is (or is nearly) boiling has been proved by experiment to retard cooking of the interior of the meat.

† Other vessels, saucepans, &c., containing dinners of other persons are, along with the pork vessel, placed for cooking on the stove. Possibly in practice the pork may occasionally make way for these vessels (or some of them), and become removed from time to time from the premier place on the stove to a situation on the hot plate remote from the central fire.

scale and in bulk cannot, except after very prolonged boiling, get equally cooked throughout. And the larger the mass of meat and the more closely the mass is packed into the cooking vessel, the longer will be the time necessary for the heat to penetrate into the interior of the meat, so as to ensure the complete cooking of its central parts. Hence in the case of 96 lbs. of meat, packed as the meat was packed on the "Cornwall" into a vessel of not many gallons' capacity, it may well be that pieces in the interior of the mass did not, during four hours' cooking, attain a temperature adequate to destroy the life of trichina parasites. Indeed it would surprise me to be told that such length of cooking was effectual to that end in the case of the "Cornwall" pork. For I myself can call to mind an instance in which a mass of salt beef 60 lbs. in weight, after what was believed to be thorough cooking in a closed boiler during nine hours, was found in its centre conspicuously under-done, notwithstanding that its exterior presented an appearance of over-cooking. In this connexion it may be remarked that tradition, as handed down by cookery-books, prescribes a quarter of an hour's boiling for each pound of meat to be cooked. If this estimate is to be trusted, the pork on board the "Cornwall" should have been boiled six times longer than was actually the practice; or else it should have been cooked in some fashion different from that ordinarily followed in "boiling."

Indications as to the quantity of the pork that might have been trichinised; as to the presence of the diseased portions in one or another cask; and as to possible specialty in distribution of such portions to a particular mess or messes, were sought for with much pains. It was hoped that some such indications might have been forthcoming during the above-recorded study of cooking operations, or from the dates of broachings of particular casks, and of the consumption of their contents. And, the pork having been consumed on certain Mondays while the manifestations of injury from its use were especially grouped about certain Tuesdays, there were many points of interest in the inquiry. Unfortunately, no record (as has been said) existed of the particular Mondays upon which pork had been consumed, or of that Monday whereon it was last eaten; nor was there any note of the date upon which each newly-broached cask of pork came into use. The pork (without discoverable trichinæ) in the harness cask might, it was seen, have been derived from one or another original cask, without such original cask being therefore exculpated. What became evident during the search was this: that no affirmative statement on any of the above points could be justified. Of no part of the pork, whether from one or another cask, or from one or another animal, could it be said that it was originally infective. And while a large proportion of the total supply might have been diseased without producing more extensive mischief than that actually observed, so, on the other hand, a small proportion of the supply being diseased could, if it were distributed after the usual fashion, be related to a prevalence of illness having the proportions and distribution that were witnessed during the outbreak. Efficiency of cooking could destroy, as far as it went, the dangerous quality of a *large amount* of originally infective pork; whereas the customary plan of distributing the meat to the several messes might result in a *small quantity* of infective meat coming to be distributed somewhat widely. For, from an overplus service to one mess, a deficiency in service to another mess or messes is made up by bits or slices. Given a diseased joint as the portion designed for one mess, and bits of it taken as makeweights to other messes: and incidence of the resulting trichinosis, largely upon the one mess, and to a less degree on the other messes, becomes readily intelligible.

In bringing this report to a conclusion certain matters that seem to call for attention may be briefly noted:—

Of all outcomes of this inquiry, both immediate and prospective, one of the most important is the circumstance that an outbreak of trichinosis has in many essential features aped an outbreak of enteric fever. This occurrence is, so far as I know, without recognised precedent in this country. No doubt in other countries something similar has occurred; but in those instances, so far as we hear of them, no sooner the cause of the outbreak seems to have been hit on than abundant and undoubted symptoms of trichinosis are found to have been observed in the patients. In the present case it was not so, for since the pathological evidence referred to was obtained I have again (along with the Medical Officer of the ship) inquired of the boys attacked, respecting the nature, order, and succession of their symptoms; and I am constrained to admit that although symptoms doubtless referable to trichinosis could be elicited from many of the boys, still such symptoms had been seemingly very imperfectly developed. Especially is it noteworthy that in no single instance had *many* of these symptoms together been present even in a minor degree.

Possibly the absence of defined symptoms of trichinosis may have been in some degree due to the youth of the patients, for it is asserted by more than one authority that children suffer less severely from the disease than do adults. But however this may have been, it has in the end become apparent that no better designation for the majority of the cases (pathology apart) would be found than "simple continued fever." Now, heretofore, it has been the custom to regard fevers that could be thus designated as partaking of the nature of either typhus or enteric fever, and as having no particular significance of their own. But the experiences here recorded point to other states of disease as being properly described under the name of continued fever. In particular cases where the evidences of typhus, enteric, or relapsing fever are inconclusive, and in outbreaks that are not capable of being surely designated by any one of these names, trichinosis (among other diseases) will now claim to be considered. The account that Mr. Mortimer de Brent (the Medical Officer of the ship) has given of the "Cornwall" disease, as it now presents itself to him after recognition of its parasitic nature, will be read with interest in this connexion. It will be found, along with notes on microscopic investigation of muscles of the fatal case, drawings by Dr. Cory, and temperature charts of the cases, in appendix to this report.

Another circumstance of interest is the small mortality in this outbreak. So far it is in accord with certain observations on the Continent. For although trichinosis has on many occasions proved very fatal, nevertheless there are on record very considerable outbreaks of the disease with but trifling mortality. At Magdeburg from 1858 to 1862 300 persons suffered from trichinosis, and two only died; at Gusten in 1861, 40 cases occurred without a single death; at Blankenburg in 1862 there were 278 cases, and only two deaths; and at Quedlinburg in 1864, of 120 patients, two only died:—a mortality, it will be observed, in no instance so high as 2 per cent. of the attacks. Probably enteric fever in outbreaks of any magnitude rarely occurs with a mortality of less than 10 per cent. Henceforward, therefore, outbreaks of so-called enteric fever characterised by exceptional paucity of fatal cases must needs be regarded with peculiar interest.

It is very noteworthy also that no suspicion could well have arisen respecting the nature of this outbreak, if it had happened that the disease, instead of occurring on ship-board, had attacked members of several different families living in town or country. In regard of enteric or of "continued" fever prevalence, under such circumstances, it is unlikely that the meat source of the sufferers would have been inquired about at all; and had inquiry in such direction been made, it is altogether doubtful whether, in view of the small proportion of attacks to escapes, community of meat source would when found have been deemed to be evidence of material value, even if the meat had been pork. In the present instance the result of inquiry must have been negative, if it had not been for the frank co-operation of the Medical Officer of the ship, and for the fact that the community concerned was in essentials known, in every detail of its daily life, to the Captain Superintendent; and that book-records concerning most matters of primary importance were put at my disposal. In thanking Captain Morrell very cordially for the help of which every page of this report gives evidence, I feel it is proper that I should observe that, in providing the ship with the article of food that has now come into question, there was no sort of suggestion that it could be unwholesome, and that he acted, as he always does, in the interest equally of the ship and of the boys; while as regards cooking operations, he merely followed time-established precedents in most ships and in many public institutions.

Finally, with reference to the question respecting cooking that has been raised, it seems desirable that direct experiment should forthwith be made to settle what are the precautions requisite to be taken for the thorough cooking of meat in establishments wherein such food is cooked *in bulk*. And further, it deserves notice that if efficient examination of imported pork had been matter of rule and duly enforced, this outbreak would in all probability not have occurred.

W. H. POWER.

February 1880.

APPENDIX (A.)

MEMORANDUM on MICROSCOPICAL EXAMINATION, two Months after DEATH, of MUSCLES and VISCERA from the BODY of RICHARD PIERCE.

Portions of the following muscles were examined microscopically.—Diaphragm, obliquus abdominis externus, psoas, intercostal (fragment), pectoralis major, biceps brachialis and heart. Specimens also of bowel contents from various portions of the intestine, and specimens from its mucous surface were submitted to investigation. The muscles generally were œdematous, much decomposed, and offensive. In colour they were no longer ruddy, but instead, livid, greenish, or even purple in hue. Notwithstanding, in most muscles (except the heart), the fibres were easily made out, and in some the transverse striæ also. The heart was the most decomposed of all the muscles, and its tissue appeared much altered. The intestines were decomposed internally, and their mucous membrane stripped readily from the subjacent tissue. Here and there the mucous membrane had disappeared. The bowel contents were extremely offensive, and in an advanced stage of decomposition.

In all the muscles examined, excepting the heart and intercostal, wandering parasites were found. They may be said to have been moderately plentiful; one muscle only, the diaphragm, can be described as absolutely "infested" with parasites. In the intestine, no sexually mature worms could be discovered; but from the under surface of folds of its mucous membrane numerous very minute, short, hair-like bodies were obtained. Under a high power these bodies appeared to be without definite structure, with the exception perhaps of what might have been a central canal. Many were irregular in their outline, and most seemed partially decomposed. Probably they had once been brood parasites.

All the muscular parasites except one appeared dead when found, and none were encapsuled. Before dying, by far the greater number had failed to attain such size as is common in trichina spiralis at the completion of its wandering stage. In most respects, such as general appearance, shape, proportion of length to breadth, &c. they appeared identical with that parasite in its immature larval stage. As regards structure, however, these immature worms were indistinct, their interior having undergone granular change; many specimens were broken up and apparently more or less decomposed. Of the comparatively few parasites that had attained the full size of muscular trichinæ, the largest measured $\frac{1}{12}$ of an inch in length. Specimens of this size were in several instances translucent and "dropsical," being much distended by clear fluid; consequently their structure, especially that of their anterior portions, was extremely clearly defined. Herein they differed from non-dropsical specimens of similar apparent age whose structure had become indistinct owing to granular change in their interior. This dropsical condition of parasites was noticed for a short time only during the investigation. Before examination of the muscles had proceeded far, no specimens could be got that had not become opaque from granular change in their interior. Probably "dropsy" did not occur (during investigation) except in parasites that were dying or had not long been dead. In any case the number of such specimens was much restricted, and it became still further diminished by accidents due partly to thickness of cover-glasses, partly to extreme tenuity of the walls of the parasites. Under manipulation of a high power the specimens, besides being generally compressed and flattened out sometimes to the extent of nearly doubling their original breadth, became in most instances ruptured and their contents extruded. As a result of this compression and rupture of the best specimens, the structure of their anterior portions only can with any confidence be depicted.

Early in the investigation some doubt as to the identity of this wandering parasite seemed suggested in that the dropsical specimens presented, in their anterior portions, a much more defined structural appearance than that depicted by other observers in regard of trichina spiralis, and further, unlike that species as figured in books, their intestine, except indeed at its very commencement, presented little appearance of a succession of bead-like bodies, (the so-called "rosary") each with a central highly refractive spot. In this connexion too the circumstance that none of the numerous specimens observed were encapsuled, and few of them even suggestive of spiral involution, seemed to require explanation.* It was very soon seen, however, that all difficulties of the above sort might readily be explained with reference to the exceptional circumstances under which the parasites in question came to be observed. These were wholly different from conditions under which trichinæ have apparently yet been studied. Heretofore, observations of trichinæ have been pretty much restricted to those occurring in recently deceased hosts, human and other, or in pigs, the flesh of which has been artificially preserved. No information is to be had respecting the behaviour of trichinæ in muscles that have undergone, as in the present instance, during many weeks post-mortem decomposition. Brief consideration therefore of these exceptional circumstances in their bearing on the subject is necessary. Early death (on the 18th day of illness) assisted by decomposition of the host, may suffice to explain the moderate (moderate, *i.e.*, in comparison with other observed cases) amount

* It will be observed that doubt as to identity of this wandering muscular parasite, if seriously raised at all, involves considerations of supreme importance. Its identity or non-identity with trichina spiralis would not alone be in question: for in view of the symptoms exhibited by Pierce and other sufferers by the "Cornwall" outbreak, possible relation of enteric fever to ravages of a muscular parasite would have to be investigated and dealt with; and current views respecting the etiology and pathology of that disease might require to be materially modified.—W. H. P.

To illustrate Mr Power's "Cornwall" Report.

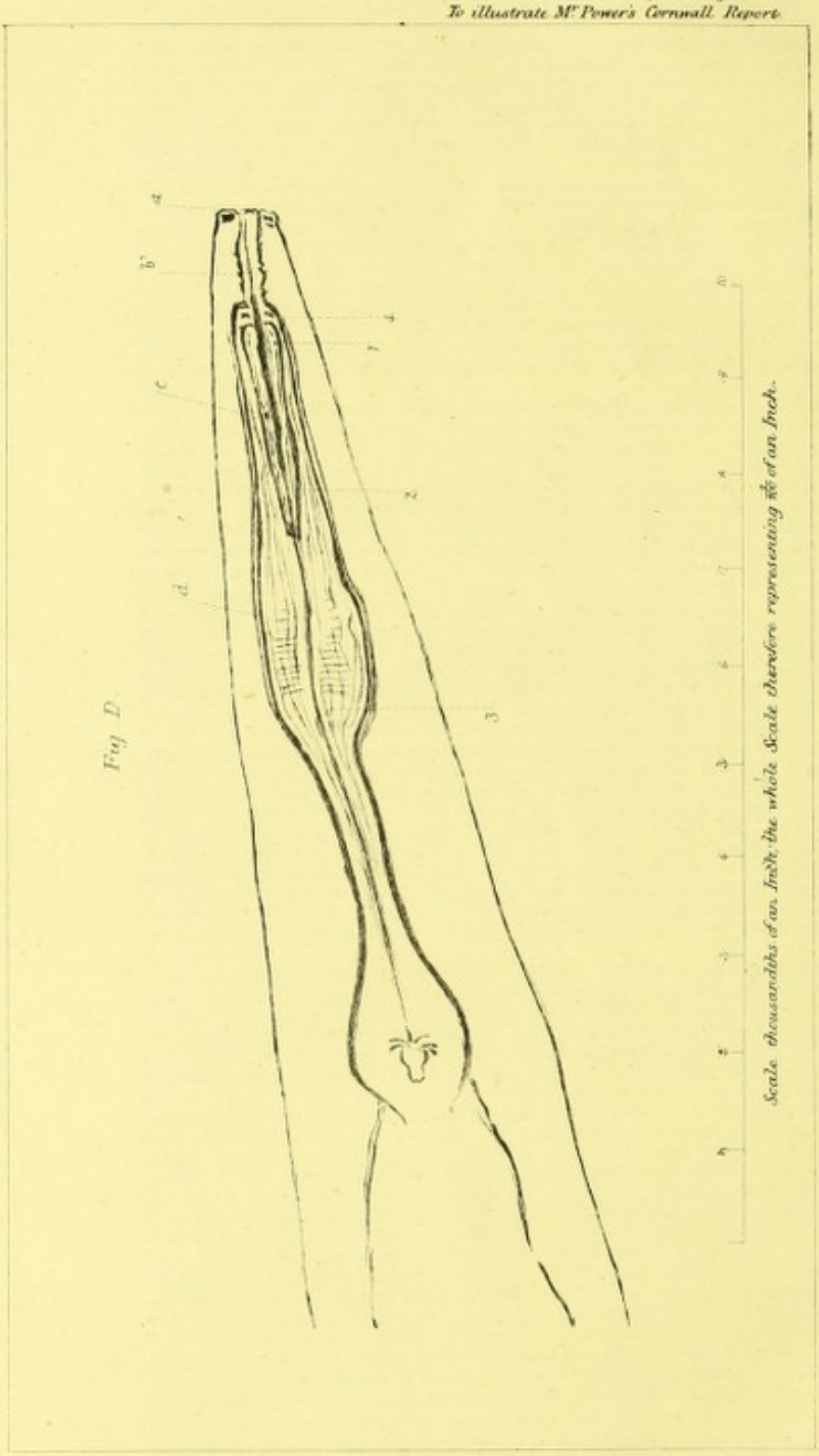
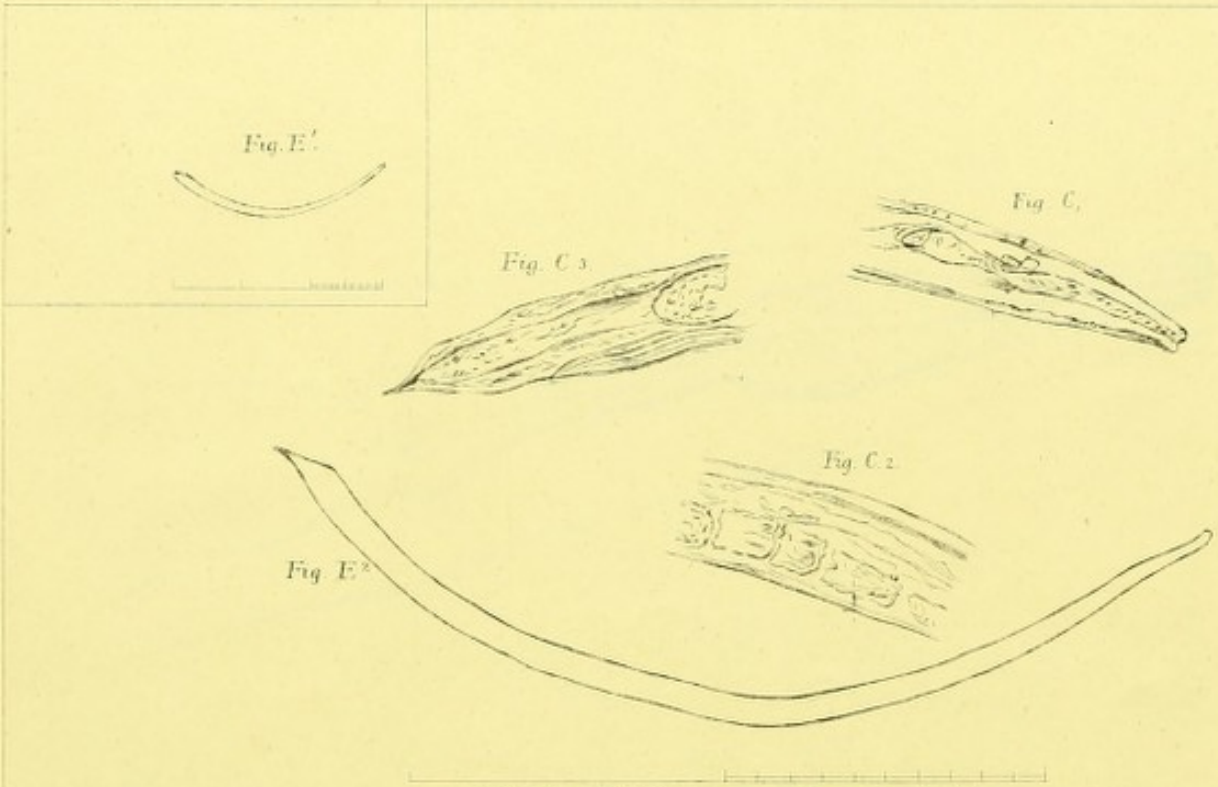


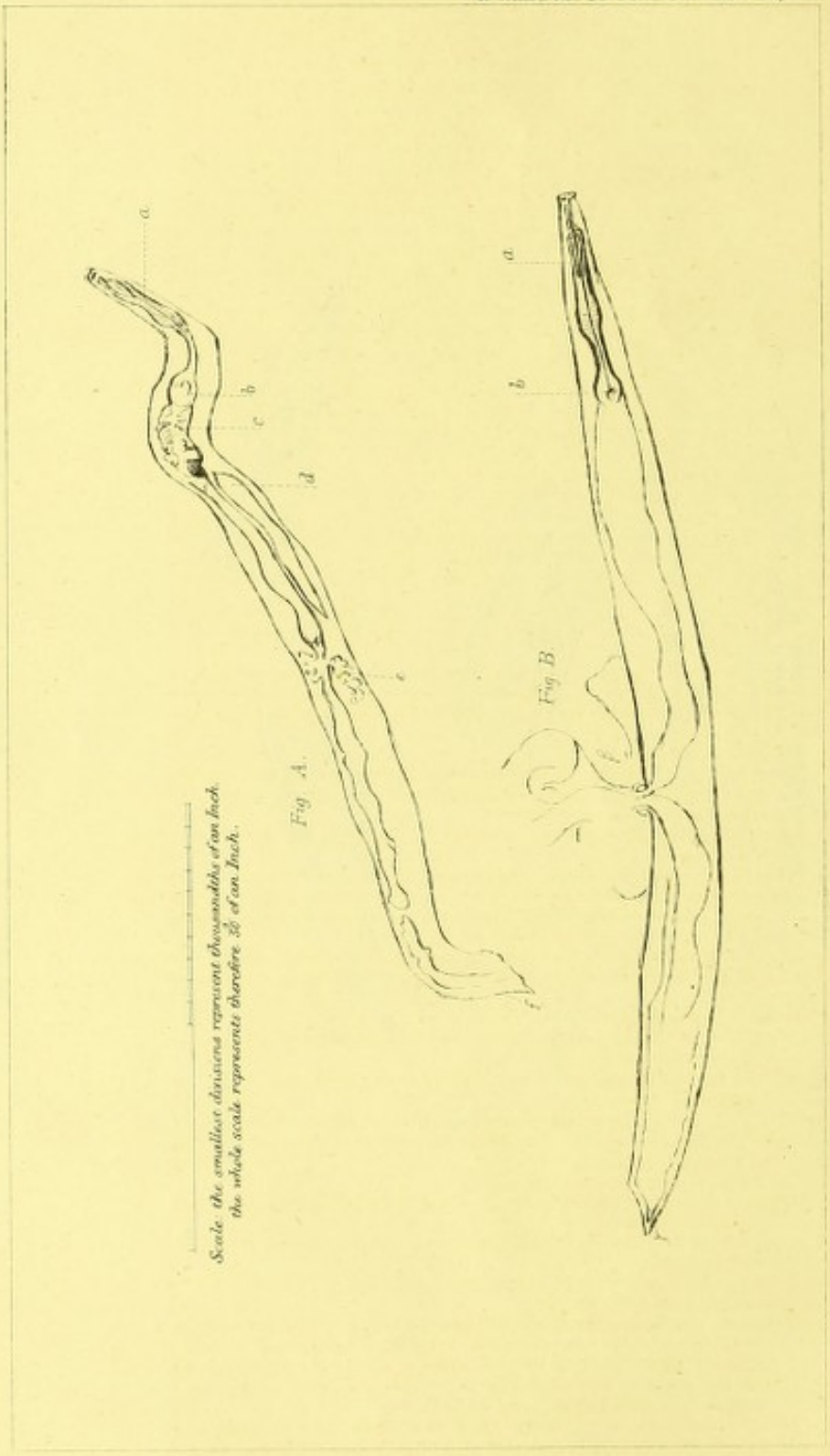
Fig D



Scale the smallest divisions represent thousandths of an Inch,
the whole scale represents therefore ⅒ of an Inch.

To illustrate Mr Powers "Cornwall" Report.

To illustrate Mr Power's "Cornwall" Report.



in the present instance of migration of parasites. It may serve also to account for the circumstance that comparatively few specimens had attained full growth as wandering parasites, that none were encapsuled, and that few exhibited any appearance of spiral involution. For a period of four to five weeks is set down as necessary for attainment by trichinæ of complete and encapsuled larval stage, and it seems that spiral involution of the worms is scarcely to be looked for short of commencement of that stage. Maturity therefore of many specimens could not be expected at the end of 18 days. Probably death alone of the host may have sufficed to stop migration, and have largely checked subsequent development of parasites, the more so if they are dependent on the general circulation for their transmission to and growth in the muscles. But what death by itself (of the host) may have been unable to effect, may well have been accomplished by death and decomposition jointly. Though death of a host may not (apparently it does not) affect the vitality of encapsuled trichinæ *that have ceased to feed*, non-nourishment of muscles and the decomposition of them which here followed death may well have caused destruction of immature parasites that had yet to undergo in their wandering further *feeding* and growth. On the other hand full-grown trichinæ, even if not yet encapsuled, to whom feeding is no longer a necessity, may (and evidently can) notwithstanding death and decomposition of their host, continue to exist in decomposing muscle long after their immature companions (which needed nourishment) have perished. In the present instance abstention from food of full-grown muscular parasites together with (instead of encapsulation) continued wandering in search (so to speak) of escape from adverse conditions, may well have sufficed after many weeks to produce in them absence from their interior of any extraneous matter, except water, and thus at length have rendered abnormally conspicuous certain details of their structure which, had they in ordinary course gone in a state of repletion into capsules, would have appeared indistinct or even altogether different. In view of all the circumstances dealt with, absence in dropsical parasites of well defined "rosary" appears of little moment; the less since more recent examination of full-grown muscular trichinæ from pigs has shown that an appearance in any great degree comparable with the "rosary" of books is by no means to be looked for. Further, the presence in these dropsical parasites of well-defined structural appearance of the anterior alimentary apparatus, instead of raising question as to identity of species, may rather be regarded as affording better opportunity than has yet been had for study of the anatomy of trichina spiralis. Whether or not the specimens mainly concerned have (as certain larvæ may be believed to do when checked at particular stages of their development *as larvæ*) skipped (or abridged) a stage (that of encapsulation) in their life history, and while continuing to exist in the decomposing muscle, have gone on toward higher development in the direction of mature sexual intestinal trichinæ, is a question that need not here be discussed. Figures illustrating points that have been referred to are submitted for use of other observers.

W. H. POWER.
ROBERT CORY.

Fig. A. A parasite from the abdominal muscle measuring $\frac{1}{12}$ of an inch in length. When found it was a good deal distended by clear fluid, but was *living*. The specimen is somewhat flattened by compression between the lens and the slide.

(*a*.) Mouth and œsophagus.
(*b*.) Upper part of alimentary apparatus exhibiting indications of a rosary-like appearance, and a body with a central highly refractive spot.
(*c*.) Continuation of alimentary apparatus.
(*d*.) Represents what appeared to be a closed sac; possibly the reproductive apparatus.
(*e*.) Is seemingly a gland similar to that figured by other observers.
(*f*.) Posterior end of the worm, where was an aperture through which under pressure part of the contents of the specimen extruded, thus rendering its lower interior structure indistinct.

Fig. B. A parasite from the pectoral muscle. The specimen, which was highly "dropsical" when found, has been flattened and ruptured; its contents are extruded.

(*a*.) Mouth and œsophagus.
(*b*.) Upper part of alimentary apparatus, with bead-like body and central highly refractive spot.
(*β*.) Point of rupture of wall of parasite, and extruded contents.
(*γ*.) Anal aperture.

Figs. C^1., C^2., and C^3 represent portions of another highly "dropsical" parasite from the pectoral muscle. The specimen became during examination ruptured and its contents extruded.

C^1. Head, with mouth and œsophagus.
C^2. Middle portion of parasite (before rupture) showing indications of so-called bead-like bodies.
C^3. Posterior end of parasite after compression, which has caused extrusion at the anal orifice.

Fig. D. Anterior extremity of B. highly magnified.

(*a*.) Mouth and œsophagus.
(*b*.) Pharynx having apparently two muscles. One (*c*) having attachments at (1) and at (2); the other (*d*), external to (*c*), having posterior attachment at (3) and anterior attachment (4) at a point in front of the anterior attachment of (*c*). This muscular arrangement appears well adapted for purposes of suction.

Fig. E^1. A "non-dropsical" parasite from the diaphragm showing the relation of length to breadth as it appeared viewed under a low power.

Fig. E^2. The same as it appeared under a higher power.

APPENDIX (B.)

MEMORANDUM by MR. MORTIMER DE BRENT, Medical Officer to the School Ship "CORNWALL," on the recent OUTBREAK of ILLNESS among BOYS on board that vessel.

On 23rd September 1879, seven boys complained at one and the same time of the following symptoms: pain in the belly, principally in the epigastric region, nausea, and distaste for food. Four of them complained also of vomiting, and one (Beaumont) vomited two or three times during the ten minutes he was under examination. All had brownish white-coated tongues. Several stated that already they had suffered for two or three days from looseness of the bowels; others on the contrary (including Beaumont) had been constipated. The nature of these symptoms pointed to stomach derangement, and their simultaneous occurrence in seven boys led to suspicion that contraband food of some sort, partaken of in common by all the sufferers, had been the cause of their illness. Inquiry however in this direction failed to show that they had eaten any food other than that provided on shipboard, and very soon it became apparent that these boys were attacked by illness far more serious than mere gastric disturbance.

In the course of the next few days most of the seven boys suffered from fever. Beaumont, whose case was somewhat in advance of the rest, had on the morning of 24th September, after a very restless night, a temperature (axillary) of 105 degrees; the temperatures of the others when first taken ranged from that figure down to 102. All now had diarrhœa, which in two cases was excessive. The motions began in a few cases by being loose and brown, but afterwards were found fluid and yellow. Delirium set in early in several of the cases, notably in Beaumont, who had to be tied in bed.

By this time other boys hitherto apparently unaffected, after complaining first of symptoms similar to those of the first batch of sufferers, began to develop symptoms of pyrexia; and though not a few of them suffered comparatively slightly, no doubt was felt that the outbreak was essentially one of continued fever.

In an outbreak of this sort, characterised, namely, by gastero-enteric disturbance and fever, diagnosis (and diagnosis was called for) as to its nature was based naturally enough on the symptoms of its graver cases; and three boys, Beaumont, Pierce and Sims belonging to the first group of sufferers soon afforded symptoms that seemed to point unmistakably to *enteric fever*. Besides the diarrhœa symptoms, which in Beaumont and Pierce were very severe, abdominal tenderness was observed in all cases, and in two (Beaumont and Sims) seemed to be localised somewhat in the right iliac fossa; and all three boys had tympanites. In addition there occurred in all three an eruption of roseola spots. In the case of Beaumont, in whom the eruption appeared earliest, the spots existed in considerable numbers over the abdomen on 26th September. In all respects the spots behaved like the spots of enteric fever. They could be made to disappear on pressure, and successive crops of them occurred from time to time, as was proved by marking the earlier eruptions with ink. In the case of Pierce the spots were even more abundant and extensive; Sims had about the same amount of them as Beaumont. Further, bloody evacuation occurred in two of these cases. Sims had blood in his motions once only, and then to no great amount. But Pierce had (according to the persons attending on him) copious bleeding from the bowel on three occasions toward the end of his illness; and the manner of his death was consistent with sudden hæmorrhage into his bowel as well as with (what at the time was thought to have occurred) intestinal perforation. On the evening of the 18th day of his illness he sat up in bed resting on his elbow calling for the bed-pan, and this not being brought immediately, he exclaimed "Make haste." Before however the commode could be got to the bed, "rattling in his throat" occurred, and he fell back and died.

Inasmuch as circumstances, which have recently occurred, show the diagnosis thus made to have been a mistaken one, it appears desirable, for the help of future observers, to put on record an account of the symptoms (so far as they can now be recovered) exhibited during the outbreak. And here it may be mentioned that stress of work occasioned by the outbreak, all of which along with private practice had to be borne singlehanded, has been the reason why notes of the cases have been, excepting temperatures, less complete than could be wished.

Symptoms observed during the outbreak that might have been referable to enteric fever.

The symptoms initiatory of illness, so far as the graver cases were concerned, seemed not inconsistent with commencing enteric fever. *Vomiting* is not, it is true, usually a symptom in enteric fever, but its presence in eight or ten cases was not necessarily reason for suspecting other disease. *Abdominal tenderness and pain* existed in all the severe cases, and in two seemed to be most acute in the right iliac region. *Tympanites* was observed more or less in all the cases confined to bed. *Diarrhœa*: two only of the severe cases were without looseness of bowels at some period of their illness; some had diarrhœa throughout. In two cases it was, as has been said, severe. *The motions* in the diarrhœa cases were in colour and consistency just such as might be looked for in enteric fever. *Bowel hæmorrhage*: three boys had bleeding from the

bowels; in one, Pierce, the hæmorrhage was copious, and repeated on three occasions. *The tongue*, though at first coated with brownish-white fur, became during the progress of severe cases dry and brown, with reddish edges. In some cases the teeth and lips were covered with sordes. *Eruption of spots:* nine boys had spots of some sort, especially noticeable on the abdomen. In most cases they were just such spots as might have been expected in enteric fever. Certainly in one case they appeared in successive crops. *Epistaxis:* three boys had epistaxis; one, Brawnis, had it severely, but he was subject to it when well. *Bronchial catarrh*, though only noticeable in four cases, was just such as might have occurred in enteric fever. *Pneumonia:* one boy had pneumonia. *Deafness:* six of the boys who were severely ill (including Beaumont, Pierce, and Sims) suffered more or less from deafness. *Delirium, &c.*: seven were delirious, two to the extent of requiring forcible restraint, and two also (Beaumont and Pierce) were for some days unconscious. *Relapse and slow recovery:* three cases (including Beaumont) relapsed, and in seven cases recovery was very slow. *Loss of hair:* several boys during convalescence suffered from loss of hair.

Symptoms observed in one or another case of sickness that, after the nature of the disease had been ascertained, were seen to be consonant with symptoms of trichinosis, as described in books.

Initiatory symptoms.—Pain in the stomach, nausea, and distaste of food were complained of in all cases from the severest to the slightest. Such symptoms are certainly in accord with those described as belonging to the commencement of trichinosis, and their presence in *all* cases (including the doubtful ones which except for these subjective symptoms did not appear ill at all) may now be regarded as fitting better with trichinosis than with enteric fever. The presence too of *vomiting* in the severe cases is suggestive rather of the former than of the latter affection. *Abdominal pain, tenderness, and fulness*, which existed in all the severe cases, and in many of the slighter ones also, and which commonly was a very prominent and troublesome symptom, is in equal accord with a theory of trichinosis and of enteric fever. So also is the *tympanites*. *The diarrhœa* again, which was a conspicuous feature of the severe cases, and which was doubtfully present or even absent in the slighter ones, might as well have belonged to trichinosis as enteric fever. The character of the *evacuations* too is compatible with the affection having been trichinosis. Blood in the stools has not however heretofore (so far as I know) been noted in trichinosis. The *tongue* furred and brownish-white at the commencement (and throughout in slight cases), and becoming dry and brown with reddish edges during the progress of severe cases, was related probably rather to alimentary disturbance and fever than to specific disease of either sort. The same remark applies to *sordes*. *The temperatures* were none of them in any way typical of enteric fever; and this is especially to be remarked in the inception of the curves; moreover, in many and in severe cases the difference ordinarily to be observed in enteric fever between the morning and evening temperature was not noticeable. In short the temperatures merely showed "continued" and in severe cases long-sustained fever. *Sweating*, which is mentioned as occurring in trichinosis, was present in several severe cases. In Beaumont and Bradshaw it was profuse and wetted the bedclothes. *Eruption of roseola spots.* Excepting boils, eruption of any sort in trichinosis appears to be unknown. As regards the outbreak in question it deserves notice that in more than one case having enteric-like eruption, the spots were unusually large and blotchy; and that in one instance (Pierce) if not in others, the spots abounded on the arms, thighs, and legs as well as on the chest and abdomen. *Bronchial catarrh, pneumonia* (one case), *deafness*, and *delirium* in certain of the severe cases, are symptoms compatible with the outbreak having been trichinosis. So also was the occurrence of *relapses* and the *loss of hair* during convalescence. The *duration of illness* may now seem to favour the view of trichiniosis. It differed greatly, varying from ailment for a few days in slight or doubtful cases to illness lasting without break (except temporary temperature fall) for upwards of 70 days in the case of Sims. *Jaundice* occurred during and after the outbreak in some dozen boys, few of whom had even trifling indisposition. Though not known heretofore to be thus related to outbreaks of either enteric fever or trichiniosis, its occurrence under present circumstances deserves notice, as having possibly parasitic cause.

Symptoms that might in an outbreak of trichinosis be expected to manifest themselves, but which in the "Cornwall" outbreaks were by no means prominent.

Pain in the limbs early in illness was not complained of, except perhaps in one case (Brace), who is entered in the day-book as having "rheumatism." Another boy is remembered on falling ill to have moved as if suffering from stiffness. *Œdema of the face or eyelids* was noticed in only two instances. Many of the boys, indeed, had flushed faces on falling ill, and about the eyes looked as if suffering from bad cold in the head. *Muscular symptoms.*—In no case was obvious *swelling* of muscles present. *Contraction* of muscles might have existed in one case (Wear), who lay in bed with his knees drawn up to his chin, and with his fore-arms flexed. He was at this time only semi-conscious, and made no complaint whatever. Several others of the boys on moving about during early convalescence appeared to suffer from stiffness; but it is difficult to estimate how far this may not have been due to confinement to bed. *Tenderness and soreness of muscles* was not conspicuous. Possibly the abdominal tenderness, so noticeable in many cases may have been partly due to soreness of the muscles. In one case (Marks, who had pneumonia), the muscles of the chest were decidedly tender to touch

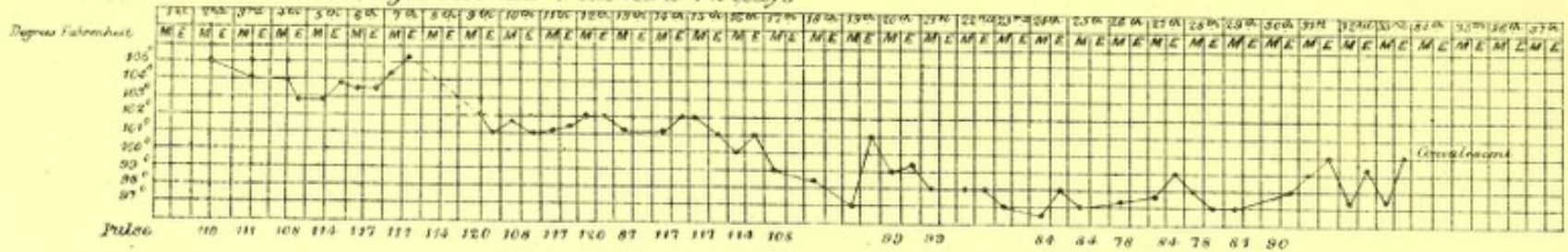
and afterwards this boy suffered from soreness of the left biceps. Several boys, too, as the attendants of the sick now remember, cried out with pain on being moved in bed. In Sims this was specially noticeable, voluntary movement of the head, in his case, on the pillow, causing exclamations of pain. *Distressing dyspnœa, trismus, marked aphonia,* or *impaired movement of the tongue,* were not noticed in any case. *Dysphagia,* however, may have been present in Pierce. He complained constantly of sore throat, and as no objective symptoms could be discovered therein, this may have been due to tenderness or soreness of the muscles of deglutition. *Œdema of the feet, legs, and thighs* was not present except in one case (Marks). This boy had an attack of pneumonia, during which he suffered early and continually from epigastric pain, complained also of nausea, and could not be got to take his food. He it was who had tenderness of the thoracic muscles, and afterwards soreness of the biceps. *Anasarca of the trunk* was absent in all cases.

APPENDIX C.

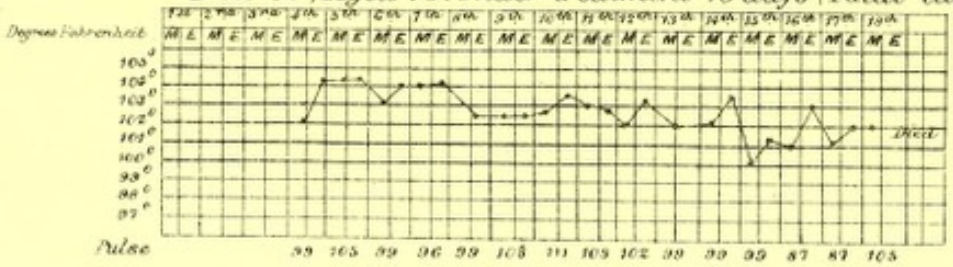
CHARTS OF THE TEMPERATURES RECORDED IN 20 CASES OF ILLNESS OCCURRING ON BOARD THE "CORNWALL."

(The tops of the columns are numbered consecutively from left to right with reference to the days of treatment; not in regard of days of the month. M represents morning and E evening temperature. The figures to the left of the columns represent degrees Fahrenheit; those at the bottom of the columns, pulse beats per minute.)

Beaumont, Aged 15. Under treatment 42 days

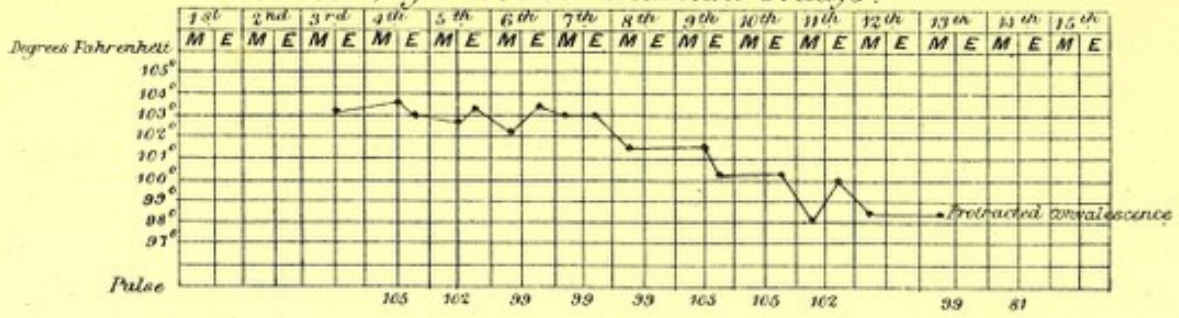


Pierce, Aged 16. Under treatment 18 days (Fatal case.)

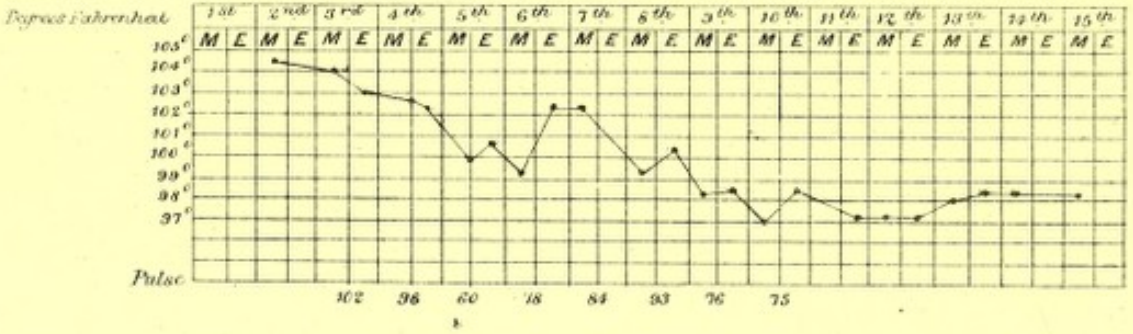


Darlington & Linn 22 Bedford St Covent Garden

Wheeler, Aged 13. Under treatment 37 days.

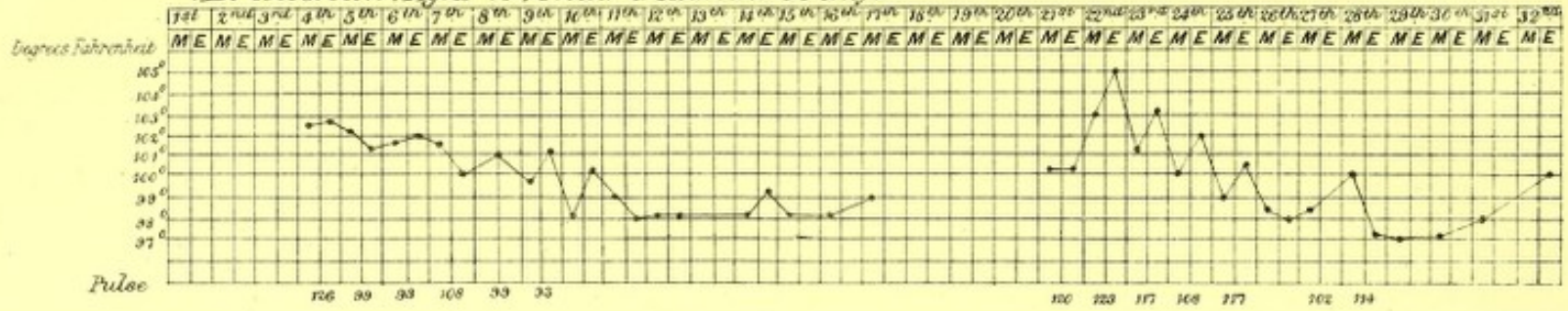


Davis, Aged 16. Under treatment 28 days.

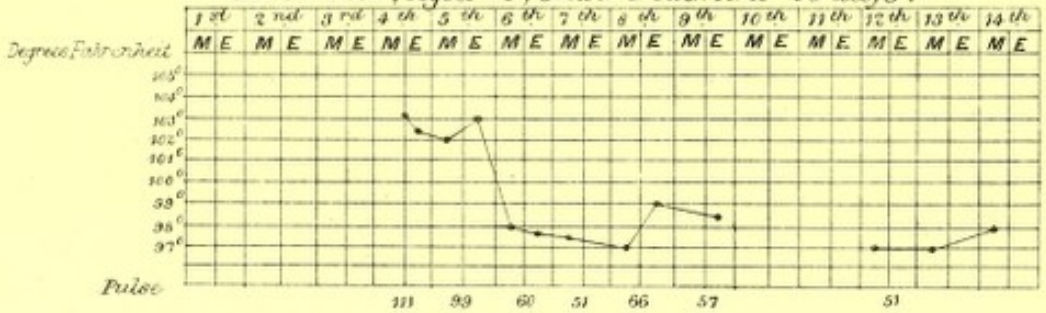


Dangerfield Lith. 22, Bedford St. Covent Garden.

Bradshaw, Aged 16, Under treatment 38 days.



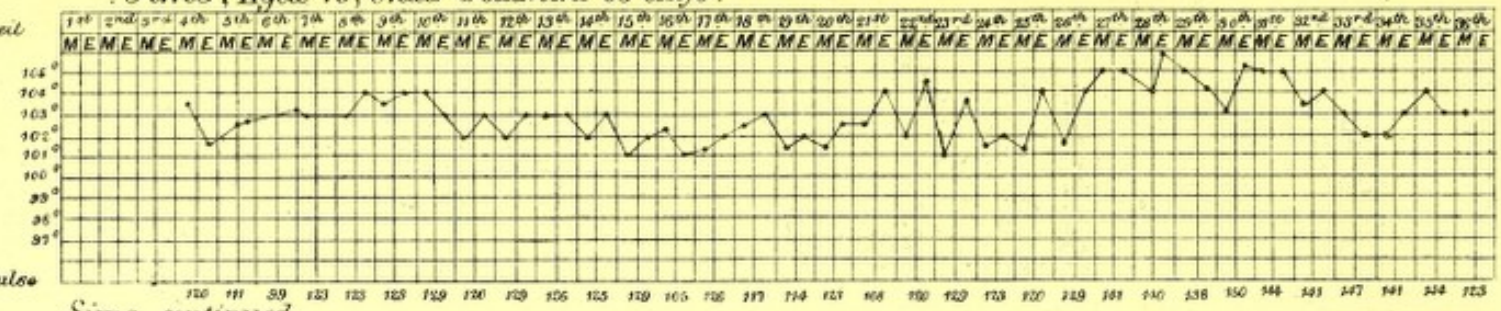
Brawnis, Aged 16, Under treatment 26 days.



Dangerfield, Lith. 22, Bedford St. Covent Garden.

Sims, Aged 15, Under treatment 88 days.

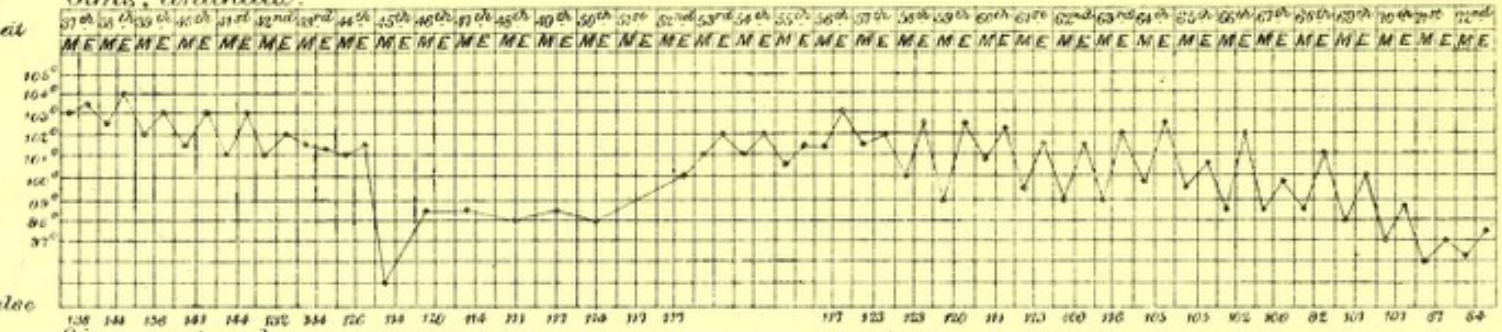
Degrees Fahrenheit



Pulse

Sims, continued.

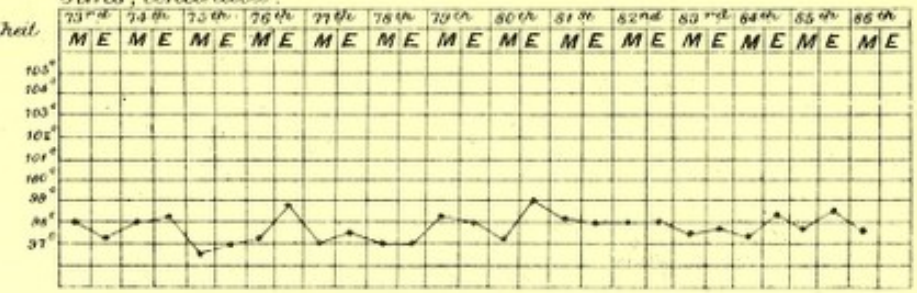
Degrees Fahrenheit



Pulse

Sims, continued.

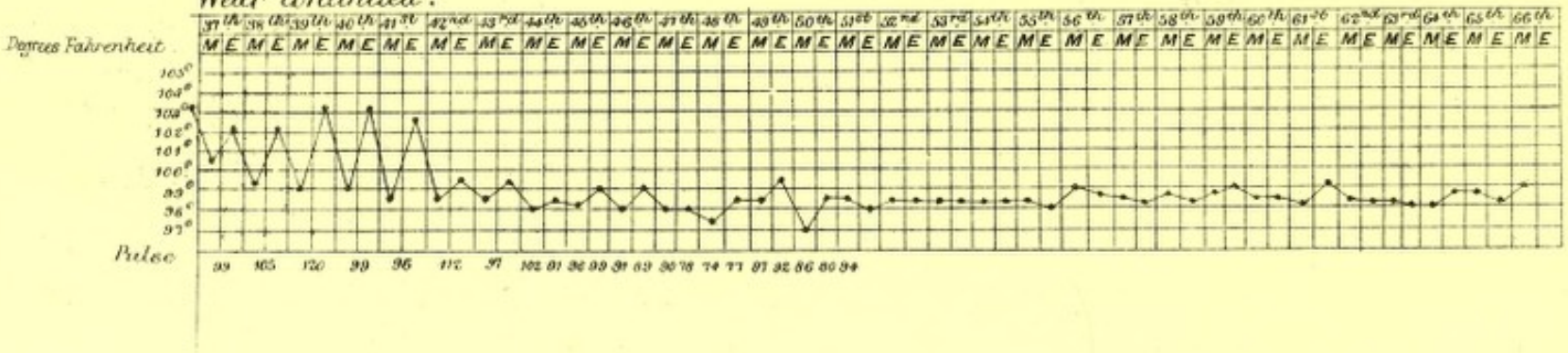
Degrees Fahrenheit



Darlington & Co., 22 Bedford St. Covent Garden

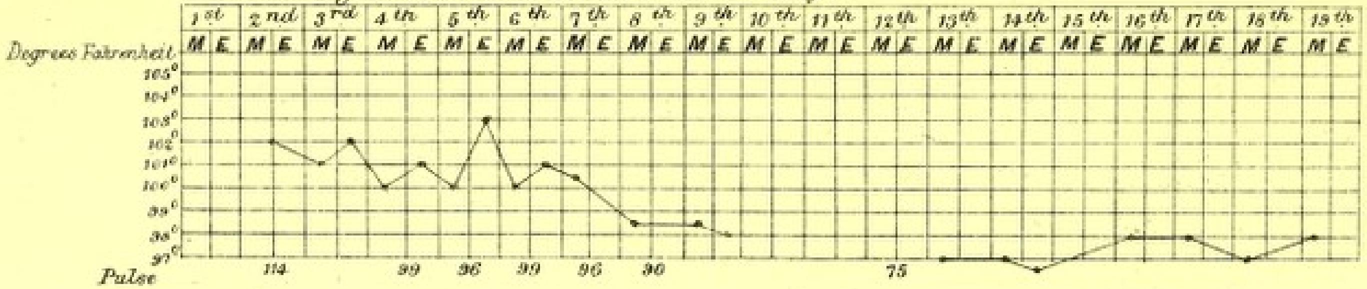
Wear. Aged 15. Under treatment 67 days.

Wear continued.

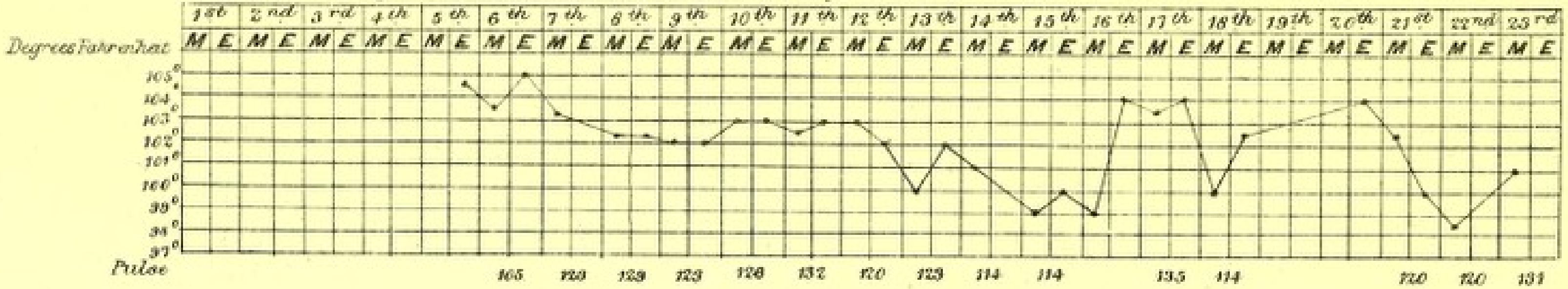


Dangerfield, Lith. 22, Bedford St. Covent Garden.

Putt, Aged 15, Under treatment 29 days.

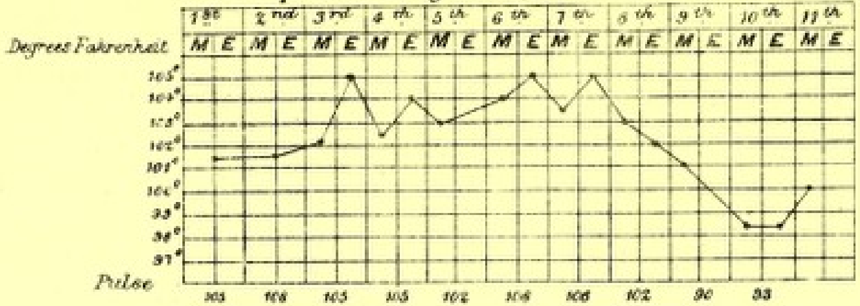


Howes, Aged 14, Under treatment 35 days.

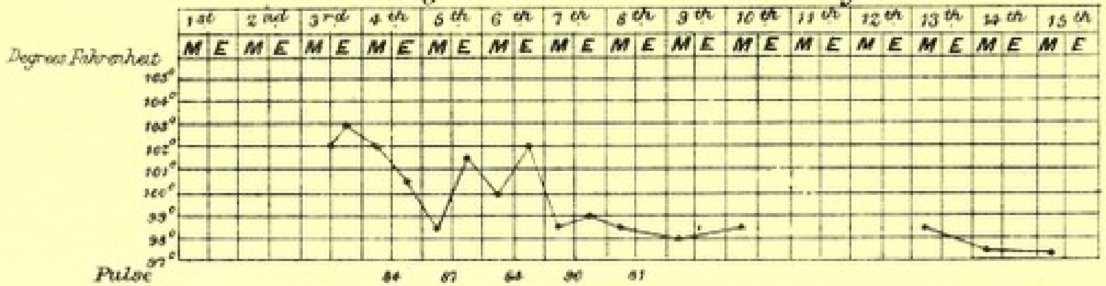


Dangerfield Lith 22 Bedford St Covent Garden.

Hopcroft, Aged 15, Under treatment 18 days.



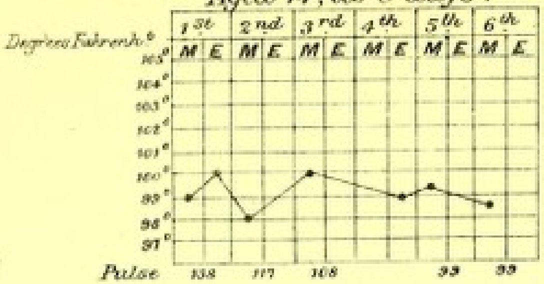
Salmon, Aged 16. Under treatment 18 days



[illegible] Lith 72 Bedford St Covent Garden

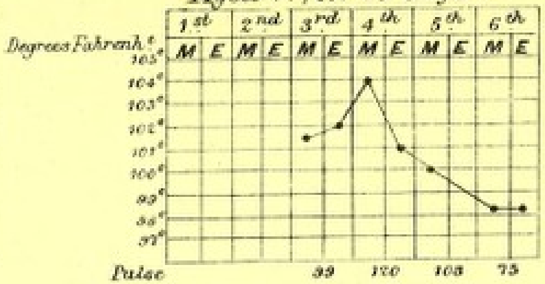
Rogers.

Aged 14, ill 8 days.



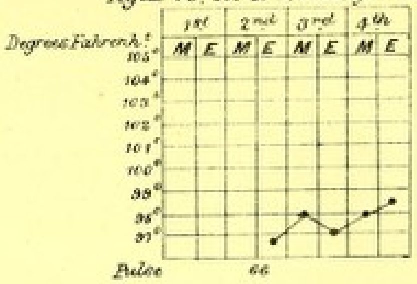
Speer.

Aged 17, ill 18 days.

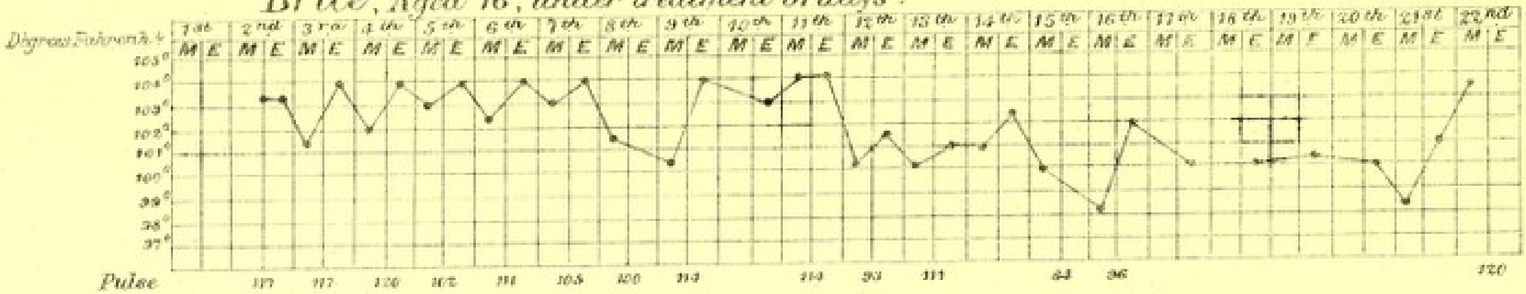


O'Hara.

Aged 16, ill a few days only

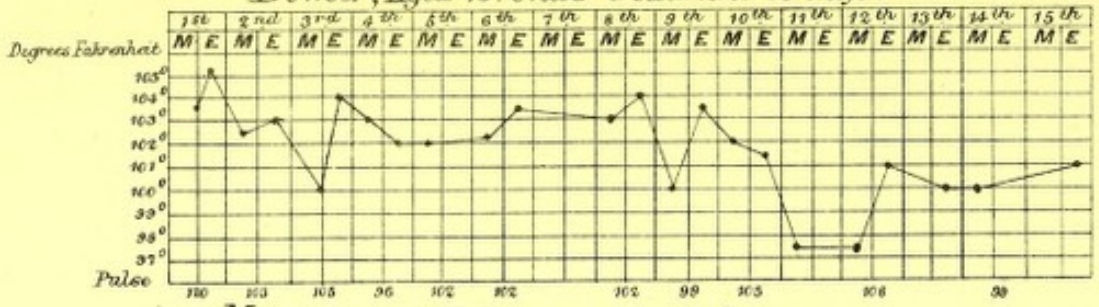


Brice, Aged 16, under treatment 31 days.

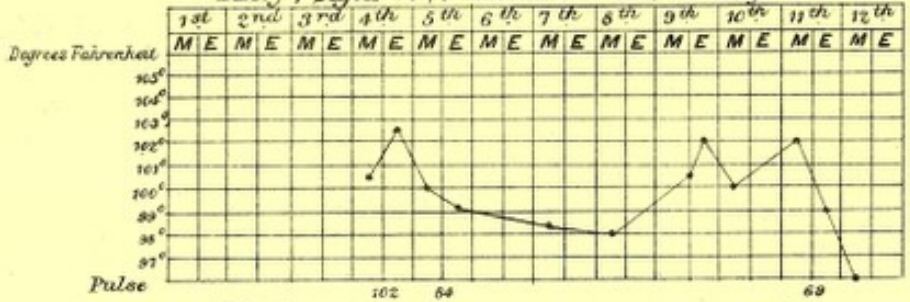


[illegible] Lith 22 Bedford S.t Covent Garden

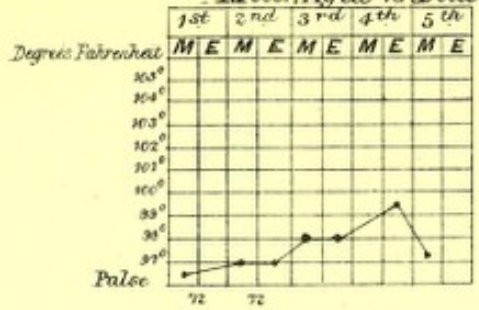
Bowler, Aged 15. Under treatment 18 days.



May, Aged 15, Under treatment 14 days.



Muir, Aged 15. Doubtful illness.



Ringrose, Aged 14, Doubtful illness.

Dangerfield Lith 22 Bedford St Covent Garden