

No. VIII.

Report on the Microscopical Examination of different Waters
(principally those used in the Metropolis) during the Cholera-
Epidemic of 1845. By Dr. Hassall.

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INTRODUCTORY REMARKS.

BEFORE proceeding to enumerate the different kinds of living organic productions, discovered by means of the microscope, in the various samples of water subjected to examination, it will be well to inquire the meaning and signification which attach to their presence in certain waters. We shall then be in a position to appreciate the nature and purport of the results arising out of the several examinations.

Water consists of hydrogen and oxygen, chemically combined in a definite proportion; of these two elements water of all kinds consists, and whatever matters are contained in it besides these have nothing to do with its composition, and are really extraneous.

But water, like all other substances, is endowed with certain physical properties; and amongst them is the power of absorbing any gases with which it may happen to be in contact. Now, as nearly all water is more or less freely exposed to the atmosphere, the gases of which the latter is formed, viz. oxygen and nitrogen, are nearly always present in water, in greater or less proportions, besides carbonic acid gas also derived from the air through which it is diffused.

Chemically pure water then consists of oxygen and hydrogen in combination, holding in solution, when exposed to the air, the elements of which this is composed. Should the atmosphere itself contain other gases, a proportion of these will likewise be taken up by the water, and hence results one kind of impurity, viz. that arising from the imbibition of one or more hurtful gases.

The greatest and most important contamination to which water is prone is that by organic matter. This may exist in water in several forms and states; it may be either dead or living, vegetable or animal, solid or fluid, and it may be present in water in all these different forms and states.

Now organic matter has a chemical constitution wholly distinct from that of water, its great distinguishing characteristic being that it contains nitrogen, which is greater in amount in animal than in vegetable productions. No constituents enter into the composition of chemically pure water, out of which living organic productions can be developed, or if developed, sustained. The presence of these affords evidences of contamination with nitrogenous matter, and they are to be regarded as a sign of impurity. Since the majority of organic productions are nourished by imbibition, their existence in water implies the presence of organic matter in a fluid state, capable of being absorbed into their systems, and of sustaining them. Some of the higher forms of infusoria have, however, stomachs, and feed upon solid organic matter, either living or dead.

If these premises are correct, as they unquestionably are, we repeat that the presence of organic matter in water, whether in the fluid

state or solid, and dead or living, animal or vegetable, and especially living animalcules in water, are to be regarded as undoubted proofs of contamination or impurity.

When vegetable productions abound in water, they indicate a positive degree of impurity; but when animalculæ abound, a higher degree of impurity is indicated, because these contain a much larger proportion of nitrogenized matter.

But the absence of organic productions, including infusoria, does not afford a certain proof of the purity of any water, because the concurrence of other conditions is necessary for the development of organic life, viz. more or less air, light, and warmth. For the development of some productions these agents must all have free access to the water; for others a limited supply of them only is necessary, while the existence of others is compatible with the admission of but little air or light, and especially with a low temperature; thus many organic productions, infusoria amongst the number, survive through the most rigorous winters.

When the above agents are entirely, or almost entirely, excluded, but little development takes place, even although the water contain nitrogen or nitrogenized matter of any kind, but a distinct series of changes occur, the nitrogen of the nitrogenized matter becomes oxydized and nitric acid is generated, which uniting with bases forms nitrates. These changes are constantly going on in wells contaminated by the contents of cesspools.

It is of extreme importance that correct notions should prevail respecting the real signification of the presence of animalculæ and other minute forms of organic life in water, for much error exists on this subject in the minds of the public, and even on the part of some few men professing acquaintance with the laws of science.

Many of the public believe that everything we eat and drink teems with life, and that even our bodies abound with minute living and parasitical productions. This is a vulgar error, and the notion is as disgusting as it is erroneous.

In the entire human body, in a state of health and cleanliness, not a single organic production or animalcule of any description, or of the most minute size discoverable with the microscope, excepting probably, under some circumstances, vibriones in the intestinal canal, is present, either outwardly on the surface or inwardly in the cavities, or in the several secretions of the body.

When the body becomes diseased or greatly disordered, or cleanliness is not observed, then, indeed, some few parasitical productions may take up their residence in it, but even in this case the proper secretions and fluids of the body, as the bile, blood, &c., are rarely, if ever, thus infested. The productions then found are, on the skin, chiefly acari, and in the intestinal canal a few species of annelidæ or worms.

The belief that the articles we eat and drink abound in infusorial life is equally unfounded. It is not true of even a single article of consumption, which is partaken of while in a sound and wholesome

state. The only substance with which we are acquainted which commonly contains living organic productions, as the larvæ of a species of fly, acari, and fungi, is cheese, and these only become developed in it after decomposition has commenced, while sound cheese is entirely free from the contaminations. Another reason why cheese is so prone to be thus attacked is explained by its highly nitrogenous character, which predisposes it to decomposition. Let the notion, then, that the articles we eat and drink, and even our very bodies, teem with invisible and parasitical forms of life be dismissed from the mind, for such a notion is opposed to every true principle of science, and is plainly contradicted by direct observation.

It was essential that the above observations should be made preliminarily to stating the results of the Microscopical Examination of the different waters, in order, as we have before remarked, that the purport of those results should be more clearly understood.

The following was the method pursued in the collection and examination of the different samples:—

They were collected, for the most part, in Winchester quart bottles, which hold half an imperial gallon, care being taken that they should be scrupulously clean. Each specimen was set aside at rest for some hours previous to examination; it was then first examined while undisturbed, and notes were taken of the different objects observed under the microscope. All the contents of the bottle were next decanted, except about 10 or 12 oz., so as not to disturb any sediment which might have fallen. These were poured into a conical glass lightly covered, so as to prevent dust or any other matter floating in the air from getting in, and set aside for a further period of about six hours. The water contained in the tumblers at the expiration of that time was decanted, reserving only the last few drops, which were subjected to microscopical examination. When the quantity of sediment was exceedingly minute, so little indeed as in the case of the purer waters almost to escape the eye altogether, the remaining drachm or so of the water from the tumblers was transferred into a very small conical glass, and allowed to rest an hour or so; the water in this in its turn being decanted, and in this way any sediment which was present was collected.

In procuring waters for microscopical examination, they should, where practicable, for the sake of comparison, be obtained in bottles similar to those above referred to, viz., Winchester quart bottles.

Of the waters examined, some were taken from *the cisterns of houses* in which one or more deaths from cholera had occurred, these being procured in many cases from localities in which the disease was at its height, and from districts the most severely visited by the epidemic: the specimens thus procured included the waters of several different companies: some of the waters were obtained from *the sources of supply*, others from *service pipes*, some from *wells and pumps* at the time and in neighbourhoods in which cholera was pre-

valent, some were procured from *the deeper springs and wells in and near London*, in order to serve as standards of comparison; lastly, a few samples were obtained *from tanks, water butts, and cisterns*, in order to show the effect of those receptacles on the condition of the water stored in them.

The results of the Microscopical Examination of these different waters I propose to embody under the following separate heads:—

(1.) Report showing the results of the microscopical examination of different waters obtained from houses, one or more of the occupants of which were either affected with or had died from cholera.

(2.) Report showing the results of the microscopical examination of different specimens of well and pump water procured in neighbourhoods in which cholera was prevalent.

(3.) Report showing the results of the microscopical examination of different waters from Sandgate, collected during the prevalence of cholera.

(4.) Report showing the results of the microscopical examination of different samples of water obtained from the service pipes of several of the metropolitan water companies.

(5.) Report showing the results of the microscopical examination of water stored in cisterns, butts, and tubs, with remarks on the state of those receptacles and their influence on the purity of water.

(6.) Report showing the results of the microscopical examination of the water of the Thames, Lea, and New River.

(7.) Report showing the results of the microscopical examination of certain deep spring and well waters situated principally in and near London.

(1.) REPORT showing the RESULTS of the MICROSCOPICAL EXAMINATION of different WATERS obtained from HOUSES, one or more of the OCCUPANTS of which were either affected with or had died from CHOLERA.

The samples were taken from the taps of the cisterns in the ordinary way, without regard to the time at which the water was turned on. They are, therefore, fair average samples of the water as used by the inhabitants of the houses from which they were procured. This should be clearly understood, because, although in the analyses we speak of sediments and residues, these represent no larger amount of organic matter and other impurities than are actually consumed, the component parts of these sediments being so suspended in the water that some hours are necessary for their complete subsidence.

The following SAMPLES were procured from Houses supplied by THE GRAND JUNCTION COMPANY.

3, *South Row, Golden Square*.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

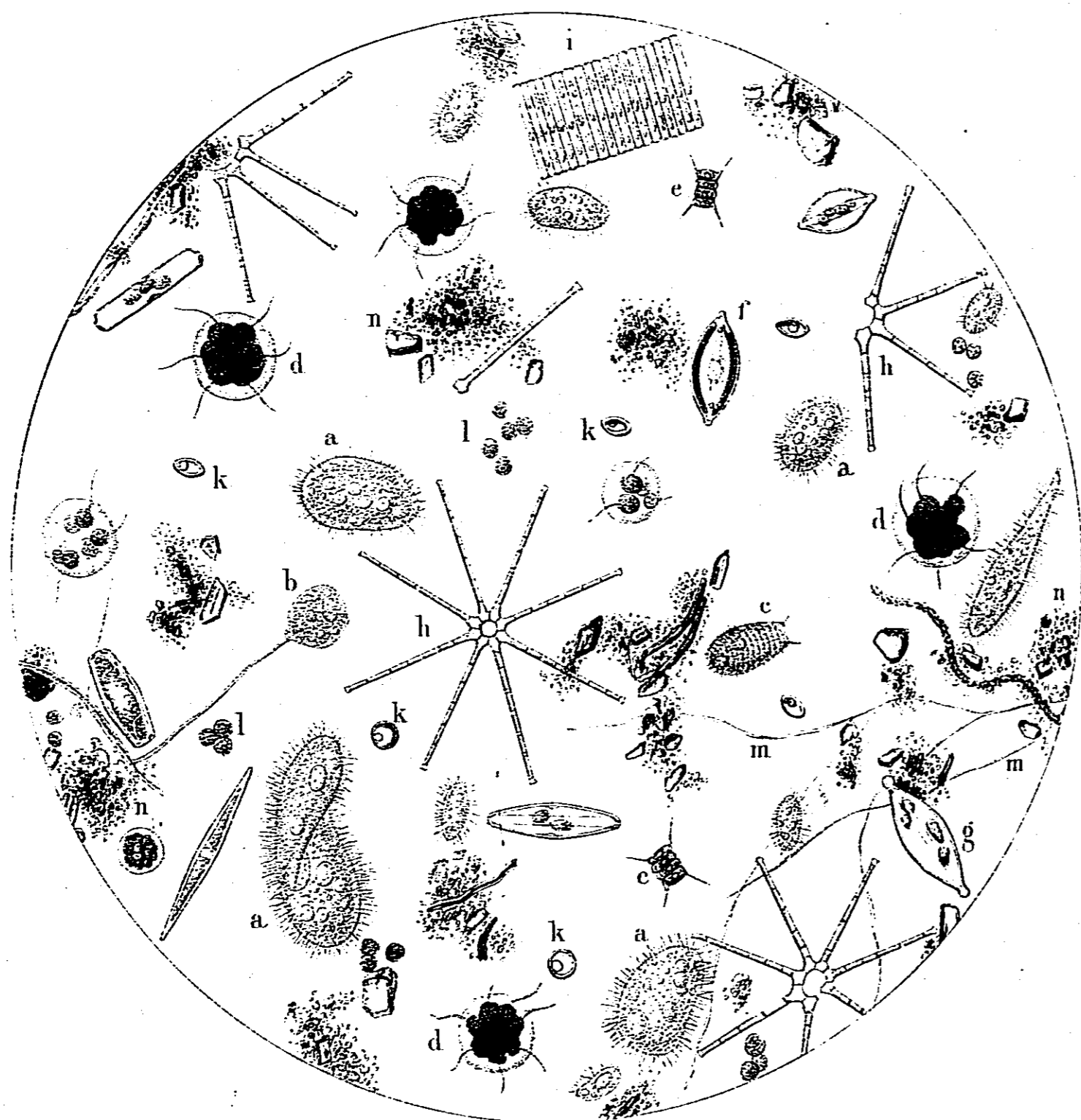
In this House there were Three Deaths.

There were detected in this water, after subsidence, two or three euglenæ, several of the brown rolling lenticular animalculæ elsewhere referred to, which I cannot identify with any described in works, and two or three other minute infusoria. The residue which collected at the bottom of the glass was not inconsiderable, and there were present in it the following living organic productions:—one small annelid, *anguillula fluviatilis*, four or five rotifers, one paramecium, a great many of the productions known as *pandorina morum* in all stages of growth, a few of the peculiar brown rolling bodies above referred to, *scenedesmus quadricauda*, a great many frustules of *synedra* and *naviculæ*, and a few of the diatoma, *asterionella formosa*.

5, *South Row, Golden Square*.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Three Deaths from Cholera.

This water was tolerably clear and bright, and after having stood at rest for 24 hours there was but little visible sediment. There were observed in the water itself a few small infusoria, including three or four euglenæ and monads, also a few sporules of a fungus, but rather many of the peculiar brown rolling bodies or animalculæ. The residue was rather small, and in it were noticed all those organic productions, more or less characteristic of the water of the Grand Junction Company, as species belonging to the following genera—*pandorina*, *paramecia*, two species, *vorticella*, *oxytricha*, *coleps*, the brown rolling animalcula, many *asterionellæ* and *naviculæ*, especially *A. formosa*, *N. amphiscæna*, *N. sphaerophora*, and *fragillaria capucina*. Fig. 1.



Magnified 230 diameters

- | | | |
|----------------------------------|-----------------------------------|--------------------------------|
| a. <i>Paramecia</i> 2 species | e. <i>Scenedesmus quadricauda</i> | i. <i>Fragillaria capucina</i> |
| b. <i>Vorticella convallaria</i> | f. <i>Navicula amphiscæna</i> | k. Brown active sporules |
| c. <i>Coleps hirtus</i> | g. ———— <i>sphaerophora</i> | l. Stationary Green sporules |
| d. <i>Pandorina morum</i> | h. <i>Asterionella formosa</i> | m. Threads of slender Fungus |
| | n. Organic & Earthy matter | |

39, *Broad Street, Golden Square*.—Collected 9th September 1854,
by Dr. Hassall and Dr. Thomson.

Three Deaths occurred in this House.

In this water, after subsidence, the following infusoria were noticed: polyarthra, three or four; pandorina morum, several; one or two small euglenæ, and one only of the brown rolling animalculæ. In the sediment, which was not very considerable, there were rather many infusoria, as well as other organic productions: the following were observed, a cyclops, and two acarus-like entomostracans, three or four euglenæ, many pandorinæ, hundreds of asterionellæ, threads of fragillaria capucina and meloseira varians, scenedesmus quadricauda, pediatrum heptactis, and a closterium.

13, *Marshall Street, Golden Square*.—Collected 9th September 1854,
by Dr. Hassall and Dr. Thomson.

Four Deaths and Two other Cases.

Some of the brown animalculæ were detected in this water after subsidence, as well as several pandorinæ rolling actively about. The sediment was rather considerable, and in it were detected dozens of pandorina, a few large infusoria, and several of the brown animalculæ, also hundreds of asterionella formosa, a few frustules of meloseira varians and fragillaria capucina, a small closterium, and the thallus or threads of two species of fungus, that with the slender threads and the yellow fungus-like production, resembling the stems of a species of anthophysa.

14, *Cambridge Street, Golden Square*.—Collected 9th September 1854,
by Dr. Hassall and Dr. Thomson.

Two Deaths occurred in this House.

This water deposited scarcely any sediment; eight or nine minute infusoria, including two euglenæ, were seen in it after subsidence, but none of the brown animalculæ were detected although sought for a long time; scarcely any organic productions of any kind were observed in the minute quantity of sediment which was deposited, neither diatomaceæ nor the brown animalculæ, and indeed only a few small infusoria.

The following SAMPLES were procured from Houses supplied by
THE NEW RIVER COMPANY.

23, *Peter Street, Golden Square*.—Collected 9th September 1854, by
Dr. Hassall and Dr. Thomson.

In this House there were Six Deaths.

A few infusoria were seen in this water after subsidence, including two of a species of polyarthra, which was the largest animalcula seen, and only one of the brown animalcules. The residue was rather considerable, and contained a good many of the brown lenticular animalcules, but not many other infusoria. Those that were noticed belonged to the genera paramcium, oxytricha, and euglena; amongst the diatomaceæ were frustules of pleurosigma acuminatum, Nitzschia

FROM WATER OF NEW RIVER COMPANY
(from Cistern.)

PL. 2.



- | | | |
|-----------------------------|----------------------------|-------------------------------------|
| a Cyclops quadricornis. | f. Nitzschia Sigmoidea | l. Vicular rolling sporular bodies. |
| b. Ova of Same | g. Pinnularia radiosa | m. Germinating Fungus. |
| c. Tricamaria. | h. Pleurosigma acuminatum. | n. Threads of slender Fungus. |
| d. Euglena longicauda. | i. Synedra Ulna. | o. Spicula of Fresh Water Sponge |
| e. Scenedesmus quadricauda. | k. Meloseira varians. | p. Organic debris & Earthy matter. |

sigmoidea, synedra ulna, and fragillaria capucina; and, lastly, a few masses of circular green sporules, stationary, and imbedded in a mucous base, a few spiculae of sponge, and much dead organic matter, mixed up with a great many threads of the usual slender fungus, were noticed.

9, Hopkins Street, Golden Square.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Eight Cases occurred in this House.

Several of the entomostracan, Cyclops quadricornis were seen in this water, and after subsidence many of the brown animalculae, as well as one or two other small infusoria; the sediment deposited was scarcely perceptible, but it contained a good number of the brown animalcule, and a few other small infusoria, of the genera paramecia and euglena; also scenedesmus quadricauda, and amongst the diatomaceae frustules of pinnularia radiosa, pleurosigma acuminatum, synedra ulna, meloseira varians, Nitzschia sigmoidea; also sporules of fungus germinating, threads of slender fungus, and fragments of vegetable tissue. Fig. 2.

11, Hopkins Street, Golden Square.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House Three Deaths and Two Cases occurred.

Four or five of the brown animalcules were the only organic productions met with in this water after subsidence, but in the sediment which was small the following productions were noticed:—a Cyclops, and a second species of entomostracan, the name of which was not ascertained, several paramecia, a few smaller infusoria, mostly monads, and a considerable number of the brown animalcule; amongst the diatomaceae were frustules of synedra ulna, one or two of a small navicula, a thread of fragillaria, and a pleurosigma; amongst the desmideae, scenedesmus quadricauda was rather plentiful, as well as many masses of the circular and oval green stationary sporules, so commonly present in samples of the water of this Company.

5, Berwick Street, Golden Square.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House there were Five Deaths and Two Cases of Cholera.

This was the specimen in which the brown rolling animalcula were first observed; many of these were present in this water after subsidence, as well as one or two other small infusoria of two or three different kinds, including a species of the genus uvella. In the residue, which was small, there were observed one of the eel-like annelids, anguillula fluviatilis, a brachionus, oxytrichae, and a few monads; frustules of naviculae and meloseira, and a few of the motionless bunches of green sporules.

3, Broad Street, Golden Square.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Three Deaths took place in this House.

There were discovered in this water, after subsidence, several of the brown rolling animalcule, as well as four or five other minute infusoria; while in the residue, which was but small, a few infusoria

and diatomaceæ were seen, belonging to the genera pandorina, oxytricha and monas, pleurosigma, fragillaria, and meloseira, as well as some green threads of a conferva.

10, *Portland Mews, Portland Street, Golden Square*.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

In this House there occurred Three Deaths from Cholera, and there were two other persons lying ill with that disease.

There were observed in the fluid part of this water, after subsidence, four or five of the brown rolling animalcule, a uvella, and a very few small infusoria, chiefly monads. The sediment was rather considerable, and contained many infusoria, some of large size, an oxytricha, one or two uvellæ, an annelid, a polyarthra, and many vorticellæ, as also a few frustules of synedra, and several of the masses of green motionless sporules, and a considerable quantity of the slender fungus; lastly, there was a good deal of brown granular organic matter. The cistern in this case was placed below the ground floor, and the water had to be raised by means of a pump.

9, *Broad Street, Golden Square*.—Collected 9th September 1854, by Dr. Hassall and Dr. Thomson.

Six Deaths from Cholera.

In this water, after subsidence, several infusoria were seen, two or three of the usual species of polyarthra, remarkable for the sudden jerking leaps which it took, a few monads, and two or three of the brown animalcula. The residue contained a considerable number of infusoria of the genera vorticella, rotifer, oxytricha, uvella, and also some of the brown animalcules; amongst the diatomaceæ were a great many frustules of a small oval pleurosigma and several of synedra ulna; also many stationary bunches of green oval sporules.

6, *Allen Street, Clerkenwell*.—Collected 4th October 1854, by G. Glover, Esq.

Two Deaths.

This water was pretty clear, but it threw down a blackish sediment visible to the naked eye. In the water, after subsidence, two free vorticellæ were seen, as well as three or four other infusoria. The sediment deposited was very large, and consisted chiefly of organic matter, remnants of Cyclops shells, numerous vorticellæ, a large number of rotifera, a good many oxytrichæ belonging to three different species, a few actinophrydes, an annelid, and one or two large euglenæ, besides which there were a few small frustules of diatomaceæ, scenedesmus quadricauda, and a great deal of the slender fungus; there were also several large fatty masses in this water visible to the eye, about which a species of fungus (leptomitus?) was growing; the masses appeared like muscular fibre degenerated into fat.

3, *Allen Street, Clerkenwell*.—Collected 4th October 1854, by G. Glover, Esq.

Five Deaths.

In this water, after subsidence, there were seen one or two small infusoria and two synedras. The residue was very considerable, and

consisted chiefly of organic matter, dead and living; there were a considerable number of infusoria, especially actinophrydes, shells of Cyclops, oxytrichæ, colems, uvella, and polyarthra, a few of the brown animalcule, and some vibriones. The diatomaceæ present included a good many frustules of synedra ulna, cocconeus placentula, navicula, gomphonema, fragillaria, and cymbella, also two species of pleurosigma; there were likewise single large green oval and moving sporules, and three or four groups of stationary sporules, a good many green threads of conferva, and much of the slender fungus.

15, *Broad Yard, Clerkenwell*.—Collected 4th October 1854, by G. Glover, Esq.

One Death.

In this water, after subsidence, three or four small infusoria only were seen, but the sediment deposited was rather considerable, and in it a great many infusoria and other organic productions were found; amongst the infusoria were numerous actinophrydes, two or three species of oxytrichæ, one very large, a few of what appeared to be the brown animalcule, but dead and motionless, many granular masses of vibriones, and great numbers of the same loose; in addition to the infusoria, there were rather many diatomaceæ of the genera navicula, two species of synedra; lastly, one small mass of the fatty animal matter already noticed, with the fungus growing round it, was likewise seen.

13, *Broad Yard, Clerkenwell*.—Collected 4th October 1854, by G. Glover, Esq.

One Death.

Three or four small infusoria and one oxytricha were seen in the water after subsidence. The sediment deposited was rather considerable, and of a light yellow colour; it contained a good many infusoria, principally of the genera actinophrys, uvella, and oxytricha, there being three different species belonging to the last named genus; there were also a few vibriones, and many of the peculiar brown animalcule, dead; the diatomaceæ were abundant, and in great variety; two species of pleurosigma were noticed, synedra ulna, cocconeis placentula, and a species of navicula; there was also much of the slender fungus, and many fragments of decaying vegetable tissue.

The following SAMPLES were taken from Houses supplied by
THE LAMBETH COMPANY.

111, *Cornwall Road*.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This water was bright and clear to the eye, but numerous entomostraceæ were seen swimming about in it; after having stood at

rest for some hours hardly any sediment was deposited. In the water itself, after subsidence, scarcely a moving particle of any kind was to be detected except the entomostraceæ; in the sediment there were noticed five or six euglenæ, two polyarthræ, a few monads and other equally minute infusoria, together with a very few diatomaceæ belonging to the genera navicula and synedra.

107, *Cornwall Road*.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This water was also clear and bright, but it deposited rather more sediment. In the water, after subsidence, only one polyarthra and two or three other very minute infusoria were detected, while in the sediment there were observed several of the eel-like river annelidæ of small size, *anguillula fluviatilis*, one entomostracan and the remains of several others, rather many infusoria, a few diatomaceæ, a thread of *conferva*, some dead and decomposing organic, principally vegetable matter, and many spiculæ of sponge; amongst the infusoria were two or three parameciæ and oxytrichæ, while the diatomaceæ noticed consisted chiefly of a few frustules of *synedra*.

17, *Commercial Road*.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This water was, like the previous samples, clear and transparent, but contained many entomostraceæ, and the sediment which collected was very trifling. In the water itself, after subsidence, not a single animalcule or other organic production was to be seen, while in the sediment there were observed a very few infusoria, including two or three vorticellæ, a few monads, two or three spiculæ of sponge, bunches of the branched, and threads of the slender fungus so common in the less pure waters, with a few fragments of decomposing organic matter.

66, *Wootton Street*.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This water deposited only a very small quantity of sediment, and but few infusoria were detected in it after subsidence, principally one or two small ones of the genera euglena and monas, but several entomostracans were swimming about in it, visible to the naked eye. In the sediment there were seen, with the microscope, one of the eel-like annelid, *anguillula fluviatilis*, part of an articulated annelid, a few pellet-like masses, most probably the exuvia of the entomostraceæ, and some spiculæ of the fresh water sponge.

4, *Little King Street, Kent Road*.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

In this House there were Two Deaths.

There were seen in this water, after subsidence, by the aid of the microscope, rather many minute infusoria, including one small para-

meceum and one euglena. The residue was rather small; it contained many living entomostracans, many infusoria, three or four oxytrichæ and vorticellæ, and many monads, a few minute threads of green *conferva*, two green sporules, and threads of the two species of fungus, a few very small naviculæ, and one frustule of *cymbella*.

7, *Monmouth Place, Walworth Common*.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

Two Deaths.

This water, after subsidence, was found to contain a good many infusoria, including several paramecia, and other smaller animalculæ. The sediment was rather considerable, and in it were seen more than a dozen eel-like worms, *anguillula fluviatilis*, a rotifer, a shell of daphnia, a great many vorticellæ, several actinophrydes, oxytrichæ, large and small, amphileptus, amæba, one polyarthra, as well as some other curious infusoria. Besides the above, two or three desmideæ were seen of the genera *pediastrum* and *scenedesmus*, and a great many diatomaceæ, especially frustules of *gomphonema capitatum*, *cocconeis placentula*, and *synedra ulna*, together with a few of the brown stationary festooned sporules, represented in more than one of the figures; lastly, much of the slender fungus was present.

21, *Bollinbrooke Row, St. Peter's, Walworth*.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

Here Two Deaths occurred.

This water was clear and did not contain entomostraceæ, but there were seen in it, after subsidence, four or five very minute infusoria. The quantity of sediment which was deposited was very small, and in it the following matters and productions were noticed; broken shells of entomostraceæ, a few vorticellæ, several small paramecia, one or two oxytrichæ, several frustules of *gomphonema curvatum*, four or five of *cocconeis placentula*, two spiculæ of the fresh water sponge, and a few threads of the slender fungus.

1, *Bedford Court, St. James', Bermondsey*.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

Three fatal Cases of Cholera took place in this House.

This water, although tolerably clear and bright, gave off some gas on the removal of the stopper, and was found to swarm with infusoria, chiefly monads. The residue was rather considerable, and nearly black, and in it the following organic productions were observed to be present: one annelid, a great number of paramecia, several oxytrichæ, a good many vorticellæ and monads, threads of *oscillatoria*, one or two small naviculæ, five or six spiculæ of sponge, and the two usual fungi.

22, Carter Street, St. Peter's, Walworth.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

One Death only in this House.

This water was clear and bright, but it contained a good many large entomostraceæ, of which there were two species; after subsidence, but very few infusoria were seen, and these all very small; the residue was inconsiderable, and contained but few organic productions, a piece of shell of daphnia, several paramecia, one lagenella, two threads of conferva, green moving sporules, spiculæ of sponge, and some threads of the slender fungus.

The following SAMPLES were procured from Houses supplied by SOUTHWARK AND VAUXHALL COMPANY.

154, Waterloo Road.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

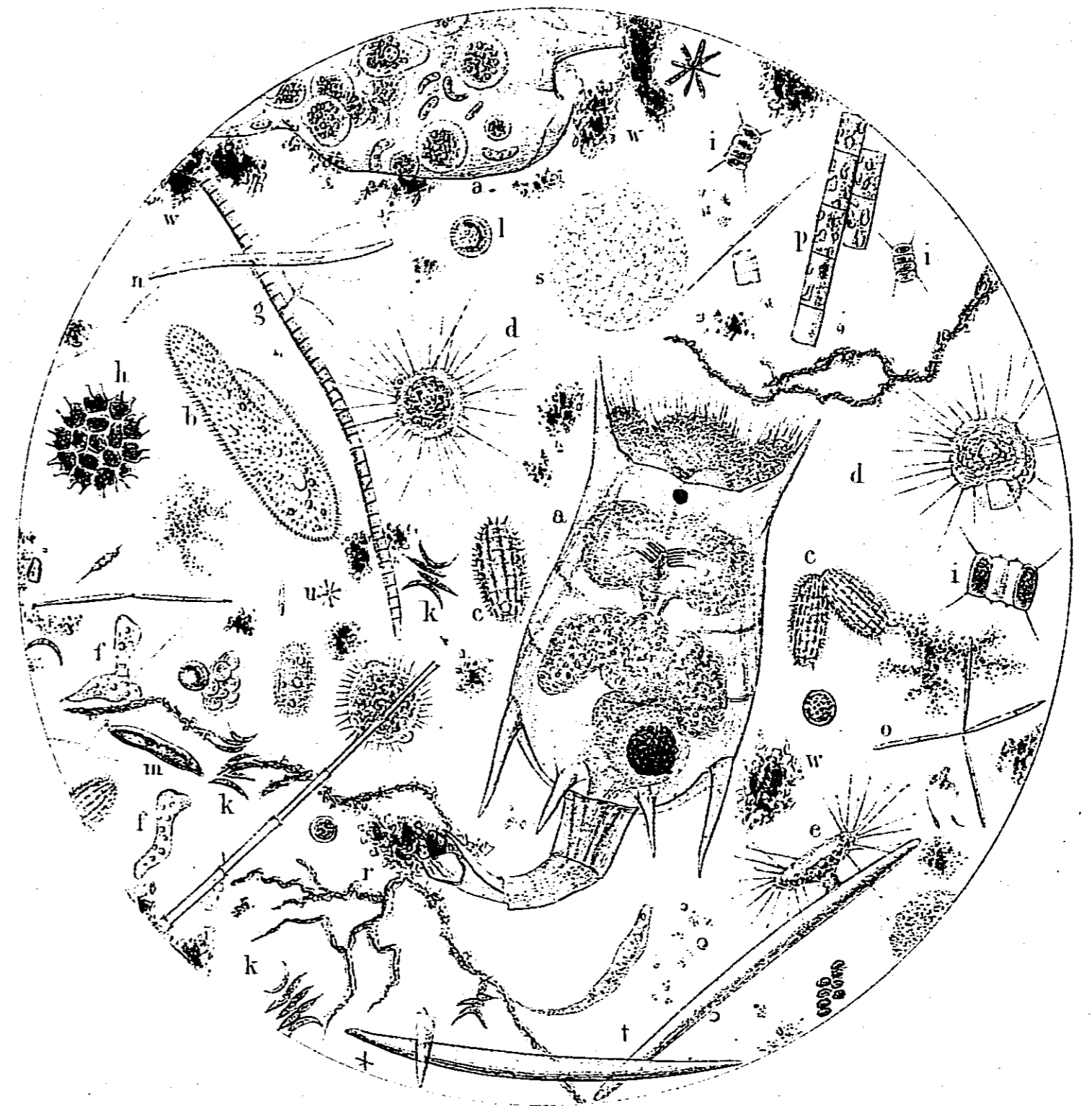
One Death from Cholera.

This specimen was decidedly dull and opalescent to the eye, as contained in a Winchester quart bottle, and there were numerous entomostraceæ swimming about in it. There were detected in the water itself, after subsidence, a few small infusoria, while the residue, which was very considerable, abounded with living organic productions, infusoria especially, of the genera stentor, rotifer, actinophrys, acineta, amœba, oxytricha, coleps, vorticella, and paramecium; amongst the diatomaceæ were a great many frustules of the Nitzschia sigma, with a few of N. amphyois, many of synedra minutissima, some of cyclotella operculata and melosira varians; amongst the desmideæ were scenedesmus acutus S. quadricauda, and pediastrum boryanum; while in the dead organic matter were spiculæ of sponge, and the exuvial masses before referred to, intermixed with, and lying amongst which, were many threads of the yellow fungus alluded to as occurring in the water from 29, Wootton Street, as well as in other waters. Fig. 3.

131, Waterloo Road.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

Two Deaths from Cholera.

Many entomostraceæ were swimming about in this water, and there were discovered, by means of the microscope, after complete subsidence, rather many small but active infusoria, while in the residue, which was considerable, the organic productions met with were for the most part similar to those of the previous sample, and included many infusoria, as oxytrichæ and paramecia, and one rotifer; amongst the desmideæ were scenedesmus quadricauda, scened. lunaris, and one or two species of pediastrum, while amongst the diatomaceæ were a great many frustules of Nitzschia sigma and cyclotella operculata; lastly, fragments of vegetable tissue and the yellow fungus were noticed.



Figured 20 Figures

- | | | |
|-----------------------|----------------------------|----------------------------------|
| a. Brachionus | f. Amœba diffluent | o. Synedra minutissima |
| a. ——— dead infusoria | g. Oscillatoria | p. Melosira varians |
| feeding upon it. | h. Pediastrum Boryanum | r. Stem of Actinophrys? |
| b. Paramecium aurelia | i. Scenedesmus quadricauda | s. Circular mass apparently |
| cc. Coleps lirtus | k. ——— acutus | composed of Vibriones |
| dd. Actinophrys Sol | l. Cyclotella operculata | v. Spicula of Fresh Water Sponge |
| e. Acineta tuberosa? | m. Nitzschia amphyois | w. Minute Star-shaped bodies |
| | n. ——— Sigma | |

15, *Eaton Street, Waterloo Road*.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

One Death from Cholera.

This water was also decidedly opalescent, and contained several entomostraceæ; it also threw down a very considerable sediment. There were detected in the very first drop examined, after subsidence, several small infusoria, including one polyarthra, while the sediment swarmed with infusoria and other organic productions; species belonging to the following genera were observed—actinophrys, a great many, rotifer, vorticella, oxytricha, paramecium, and coleps, synedra and navicula. Amongst the dead organic matter noticed were fragments of vegetable tissue, besides which there was the yellow fungus-like production resembling anthophysa.

29, *Wootton Street, Waterloo Road*.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

Two Deaths from Cholera.

This water, as contained in a clear glass Winchester quart bottle, was somewhat dull and opalescent, it swarmed with entomostraceæ, and after having stood for some time a considerable sediment collected at the bottom of the conical glass into which it was poured. There were detected in the water itself, after complete subsidence, many small animalcules belonging to the genera coleps, euglena, paramecium, and monas, as well as three or four navicula. The animalcules were so numerous that commonly four or five, and often more, were present in every drop of the water subjected to examination. The sediment was composed, as it is in nearly all cases, in part of dead and in part of living organic matter, animal and vegetable. Amongst the living were a great variety of infusoria, mostly of the genera oxytricha, coleps, paramecium, and pandorina, a great many diatomaceæ, especially meloseira varians, meloseira nummuloides, cyclotella operculata, and many of the usual Nitzschia, *N. sigma*; some desmideæ, as different species of scenedesmus, especially *S. quadricauda*, and pediastra, as *P. hexactis*. In addition to the above there were the two usual species of fungus, the one with yellow branched threads, the other with very slender branched threads, also a few filaments of an oscillatoria. The two species of fungus noticed are of very common occurrence in many of the more impure waters. Amongst the dead organic matter were many fragments of vegetable tissue, hairs of animals, a dead entomostracan, and shells of the same.

10, *Berkeley Terrace, St. Peter's, Walworth*.—Collected 16th September, 1854, by Dr. Hassall and Mr. Walker.

Two Deaths from Cholera.

This water contained several entomostraceæ, chiefly of the genera Cyclops, visible to the naked eye, while in it, after subsidence, by means of the microscope, there were seen four or five small infusoria. The residue was not considerable, but it contained several paramecia.

a good many oval euglenæ, and three or four of another species of the same genus (*E. longicauda*), as well as several of a third species, many amabæ, and one or two vorticellæ; there were also present the two usual species of scenedesmus in great numbers, a good many frustules of the usual cyclotella, a few of synedra ulna, two or three lagenellæ, and a great many brown motionless sporules having a festooned border, and which are of rather common occurrence in water, also several branched threads of draperaldia.

25, *Bollinbrooke Row, St. Peter's, Walworth*.—Collected 16th September, 1854, by Dr. Hassall and Mr. Walker.

There were Two fatal Cases in this House.

This water was dull and opalescent, and contained several entomostraceæ swimming about, and of course plainly visible to the naked eye, while in it, after subsidence, there were detected, with the microscope, a considerable number of infusoria, including one or two polyarthræ, several pandorinæ, oval euglenæ, and a rotifer resembling a species of triarthra. The residue was very considerable, and abounded in organic living productions, representing the different orders entomostraceæ, infusoria, desmideæ, diatomaceæ, and fungi. Amongst the entomostraceæ were two daphnias; amongst the infusoria, a rotifer, brachionus, polyacanthus, euplotes charon, amplileptus, paramecium, and many actinophrydes; amongst the desmideæ, closterium lunula, pedias-trum boryanum, scenedesmus quadricauda; sc. acutus and sc. obtusus were the most common; amongst the diatomaceæ, a very great many frustules of cyclotella operculata and synedra minutissima, and a few of pleurosigma; and amongst the fungi were the two usual species, that with slender branched filaments, and that with yellow threads; lastly, there were many circular green sporules, free, but motionless, and two or three broken fragments of muscular fibre. Fig. 4.

Flora Cottage, Windmill Road, Bermondsey.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

Two Deaths and Five Cases of Cholera besides.

Water very dull and opalescent, and in it, after subsidence, there were seen a great many infusoria swimming about, some large, including paramecia and oxytricha, and a rolling oval granular animalcule, very common in water from the River Thames, and in that of the Southwark and Vauxhall Company; there were also a few entomostraceæ visible to the naked eye. The residue was very considerable, and contained a great number of actinophrydes, very many frustules of cyclotella operculata, the usual Nitzschia, *N. sigma*, as well as many micrasterias, and much of the yellow fungus.

Batchelor's Guano Manufactory, 9, Cottage Row, St. James', Bermondsey.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

In this House there were Two fatal Cases.

This water was somewhat turbid and opalescent, and in the first cell full of it placed under the microscope, after subsidence, several

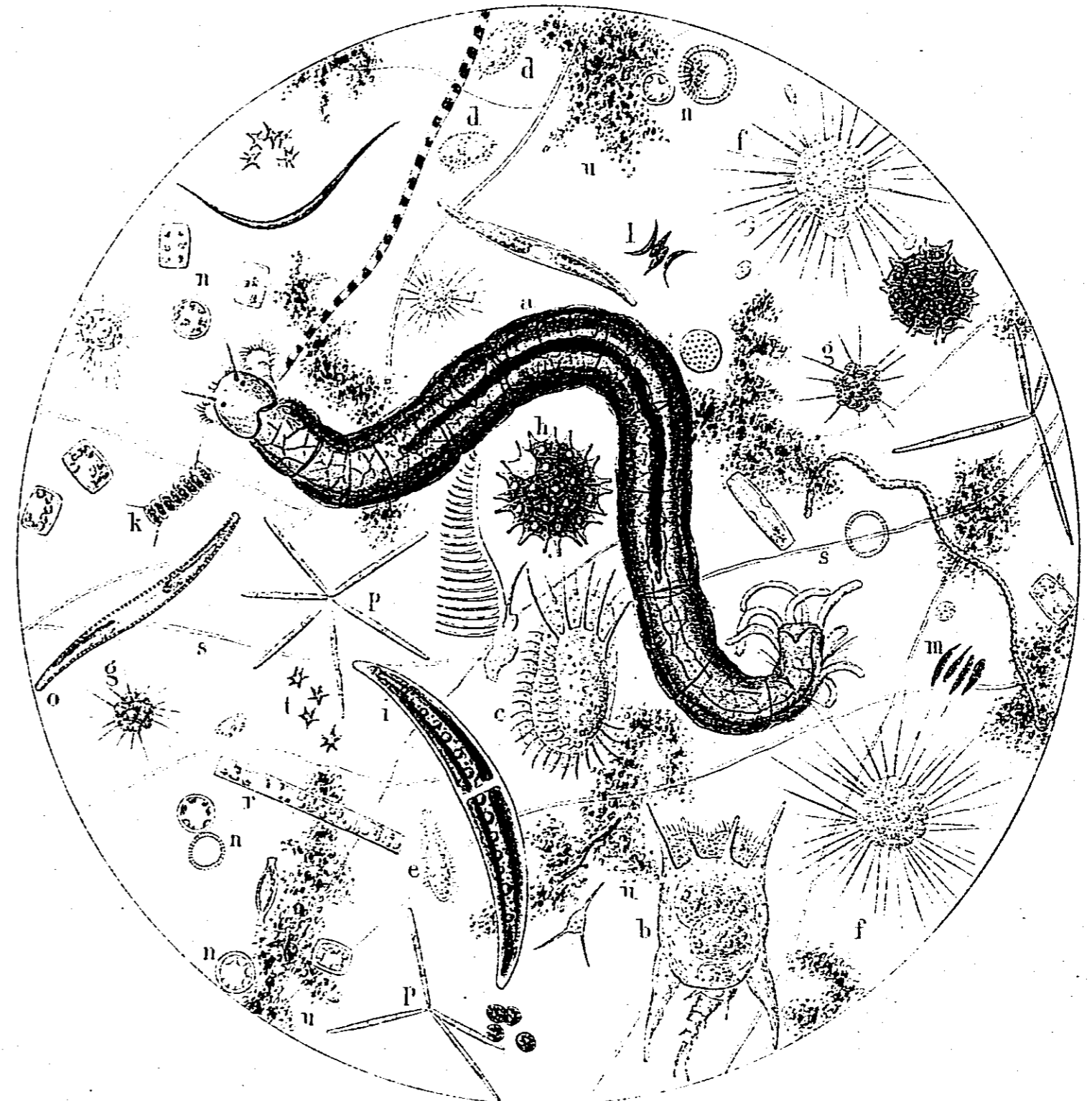


Fig. 4. a. Daphnia, b. Actinophrys, and the rest as in the text.

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|-----------------------------|-----------------------------|-------------------------------|
| a. Blood red Annelide. | g. Actinophrys viridis. | n. Cyclotella operculata. |
| b. Brachionus polyacanthus. | h. Pedias-trum Boryanum. | o. Nitzschia Sigma. |
| c. Euplotes charon. | i. Closterium Lunula. | p. Synedra minutissima. |
| d. Paramecium. | k. Scenedesmus quadricauda. | r. Nitzschia varians. |
| e. Amphileptus. | l. ——— acutus. | s. Threads of Slender Fungus. |
| f. Actinophrys Sol. | m. ——— obtusus. | v. Minute star-shaped Bodies. |
| | u. Organic & Earthy matter. | |

small infusoria and frustules of diatomaceæ were seen; amongst others, a few groups of frustules of *synedra minutissima*, a considerable number of frustules of *cyclotella operculata*, and green and brown stationary sporules. The residue was considerable, and in it there were seen one large cyclops, a large red-jointed worm, a great many actinophrydes, many large oxytrichæ, and numerous pediastra.

9, *Prospect Row, St. James', Bermondsey*.—Collected 16th September 1854, by Dr. Hassall and Mr. Walker.

Father and Daughter died in this House.

This water was also somewhat turbid and opalescent, and in it, after subsidence, a good number of infusoria were seen by means of the microscope, including several euglenæ, polyarthræ, and a scenedesmus, while swimming in the water, and visible to the naked eye, were several entomostraceæ. The residue deposited was considerable, and it was found to be made up to a considerable extent of the same elements and productions as that of most of the other specimens of Southwark and Vauxhall water. Amongst those specially noticed were some antinophrydes, a few pandorinæ, and a great many desmideæ and diatomaceæ, including, amongst the former three species of pediastrum, *scenedesmus lunaris*, sc. *quadricauda*, and a closterium, and amongst the latter a great many frustules of *cyclotella operculata*, and *Nitzschia sigma*, a few frustules of *diatoma vulgare*, *gomphonema capitatum*, and *navicula amphiscæna*, many bunches of frustules of *synedra minutissima*, a thread of *meloseira varians*, and a few frustules of a species of amphora, much yellow fungus, and portions of altered muscular fibre.

13, *Clanden Street, Newington*.—Collected 26th September 1854, by Dr. Headlam Greenhow.

Two fatal Cases of Cholera and Two ill of Diarrhœa.

A four-ounce bottle only of this water was obtained, and in the deposit from it there were seen a great many frustules of the usual *cyclotella*, one or two short threads of *meloseira varians*, a few frustules of a *gomphonema*, and of other diatomaceæ; amongst the infusoria were several of the olive-coloured euglenæ, many monads, and one or two other infusoria, likewise much of the yellow fungus, and one bunch of thallus, resembling that of *penicilium glaucum*.

29, *Clanden Street, Newington*.—Collected 26th September 1854, by Dr. Headlam Greenhow.

Two fatal Cases of Cholera, and One ill of Diarrhœa.

A six-ounce bottle only of this water was procured, and yet the sediment was found to abound in all the organic productions of various kinds, so commonly present in the water of the Southwark and Vauxhall Company—rotifers, a great many, actinophrydes, oxytrichæ, coleps, euglenæ, a great many diatomaceæ of the genera *cyclotella* and *Nitzschia*, especially *N. sigma*, also *scenedesmus lunaris*.

28, Clenden Street, Newington.—Collected 26th September 1854, by Dr. Headlam Greenhow.

One fatal Case of Cholera, and One ill of Diarrhoea.

In this water, although, as in the case of the two previous samples, the quantity obtained was small, all the usual productions characteristic of the water of the Southwark and Vauxhall Company were present in great abundance, including a great many actinophrydes, &c.

The following SAMPLES were obtained from Houses supplied by THE CHELSEA COMPANY.

3, Eatley's Buildings, Manor Street, Chelsea.—Collected 27th September 1854, by Dr. Hassall and Dr. Headlam Greenhow.

One Case of Cholera and Four of Diarrhoea in this House.

This water was not thoroughly bright, and in it, after subsidence four or five minute infusoria were detected; there was but little deposit, and only a few infusoria were seen, these being chiefly monads; in addition, a few frustules of cyclotella operculata, synedra munitissima, three or four fronds of scenedesmus, and a little of the yellow fungus were discovered.

53, Queen's Road West, Chelsea.—Collected 27th September 1854, by Dr. Hassall and Dr. Headlam Greenhow.

Two Deaths and Two Cases of Diarrhoea.

There were detected in this water, after subsidence, a uvella, brown oval and circular moving sporules, and one or two small infusoria. The quantity of sediment was small, but it contained a good many infusoria and other productions, a cyclops and a daphnia, a rotifer, an annelid, several actinophrydes, green oval uvellæ, and many infusoria of the genus coleps, with a few euglenæ of two different species, monads, and brown moving sporules, including a species of lagenella; there were also large numbers of the fronds of scenedesmus, a few pediatra, many frustules of cyclotella operculata, a few of synedra munitissima, and much of the yellow fungus.

5, Bolton's Gardens, Chelsea.—Collected 27th September 1854, by Dr. Hassall and Dr. Headlam Greenhow.

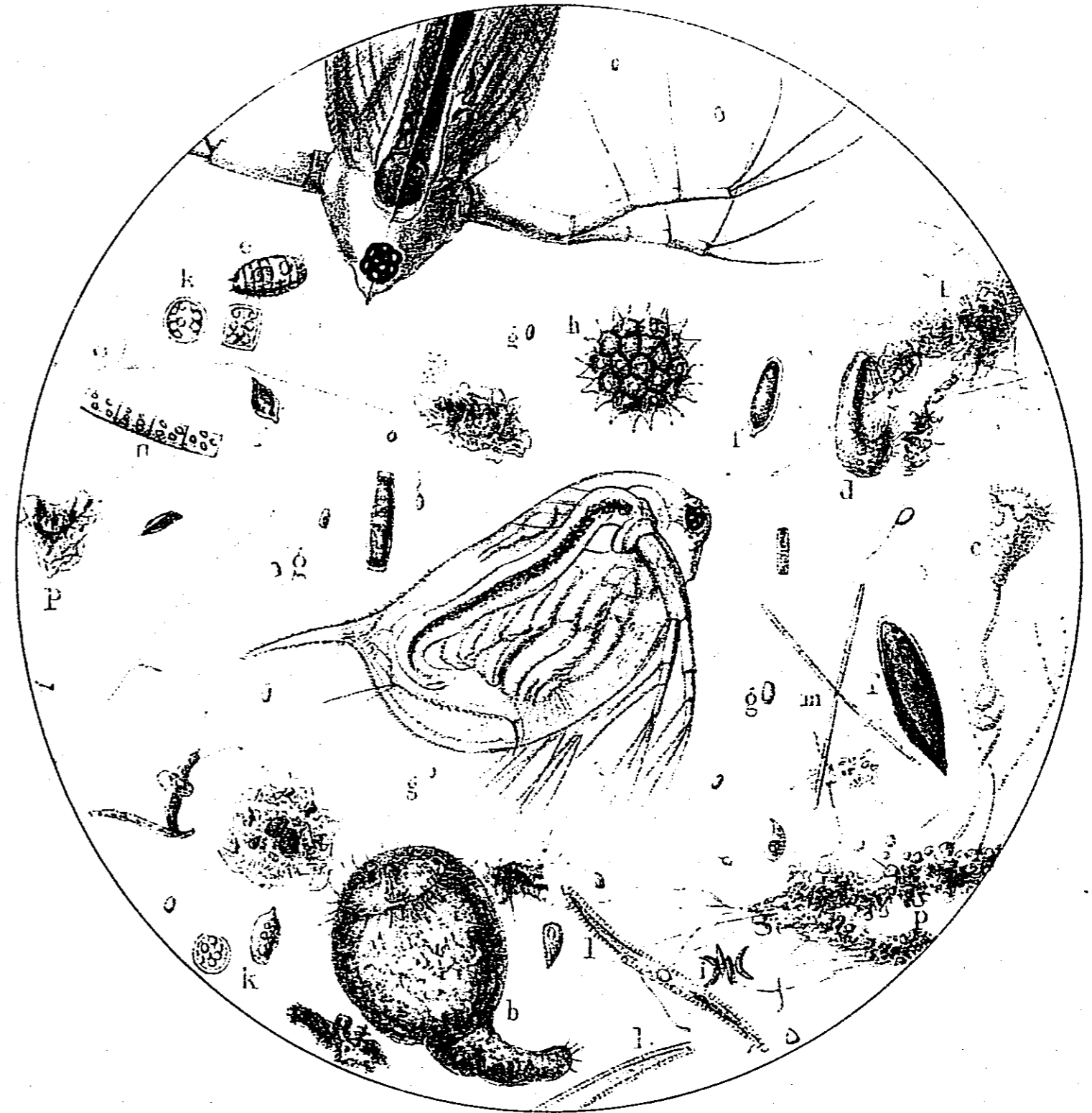
Five Deaths; Diarrhoea general.

In this water, after subsidence, there were a great many entomostraceæ swimming about, principally daphnia pulex, as well as rather many infusoria, the latter included three or four euglenæ, a paramecium, one polyarthra, two yellow rolling spherules, and other still more minute animalcula. The residue was rather considerable, and contained all the same elements as the Southwark and Vauxhall

FROM WATER OF CHELSEA COMPANY.

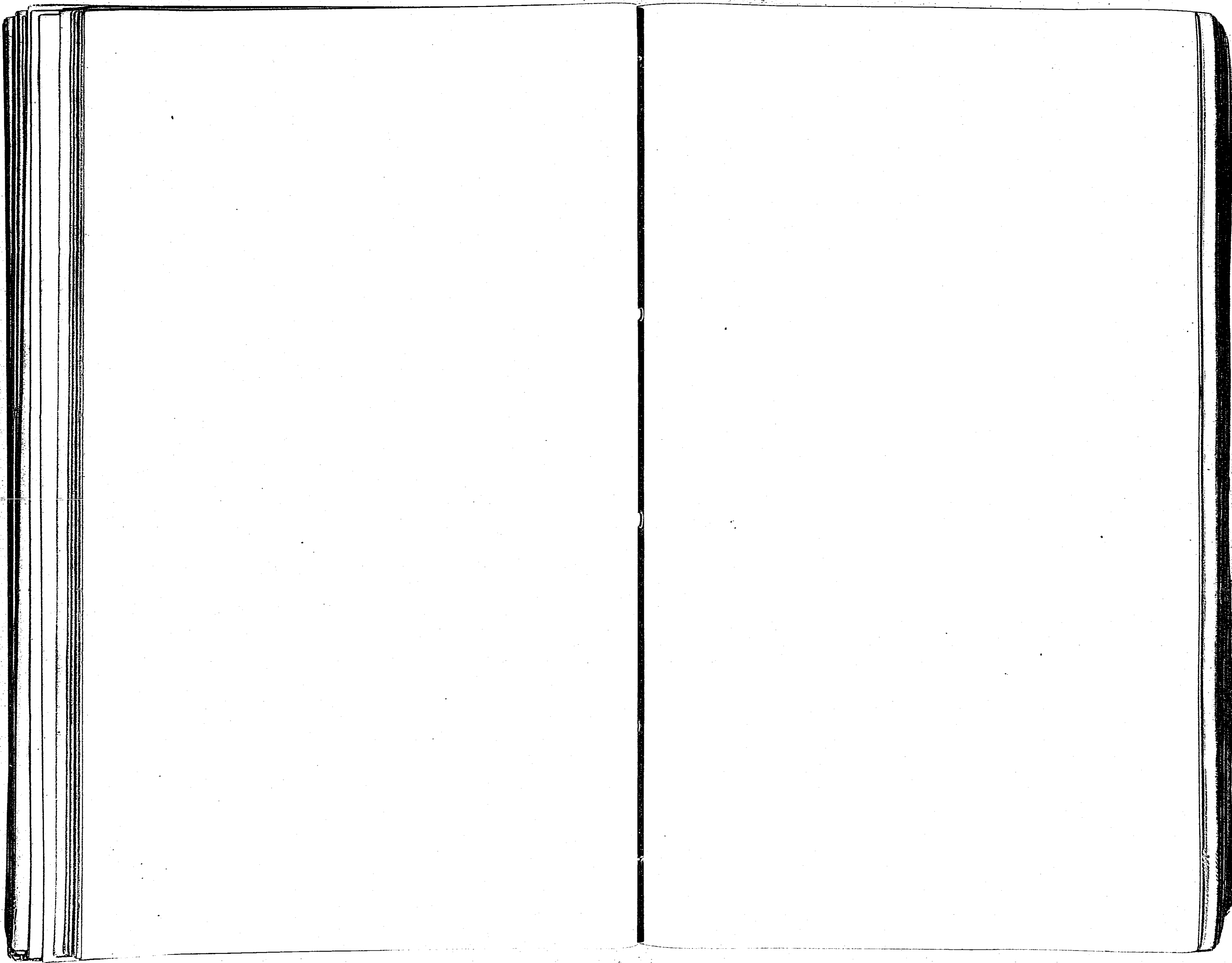
Pl. 5.

(From Cistern)



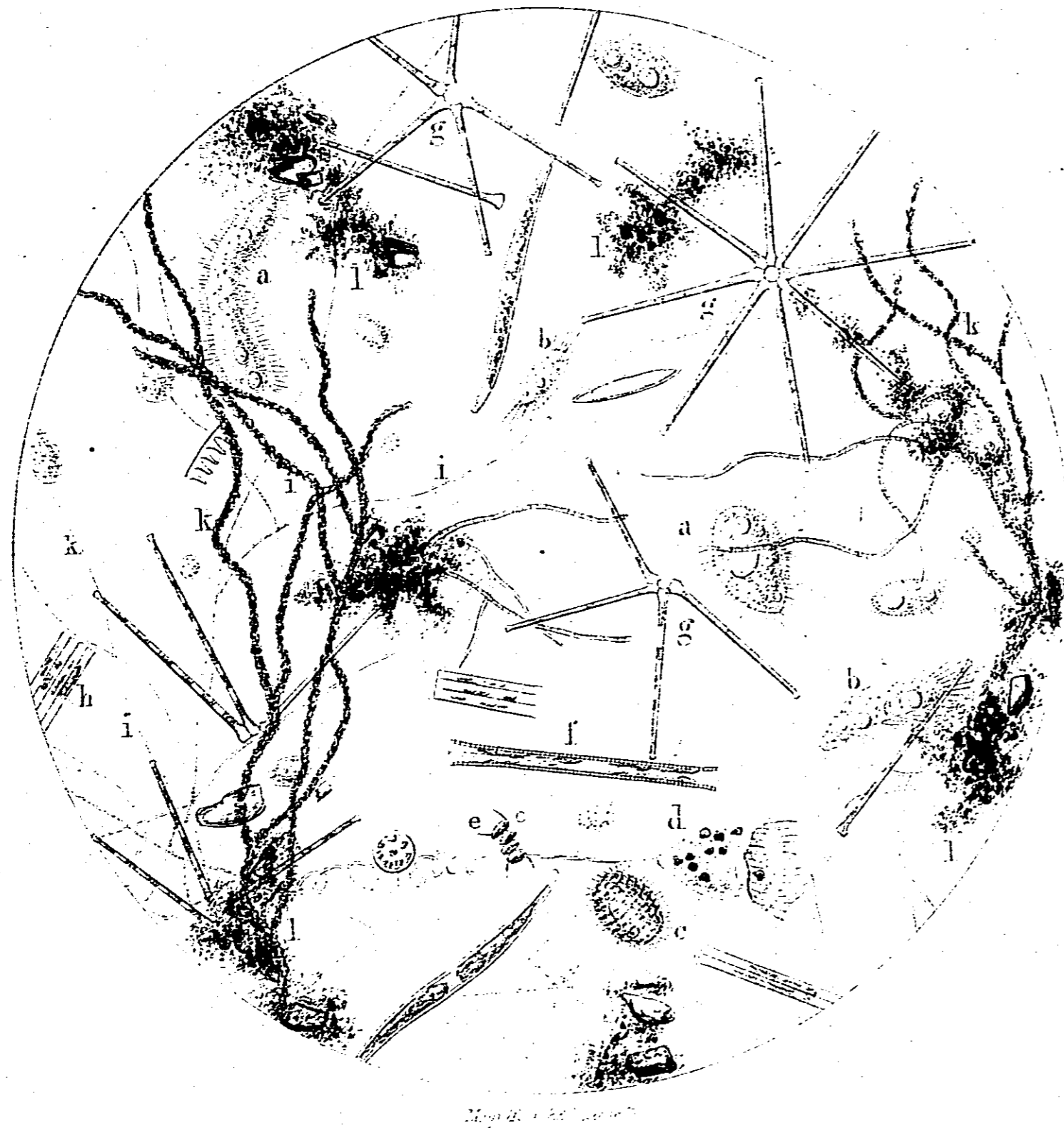
Daphnia magna 25 diam. 6
the remainder 200 diam. 6

- | | | |
|--------------------------------------|---------------------------------|-----------------------------------|
| a. <i>Daphnia pulex</i> mas. | e. <i>Coleps hirtus</i> . | k. <i>Cyclotella operculata</i> |
| a'. " fem | f. <i>Euglena viridis</i> . | l. <i>Nitzschia sigma</i> . |
| b. <i>Rotifer</i> in peculiar state. | g. Monads. | m. <i>Synedra munitissima</i> . |
| c. <i>Vorticella convallaria</i> | h. <i>Pediastrum Boryanum</i> . | n. <i>Melosira varians</i> |
| d. <i>Pezizochia</i> | i. <i>Scenedesmus acutus</i> | o. <i>Threads of the Fungus</i> . |
| | p. Organic debris. | |



FROM WATER OF EAST LONDON COMPY
(from Cistern.)

Pl. 6.



- | | | |
|------------------------------------|-------------------------------------|---------------------------------|
| a. <i>Paramecium</i> . | e. <i>Scenedesmus quadricauda</i> . | i. Filaments of slender Fungus. |
| b. <i>Oxytricha</i> . | f. <i>Synedra ulna</i> . | k. <i>Sieve of Anthoplyssa?</i> |
| c. <i>Coleps hirtus</i> . | g. <i>Asterionella formosa</i> . | l. <i>Grit and Dirt</i> . |
| d. <i>Vorticella convallaria</i> . | h. <i>Fragillaria capucina</i> . | |

water, only in smaller numbers. Amongst them were observed a rotifer, vorticella convallaria, oxytrichæ, coleps hirtus, euglena viridis, and monads; scenedesmus acutus, pediatrum boryanum, meloseira varians, cyclotella operculata, Nitzschia sigma, and synedra munitissima. Fig. 5.

Wink's Court, Chelsea.—Collected 16th September 1854, by Dr. Headlam Greenhow.

This water was tolerably clear and bright, but it contained many entomostraceæ swimming about in it. After subsidence, five or six small infusoria were seen, including two paramecia; rather much brownish sediment subsided, this contained broken shells of some entomostracan, a few infusoria of the genera coleps, euglena, and monas; plenty of scenedesmus, a few pediatra, a closterium, frustules of cyclotella operculata, the brown festooned sporules, and one of the usual Nitzschia N. sigma, filaments of the slender fungus, and rather much yellowish organic débris.

The following SAMPLES were procured from Houses supplied by THE EAST LONDON COMPANY.

Allen's Cottages.—Collected 7th October 1854, by Dr. Hassall and Mr. Walker.

One Death.

This water, after subsidence, was found to contain infusoria and other animalculæ, amongst which were some of the genera paramecium, coleps, and vorticella. The sediment in this case was rather copious, and contained two large paramecia, several oxytrichæ, vorticellæ and coleps; amongst the vegetable productions were to be seen rather many diatomaceæ, especially asterionella formosa, which was present in immense numbers, several frustules of pleurosigma, synedra ulna, and frustules of fragillaria capucina, also scenedesmus quadricauda, a good deal of the slender fungus, and a second species of fungus. Fig. 6.

25, Willis Street.—Collected 7th October 1854, by Dr. Hassall and Mr. Walker.

One Death.

In this water a small quantity of sediment only was deposited, but there were detected hundreds of minute infusoria actively swimming about, dozens of small paramecia, and one large one, two amœbæ, and a few small oxytrichæ. Amongst the diatomaceæ were a few frustules of synedra ulna, and also of another species of synedra; frustules of navicula and coconema, together with a few of the circular festooned brown sporules; two species of fungus were also present, that with the slender threads, and another larger kind with germinating sporules, most probably penicilium glaucum, together with four or five fragments of decaying vegetable tissue.

The following SAMPLES were procured from Houses supplied by
THE KENT COMPANY.

5, *Duke Place, Deptford*.—Collected October 1854, by Dr. Hassall
and Registrar of Births and Deaths for the District.

One Death occurred in this House.

Rather many monads were detected in this water after complete subsidence; there was scarcely any sediment, but in the little that did subside the following organic production were noticed: one small worm (*anguillula fluviatilis*), one vorticella, a few oxytrichæ, two animalculæ of the genus *amphileptus*, many small paramecia and monads, one brown globular moving sporule and several brown ova cases; the only desmidium seen was a small *cosmarium*; and of the diatomaceæ, three frustules only were noticed, but there was a good deal of the slender fungus.

97, *New Street, Deptford*.—Collected October 1854, by Dr. Hassall
and Registrar of Births and Deaths for the District.

Six Deaths in this House.

Rather many infusoria were seen in this water after subsidence, and these of larger kinds than those in the preceding sample. The residue was also rather considerable, and contained a great many animalculæ of the genus *amphileptus*, three loricated infusoria, allied to rotifer, one jointed worm, about twenty vorticellæ, several oxytrichæ of three or four different species, large and small, numerous rather small paramecia, two or three actinophrydes, a few monads, and three or four animalculæ of the genus *polyarthra*. No diatomaceæ were seen, and only one *scenedesmus*. Fig. 7.

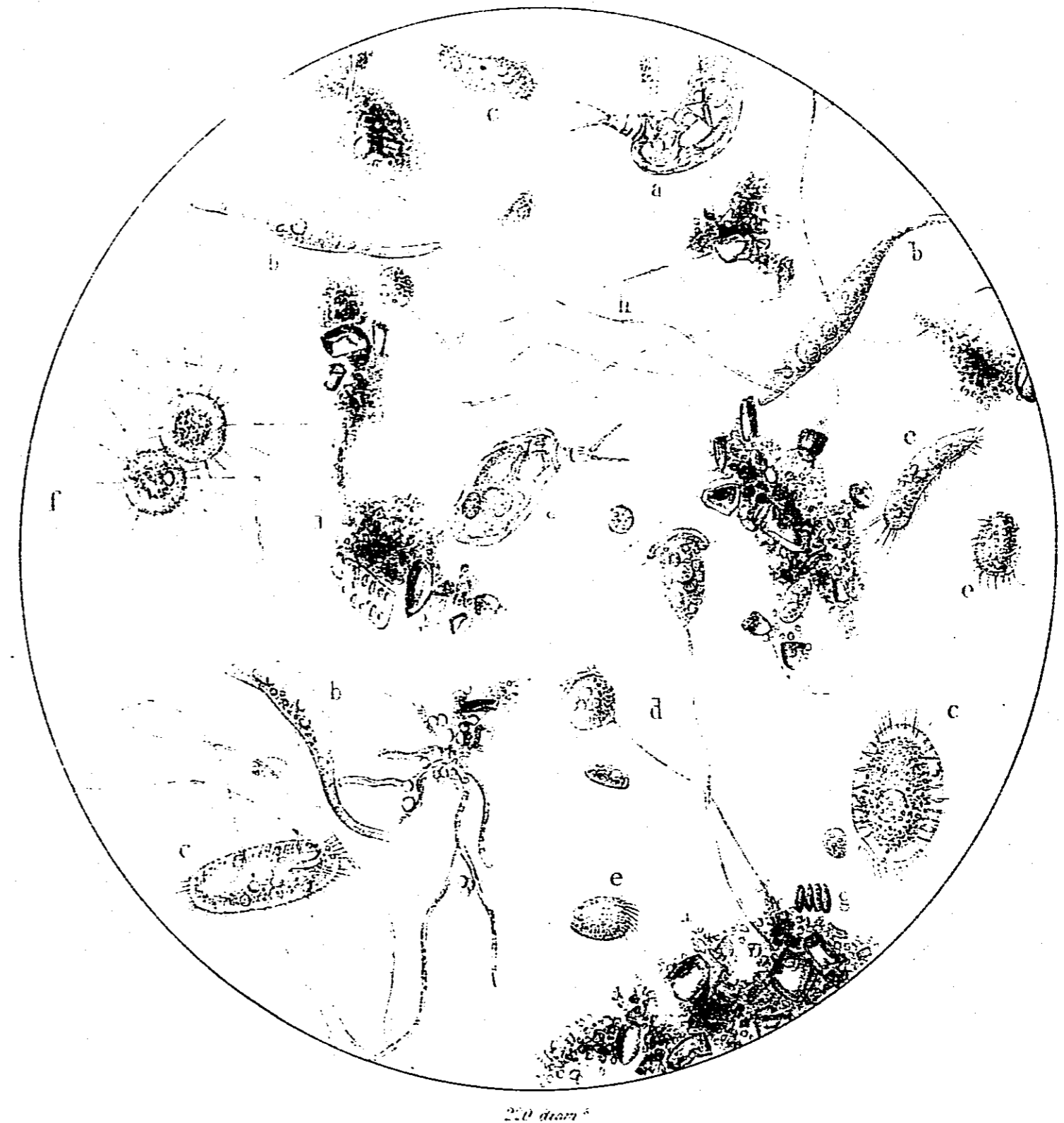
From an examination of the preceding Microscopical Analyses of water procured from cholera houses, the following conclusions may be deduced:—

1st. That the whole of the numerous specimens of water subjected to examination contained organic matter, dead and living, animal and vegetable, including, for the most part, several distinct classes of productions, as annelidæ, entomostraceæ, infusoria, confervæ, desmideæ, diatomaceæ, and fungi, as well as hairs of animals, starchy matter of different kinds, and dead and decaying fragments of vegetable tissues.

2d. That the quantity and kinds of organic matter varied considerably in different cases, but were usually more or less constant for the same water.

3d. That the waters which contained the largest amount of organic matter, and in which the greatest number and variety of productions, dead and living, were discovered, were those from houses supplied by the *Southwark and Vauxhall Company*. The whole of the samples of this water examined abounded in living animalculæ of different genera and species, in desmideæ, in certain very characteristic species of diatomaceæ, and in fungi. They likewise contained a large quantity of dead organic matter, amongst which were frequently to

From Cistern



- | | | |
|------------------------|-------------------------|-------------------------------|
| a. a. Rotifer | d. Vorticella conularia | g. Scenedesmus quadrivittatus |
| b. Amphileptus | e. Polyarthra | h. Threads of slender Fungus |
| c. Oxytricha 3 Species | f. Actinophrys Sol. | i. Organic debris & dirt |

be detected fragments of the husk of wheat, hairs of the same, starchy matter of different kinds, cells of potato and other vegetable tissues, with, in some cases, fragments of altered muscular fibre: these latter structures and elements being undoubtedly derived from the fœcal matter contained in the sewage. In addition to the organic matters in the solid form, there was also a large quantity of fluid organic matter in these waters, the presence of which caused them to present a somewhat milky and opalescent appearance, as seen in the Winchester quart bottles.

4th. That the same species of organic productions, especially the different pediastra, synedra, cyclotella, Nitzschia, &c., discovered in the Southwark and Vauxhall water, were present in the waters obtained from houses supplied by *the Chelsea Company*, although in greatly diminished numbers. This result is just what might have been anticipated, since this Company derives its supply of water from the same part of the Thames as the Southwark and Vauxhall Company, but filters it before delivery. The state of this water shows the extent to which impure water may be improved by efficient filtration; but it proves also, at the same time, that such filtration does not deprive a water originally impure of even all the solid organic productions contained in it; therefore filtration does not restore such water to the requisite degree of purity.

5th. That the water procured from houses supplied by *the New River, Grand Junction, and East London Water Companies*, but especially the two former, all contained a great many organic productions. The New River Company does not at present filter the water which it supplies, and hence it is not surprising that such matters should be contained in it. From the condition of the water of the Grand Junction Company, it may be suspected that this also is not filtered previous to delivery, at all events, if filtered, the method of filtration adopted is defective. The East London Company now supplies filtered water, notwithstanding which, as has been already shown, it contains animalculæ and other living organic productions.

6th. That the water obtained from houses supplied by *the Lambeth Company*, contained fewer organic productions than any of the rest, but still more or less were present in all the waters taken from cisterns supplied by that Company.

7th. That of the organic productions discovered in the waters examined, the great majority belonged to species which are known, and which have been long described in systematic works, and since the greater number of these are present in these waters at nearly all seasons, and since they are, therefore, continually consumed, it is clear that they are in no way concerned in the production of cholera; when received into the stomach, they are, for the most part, speedily destroyed, without giving rise to any obvious symptoms.

The number of living organic productions detected in the waters, the names of which were not known, or their nature undetermined, was not considerable; and of these there was no one common to all the waters obtained from cholera houses, which could be supposed to be influential in any degree in the production of the epidemic. One only living and moving sporule-like body was observed which excited

for a time any degree of suspicion, this was the brown flat or lenticular actively moving body represented in Fig. 8, and which was present in nearly all the waters obtained in the Golden Square district, as well as in some of the others. But having since met with this production in waters supplied to houses and districts in which no cases of cholera occurred, and moreover, not meeting with it in any of the ejections of cholera, no grounds whatever exist for attaching any serious importance to its presence in water in relation to cholera.

In some of the waters vibriones were discovered, and since these invariably abound in the rice-water dejections of cholera, it might be inferred that their presence was of more consequence, and this, indeed, may possibly be the case, but since they are present, more or less, in many impure waters at all times and in all seasons, it is quite clear they cannot originate the disease. In some cases the vibriones, which afterwards become developed in such vast quantities in the rice-water discharges even whilst contained in the small intestines, may possibly have been introduced through the waters drunk. We are not, however, to infer that the presence of living organic productions in water is of no consequence in relation to cholera; directly, we believe that they are of little importance, but indirectly, and as evidences of the impurity of the waters in which they are found, we consider that their presence is of very considerable importance.

8th. That amongst the productions present in the water of the Southwark and Vauxhall, the Lambeth, and the West Middlesex Companies, are some which are found only in brackish waters; these are chiefly diatomaceæ, especially the following—*Nitzschia sigma*, *meloseira nummuloides*, and *coscinodiscus eccentricus*. This is a very important fact, and one to which we shall hereafter refer more at length.

Finally, it appears, as the general results arising out of the microscopical examination of the waters obtained from cholera houses:

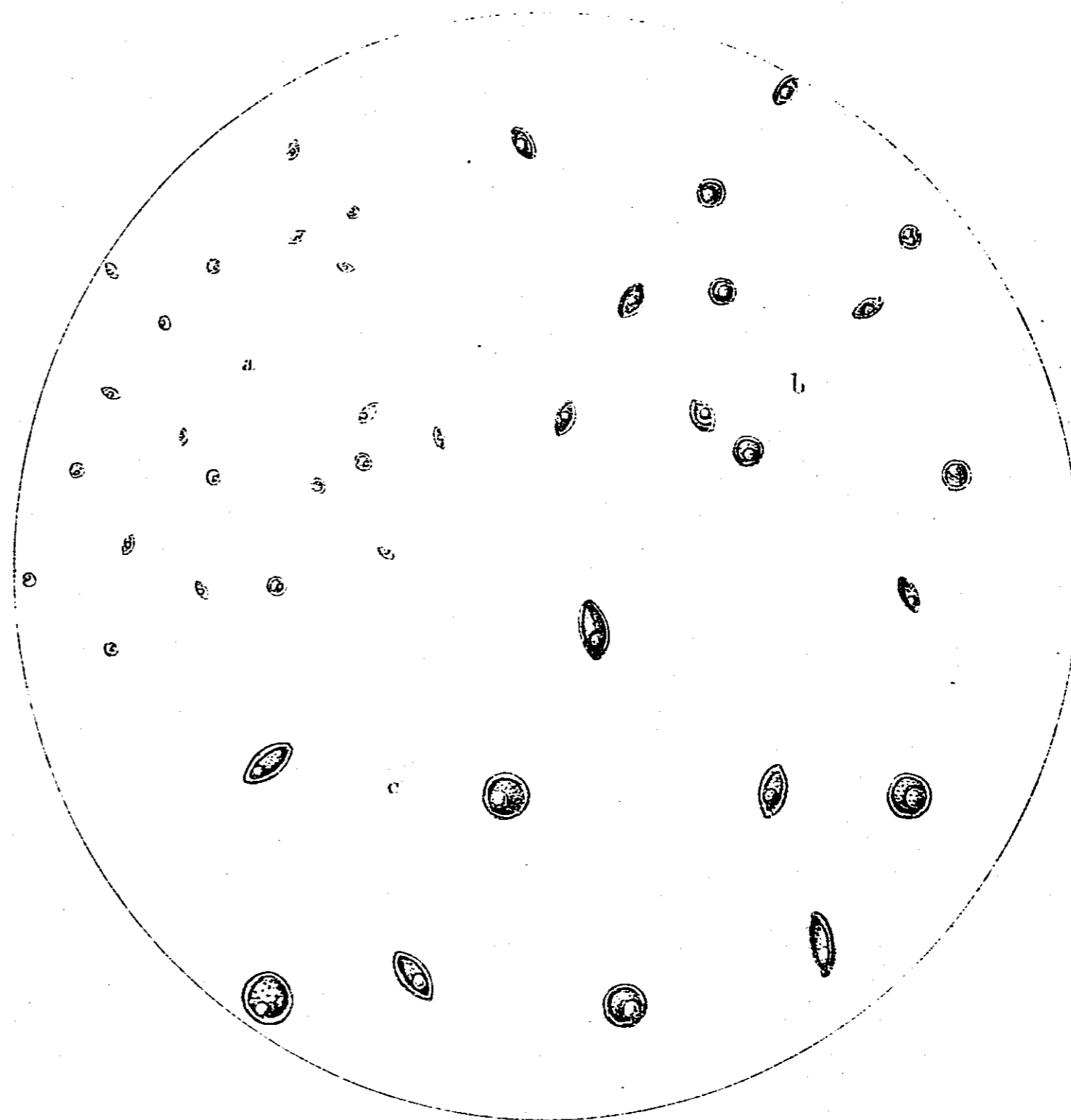
That the specimens taken from cisterns supplied by the Southwark and Vauxhall Company were very impure, indeed, far more so than any of the other waters examined, some of them being demonstrably contaminated with fœcal matter.

That the waters of the other companies were all of them more or less impure, the comparatively purest of the whole, being the freest from organic productions, was that supplied by the Lambeth Company. The contrast furnished by the water now supplied by that Company and that which it formerly furnished, taken from the river at Lambeth, is most marked; the condition of the water of the old supply was even worse than that of the water now distributed by the Southwark and Vauxhall Company.

That the microscopical examination of the different waters obtained from houses visited by cholera throws no special or direct light upon the production of that epidemic.

PECULIAR BROWN ACTIVELY MOVING
LENTICULAR BODIES.

Pl. 8.



Magnified a 200. b 225 and c 400. from

Found in Several of the Waters from the
Golden Square district.

(2.) RESULTS of the MICROSCOPICAL EXAMINATION of different Specimens of WELL and PUMP WATER, procured in neighbourhoods in which CHOLERA was prevalent.

A great deal of attention has very properly been bestowed upon the subject of the water supply of our cities and towns, but further investigation is still needed.

There is a branch of the subject of water supply, the importance of which has, to some extent, been overlooked.

A very large proportion of our secondary towns and all the villages and single houses scattered throughout the country derive their supply of water from wells. In such localities there is usually no regular system of sewerage, the refuse matters of the houses passing into privies and cesspools, which are often contiguous to the well.

It is, therefore, not surprising, especially when the absorbent character of most soils is taken into consideration, that the water of many of these wells should become contaminated. That they are liable to be rendered impure from this cause has been long ascertained, but I believe that the extent and general prevalence of this contamination is by no means fully known.

The evidence of this contamination is twofold. One evidence consists in the presence of animalculæ and other organic productions; the other in the existence of nitrates in the waters. Both may be present in the same water, but usually this is not the case, and where animalculæ abound the nitrates are not often present in large amount, and where these are abundant the animalculæ, &c. are for the most part absent.

The presence of nitrates in well water may be suspected when it presents a greenish tinge or colour.

The reasons of this difference have already been described, but they may be here again briefly referred to. When fluid or dead organic matter of any kind makes its way into the water of a well which is shallow, uncovered, and therefore exposed to air and light, the circumstances exist favourable to the development of infusorial life; but when the well is deep, and there is but little access of light and air, particularly the former, the conditions are then unfavourable to the formation of animalculæ, and the nitrogenized matter present becomes converted into nitrates.

No. 1.—Pump Water from *White Hart Court, Chelsea*.—Collected 14th September 1854, by Dr. Greenhow.

Three or four minute monads only were seen in this water after subsidence; the sediment which fell was very small and of a whitish colour; there were seen, with the microscope, three curious animalculæ, resembling acari, and which are not uncommonly met with in water, four or five vorticellæ, one or two actinophrydes, several small paramecia and monads, a few brown ova cases, and some organic débris.

No. 2.—Pump Water from *Sun Court, Chelsea*.—Collected 17th September 1854, by Dr. Headlam Greenhow.

Rather many small infusoria were seen in this water after subsidence. The residue was small, but it contained rather many infusoria,

of three or four different kinds, including a few small oxytrichæ, a single vorticella, monads, and several animalculæ three or four times larger than monads, having a long tail-like appendage, filaments and sporules of fungus, a bunch of ova cases, and a great many circular brown dotted corpuscles or bodies, and which were also seen in some of the other waters examined

No. 3.—From Pump in *Broad Street, Golden Square*.—Collected 17th September 1854, by Dr. Hassall and Mr. Patterson.

This water was clear and bright, the only living organic productions contained in it were rather many animalculæ of the genus monas, three or four small animalculæ, like a species of amphileptus, and a few ova cases; the animalcules were however present in sufficient quantity to show that this water could not be considered to be pure. This is the water to which Dr. Snow, during the recent outbreak of cholera, so strongly drew attention. Fig. 9. See Analysis of Dr. Thomson.

No. 4.—*Wilderness Row, Goswell Road*.—Collected by G. Glover, Esq., 4th October 1854.

Water of a decidedly greenish hue, probably from contamination by a cesspool; no infusoria of any kind were seen in it after subsidence, but it furnished a small quantity of blackish sediment, which contained a few infusoria, oxytrichæ of two different species, and other animalculæ; also about a dozen small diatomaceæ, belonging to the genus pleurosigma, two or three small fragments of vegetable tissue, one head of a fungus of the genus dactylium, and a good many dotted brown circular bodies, referred to under the sample No. 2.

No. 5.—From Well in *Bayley's Yard, Allen Street, Clerkenwell*.—Collected 4th October 1854, by G. Glover, Esq.

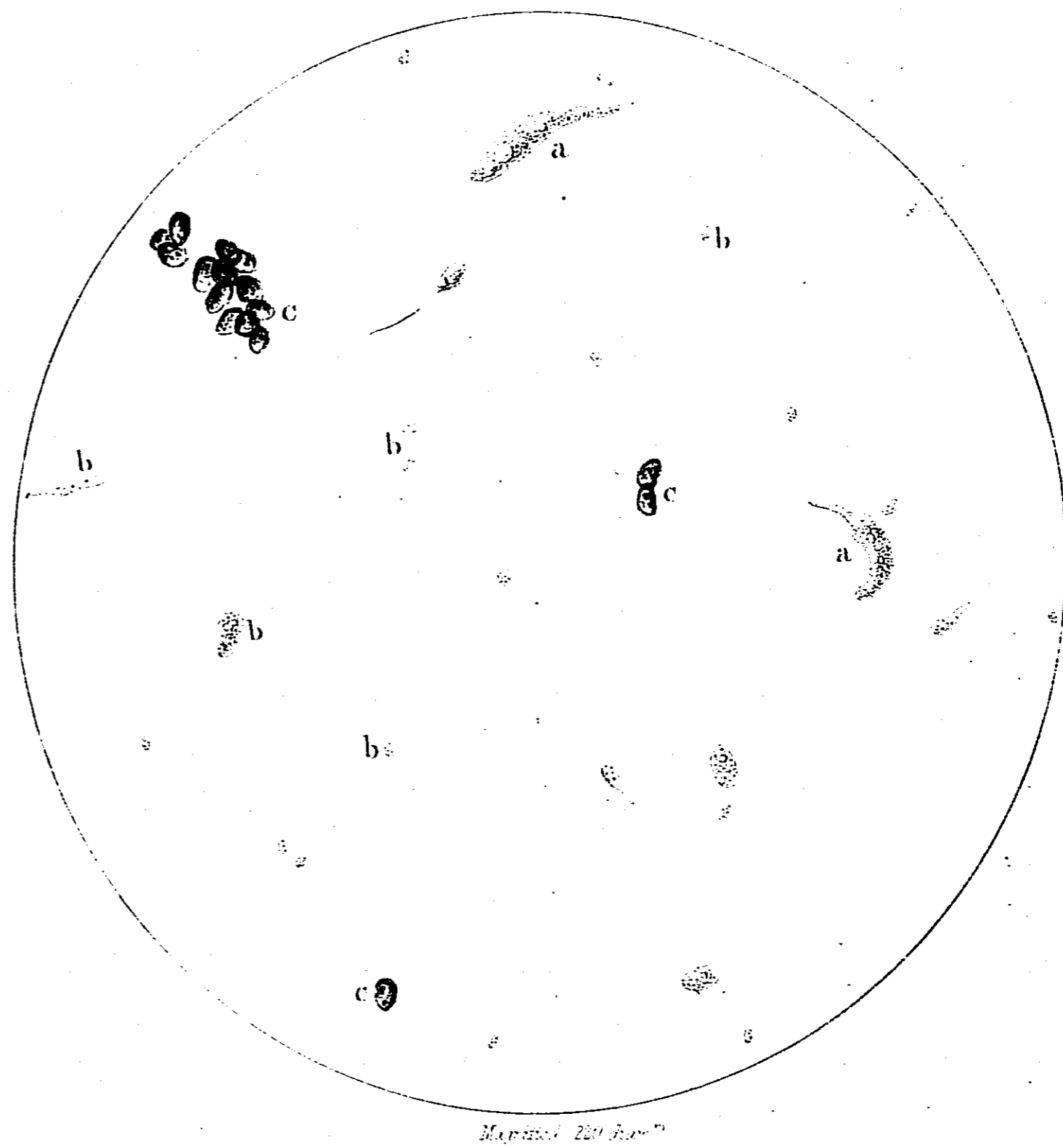
The sediment deposited from this water was very considerable, and amongst it were several of the fatty looking masses, seen in the water from 15, Broad Yard, surrounded by fungus. The sediment swarmed with infusoria, and included a great many entomostraceæ of the genus Cyclops, *C. quadricornis*, dead and living, and animalculæ, including *actinophrys sol*, *coleps hirtus*, and *amphileptus faciola*, as well as two or three other kinds, the names of which could not be ascertained, but one of which was a species of *eurocentrum*. Amongst the diatomaceæ were frustules of *pleurosigma attenuatum*, *synedra ulna*, and of a *navicula*, as well as of *asterionella formosa*. Lastly, there were three different species of fungus, and much decaying vegetable tissue. Fig. 10.

No. 6.—From Pump in *Cock's Buildings, Putney*.—Collected 8th October 1854, by Dr. Hassall and Mr. Whiteman.

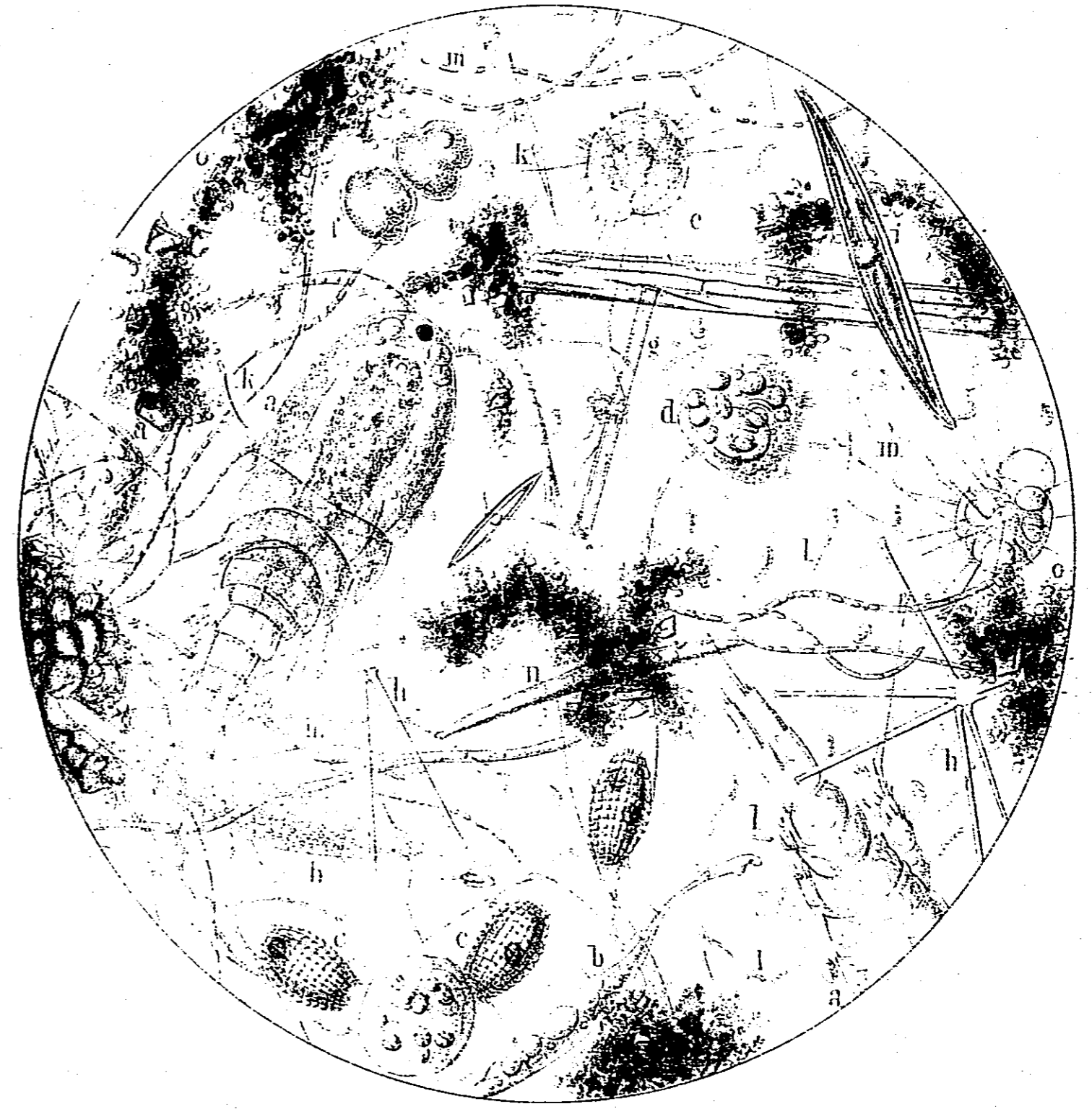
This water, during the prevalence of cholera in Putney, was of a decided green colour, as was observed by the inhabitants of the many houses supplied by it; this appearance had gone off somewhat at the period when the specimen was obtained, at which time cholera was

FROM WATER FROM PUMP IN BROAD ST
GOLDEN SQUARE.

PL. 9.

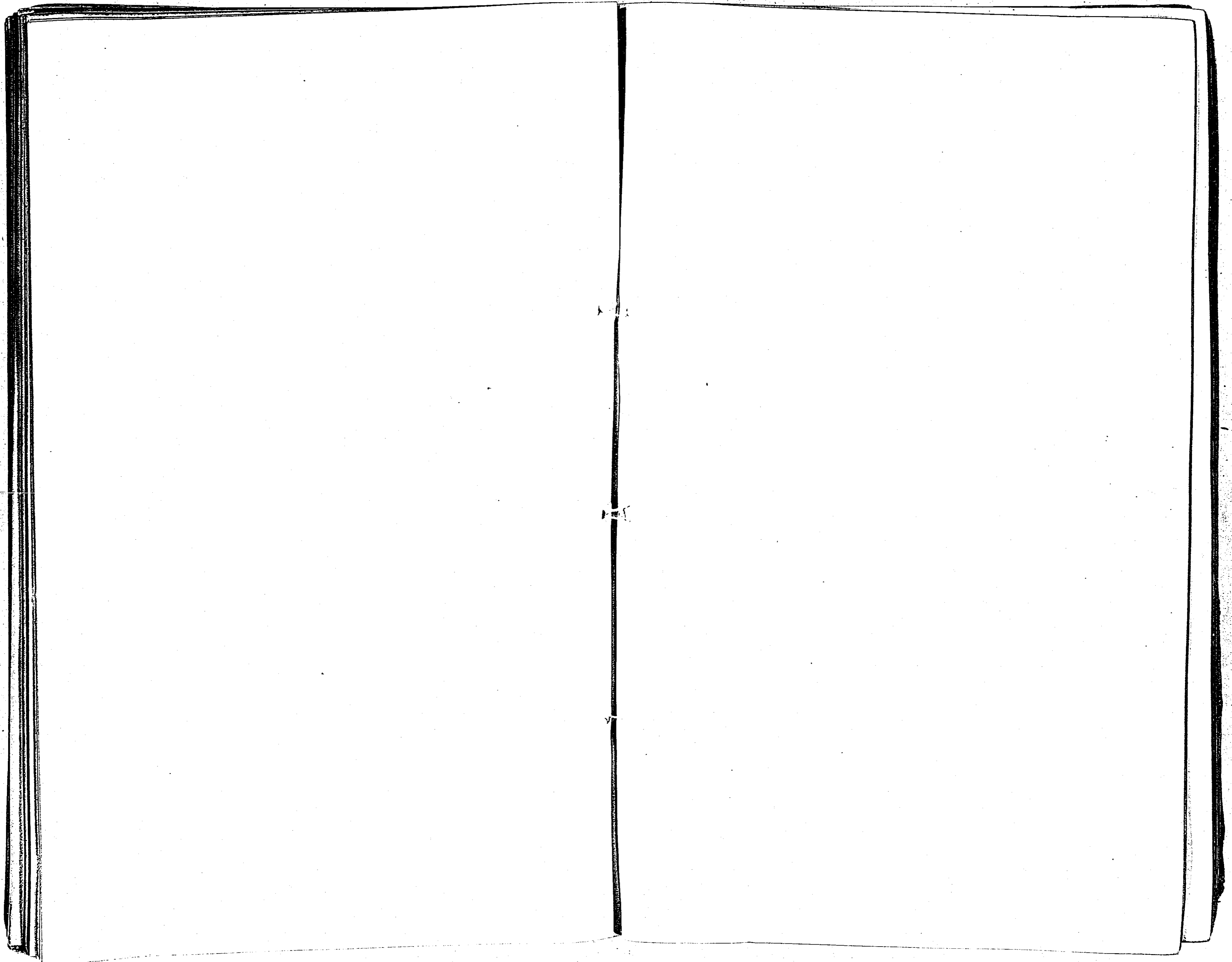


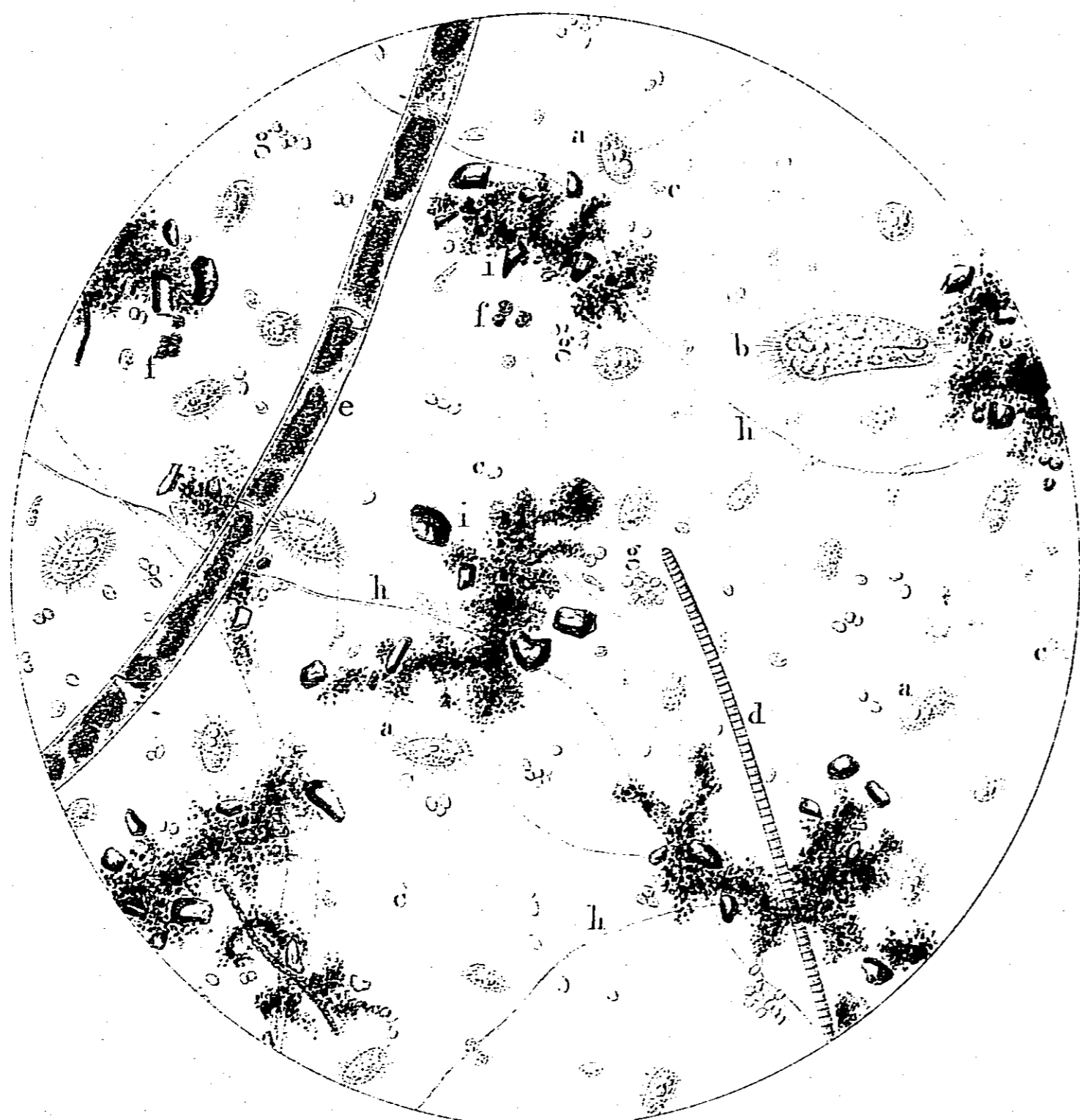
a *Amphileptus* b *Monads and other Infusoria* c *Brown Ova-cases*.



Magnified 100 times

- | | | |
|---|---|--|
| a. <i>Cydlops quadricornis</i> | f. <i>Urocentrum</i> | m. <i>Threads of Fungus of different Species</i> |
| b. <i>Amphileptus</i> | g. <i>Synedra Elva</i> | n. <i>Spicula of fresh water-Sponge</i> |
| c. <i>Cydlops hirtus</i> | h. <i>Pleurosigma attenuatum</i> | o. <i>Earthy & Organic matter.</i> |
| d. <i>Verticella detached from their stems.</i> | i. <i>Asterionella formosa</i> | |
| e. <i>Actinophrys Sol</i> | k. <i>Frustules of different Diatomaceous</i> | |
| | l. <i>Fibres</i> | |





a. *Paramecia*.
 b. *Oxytricha*.
 c. *Monads*.
 d. *Oscillatoria*.
 e. *Filament of Conferva*.
 f. *Green motionless Sporules*.
 g. *Colourless Sporules of a Fungus*.
 h. *Slender Fungus*.
 i. *Organic and gritty matter*.

also on the decline, but still it was of a greenish hue, as was clearly seen when the water was poured out into a glass tumbler; scarcely any sediment was deposited, and there was discovered, in the little that was thrown down, four or five oxytrichæ, one or two paramecia, masses and threads of the spiral vibrio, which exhibits a dotted appearance at each turn of the spire, and rather many monads. This water, from its appearance and from the account given of it, was evidently contaminated by percolation from a neighbouring cesspool, and the principal part of the organic matter present was in the fluid state, and in the form of nitrates. See Dr. Thomson's analysis.

No. 7.—From Pump in *Price's Folly, Putney*.—Collected 8th October 1854, by Dr. Hassall and Mr. Whiteman.

This water resembled the preceding in colour and appearance, but was still deeper; the source of contamination was also the same, namely, a neighbouring cesspool. Very little sediment was deposited, enough only to be just visible to the naked eye in a thin glass cell; it contained a considerable number of actinophrydes, some of the spiral vibriones before referred to, a few euglenæ, one or two small paramecia, a few small sporules and threads of fungus, and eight or ten frustules of different diatomaceæ, including navicula and gomphonema; lastly, there were a few green circular sporules aggregated into little masses, and motionless. See Dr. Thomson's analysis.

No. 8.—From Pump at 19, *Stratford Grove, Putney*.—Collected 8th October 1854, by Dr. Hassall and Mr. Whiteman.

This water was coloured like the others, but the people of the house from which it was procured fancied that it was contaminated by leakage from a gas pipe, which, however, is some distance away from it, nevertheless there is much reason to believe that the explanation given is correct, as there is no cesspool near, and as the water was always good until the gas pipe was laid down. The sediment deposited was scarcely perceptible, and in it a few monads, vibriones, and sporules of fungus only were discovered.

No. 9.—From Well at *Sevenoaks, Brasted*.—Collected 19th September 1854, by Mr. Thomas Waring.

The well is about fourteen feet deep, and uncovered, a cesspool and privy being situated about twenty-five feet from the well; it supplies ten cottages, amongst the inhabitants of which there have been numerous deaths from cholera. This water threw down a copious light brown sediment, consisting principally of organic matter; it abounded in minute infusoria, principally paramecia and monads; it also contained threads of conferva, oscillatorea, and filaments and sporules of a fungus. Fig. 11.

No. 10.—Well, *Mill Corner, Hadley*.—25th September 1854, collected by Dr. Milroy.

Water very dirty, and threw down a very large deposit; this consisted in part of grit and dirt, which was full of worm-like animalcules spirostomum ambiguum, and contained many infusoria, including a

great number of vibriones, spiral and very active, also much fungus of two different species, several large brown and dotted sporules or bodies, and a few frustules of diatomaceæ. Fig. 12.

NEWTON, WISEBEACH.

The two following are specimens of the water which is usually found in the village of Newton, if wells be dug on the land side of the old sea bank, which passes through portions of this and several neighbouring parishes. The wells are from twenty to twenty-five feet deep, and when sunk to that depth, the water rises half way up. At the depth of about twenty-five feet a layer of black clay is met with.

No. 11.—From Well.—Collected 16th September 1854, by the Rev. Dr. Corrie.

This water possessed a very offensive odour; the residue thrown down was very large, and consisted principally of organic matter in a granular form, containing a few monads and other small infusoria only.

No. 12.—From Well.—Collected 16th September 1854, by the Rev. Dr. Corrie.

Water of a brownish yellow colour, and smelling very offensively, evidently from holding sulphuretted hydrogen in solution. There was a large quantity of sediment deposited, which to the eye looked like Fuller's earth, and under the microscope presented a granular texture, but no infusoria were seen.

Both these waters, from their offensive smell, were evidently much contaminated with organic matter; it is probable that this was derived from the layer of black clay above referred to.

It was not stated whether cholera existed at Romsey at the time when the two specimens of water were forwarded, the results of the Microscopical Examination of which are given below.

No. 13.—Well water from *Romsey*.—Collected 26th September 1854, by Dr. Waller Lewis.

This water, even after standing for some time, remained somewhat opalescent; it threw down a very considerable brown sediment. This abounded in the threads and filaments of no less than three different fungi, it contained a great many filaments of a slender fungus, numerous brown sporules, single and aggregated, of another fungus, and a few threads of a third species; there were likewise present in it some infusoria, a rotifer, *coleps hirtus*, *paramecia*, but especially monads, and the cells of some decaying vegetable tissue. Fig. 13.

No. 14.—From Pump in *Reading Room, Corn Market, Romsey*.—Collected October 1854, by Dr. Waller Lewis.

A wine bottle only of this water was sent up, and yet it deposited as much sediment as would have half filled a small teaspoon; it contained a great many animalculæ, and abounded in diatomaceæ. Amongst the former were several worms, *daphnias*, *oxytrichæ*, *cuplotes*, and numerous

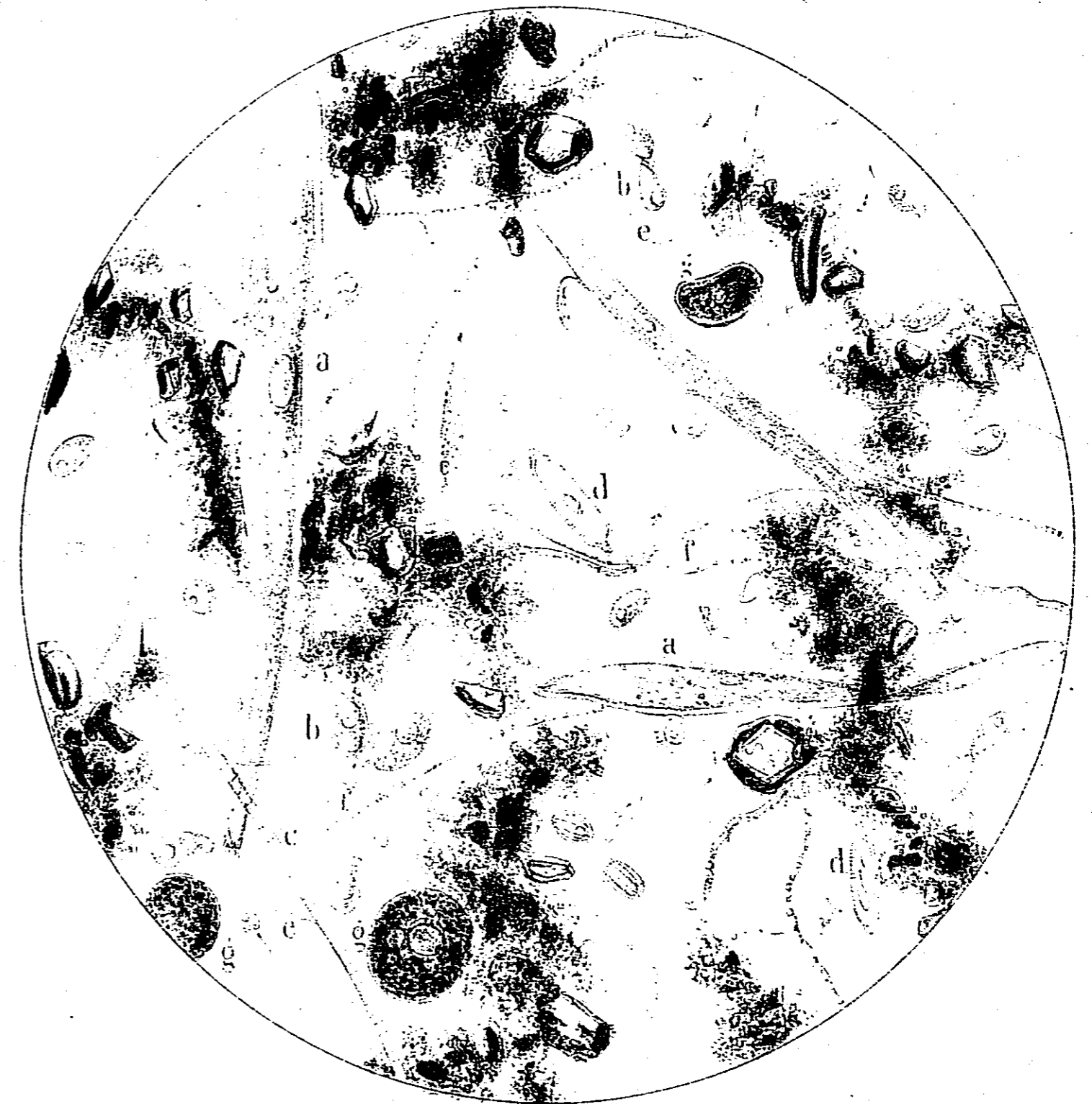
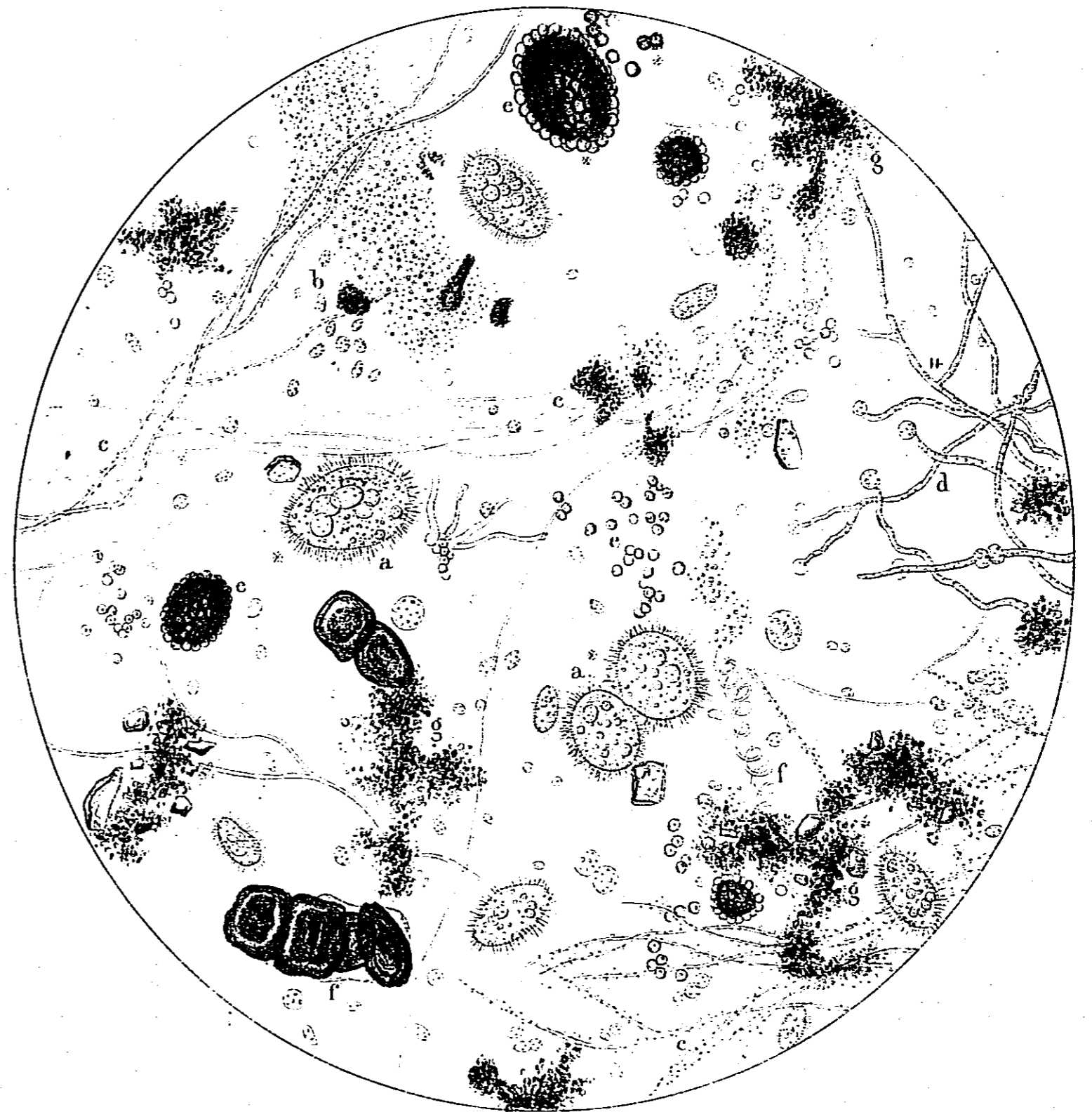


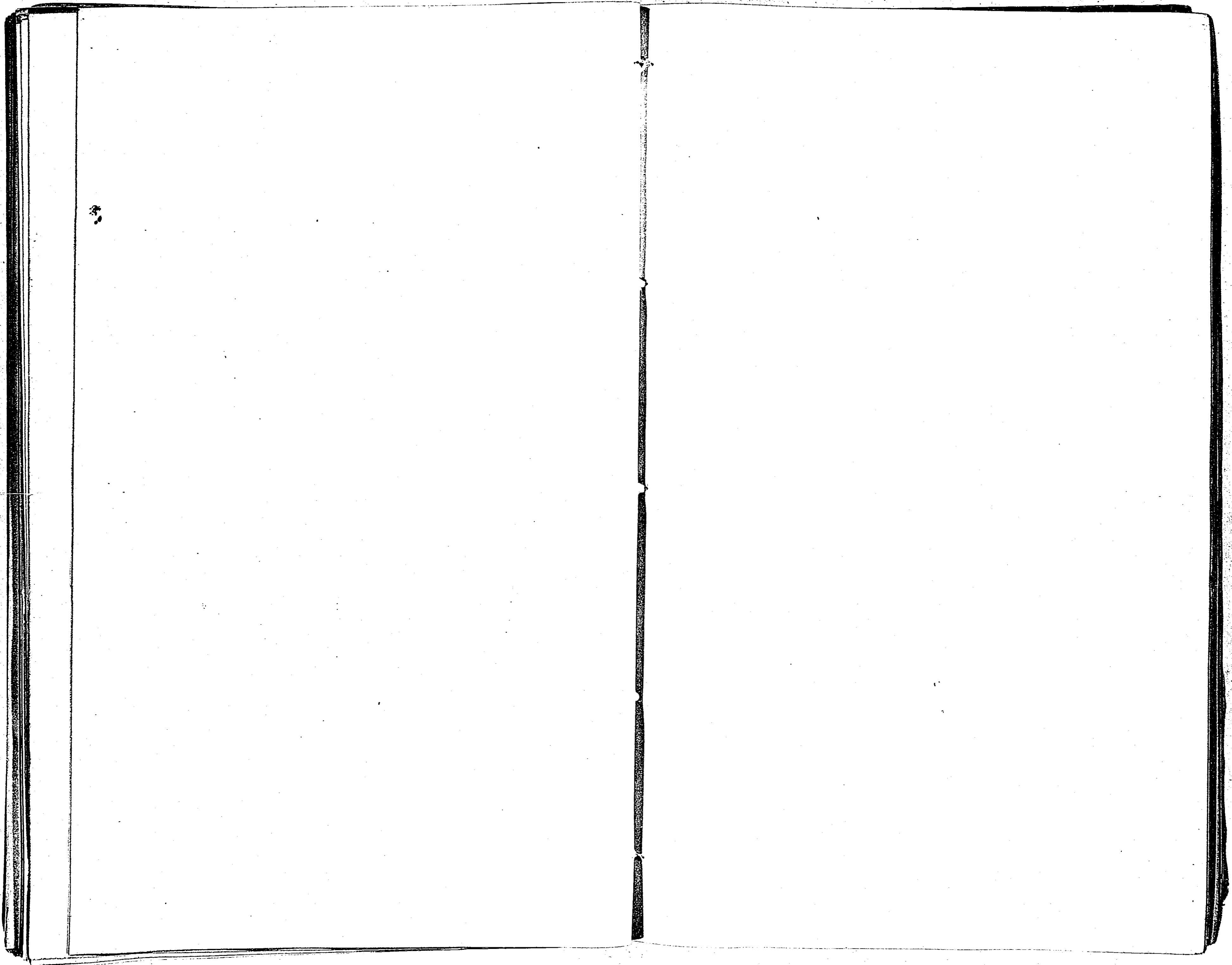
Fig. 12.

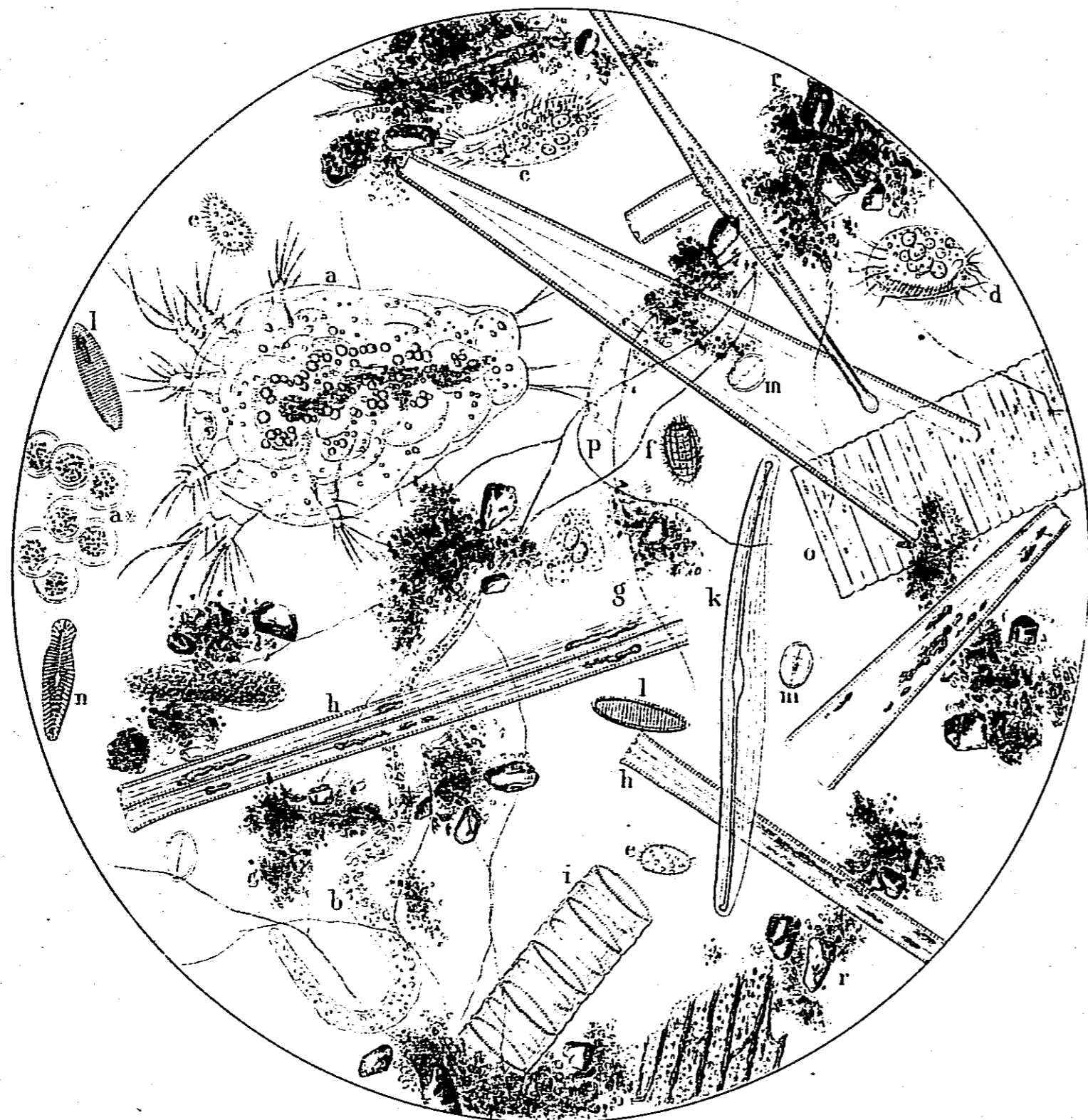
- | | |
|-------------------------------------|------------------------------------|
| a. <i>Sporostemonium analogum</i> ? | e. <i>Vibriones</i> |
| b. <i>Paramecia</i> | f. <i>Fungus</i> &c |
| c. <i>Ascellatoria</i> | g. <i>Brown corpuscular bodies</i> |
| d. <i>Frustules of Diatomaceæ</i> | h. <i>Gravel & Dirt</i> |



Water from the Well at Romsey, Hampshire.

- a *Thurmannia*
- b *Monads*
- c *Filaments of a Fungus*
- d *Sporules germinating of a Fungus Penicillium glaucum*
- e *Brown Sporules of Fungus & aggregations of the same resembling the so called "Cholera corpuscles" of Dr Swayne*
- f *Cells & fragments of spiral vessels & of decaying vegetable tissue*
- g *Grid & Dirt*
- h *Filaments of a Fungus*





Magnified 220 diam.

- | | | |
|----------------------------------|-----------------------------------|-----------------------------------|
| a. <i>Cypris?</i> | e. <i>Paramecia.</i> | k. <i>Pleurosigma attenuatum.</i> |
| a7. Ova of same | f. <i>Coleps litus.</i> | l. <i>Diatoma vulgare.</i> |
| b. <i>Anguillula fluvialis.</i> | g. <i>Amoeba diffluens.</i> | m. <i>Cocconeis Placentula.</i> |
| c. <i>Oxytricha pellionella.</i> | h. <i>Synedra Ulua.</i> | n. <i>Gomphonema capitatum.</i> |
| d. <i>Euploes Patella.</i> | i. <i>Meloseira arenaria.</i> | o. <i>Fragilaria capucina.</i> |
| p. Threads of slender Fungus | r. Decaying organic matter & Grd. | |

infusoria of the genus *coleps*; amongst the diatomaceæ were hundreds of frustules of *synedra ulna*, very large and fine, threads of *fragilaria capucina*, of *meloseira arenaria*, and several frustules of *diatoma vulgare*, *cocconeis placentula*, *pleurosigma attenuatum*, *gomphonema capitatum*, and a few of some species of *pinnularia*. Fig. 14.

The conclusions to be deduced from the preceding Microscopical Examinations of different Pump and Well Waters, principally obtained from Cholera Districts, are the following:—

That nearly all of the well waters examined were of a very impure description.

That seven of them abounded in animal and vegetable productions belonging to different classes, including entomostraceæ, annelidæ, infusoriæ, diatomaceæ, and fungi, and they also contained dead organic matter of different kinds.

That at least two of the waters were evidently contaminated with sewage matter, which had principally assumed the form of nitrates, viz., Nos. 6 and 7.

That in none of the waters was any production met which could be supposed to exert any influence in giving rise to cholera, although in several of them vibriones were detected. If any peculiar body capable of producing cholera is ever present in water, it would be in well waters that this would be most readily detected, because these waters as a rule contain a much less variety of organic productions, than does river water in general, especially Thames water, in which, from the great number of productions present, any very minute or peculiar body might possibly be overlooked.

That amongst the waters examined were two samples from the Broad Street pump to which Dr. Snow has drawn so much attention, and that in neither of these was any peculiar body or production met with calculated to excite suspicion. The only animalcules seen were two or three of small size, resembling a species of *amphileptus*, rather many monads, and several of the brown bodies termed ova cases; the animalcules were, however, present in sufficient quantities to show that the water was not in a pure condition.

These results of the examination of merely a few samples of well water are sufficient to show that much which is very wrong exists in the condition of this description of water as procured from ordinary wells, so common indeed is it to meet with impure well water, that it would have been an easy matter to have multiplied the number of specimens to almost any extent. Enough, however, has been done to show that it would be a very proper step to subject all the shallow well waters in use to some general examination, so that those that are contaminated might either be condemned, or the sources of contamination removed. The great source of contamination of well water, as already mentioned, are the cesspools; these done away with, and the wells themselves properly covered over, the waters of many of our shallow wells would be of a high degree of purity, and would to a considerable extent be free from organic matter, provided the soil surrounding these wells was not itself contaminated.

(3.) RESULTS of the MICROSCOPICAL EXAMINATION of WELL,
PUMP, and other WATERS from SANDGATE.

The following samples from Sandgate and its vicinity were procured, under the direction of Dr. Milroy, during the prevalence of cholera in that locality.

CHERITON WATER WORKS.

Mr. Bateman's, 1, Beach Cottage.—Collected 6th October 1854, by
Dr. Bond.

The sediment deposited from this water was very large, and of a fawn colour; it contained but few infusoria, and scarcely any that were large; one large annelid only was seen, and a few vibriones, one piece of decaying vegetable tissue, and a good number of the yellow branched threads of the production resembling anthophysa.

Residence of Mr. George.—Collected 6th October 1854, by
Dr. Bond.

In the House from which this Water was obtained Five Deaths from Cholera occurred.

This water was dull and opalescent, and deposited scarcely any sediment; there were seen in it a very few infusoria only, but rather a large number of vibriones, and masses of the same motionless; there were no diatomaceæ, but it contained a few small fragments of decaying vegetable tissue. The worst characters of this water were its opacity and the number of vibriones present in it.

FOLKSTONE COMPANY.

Residence of Mr. Penreth.—Collected 6th October 1854, by
Dr. Bond.

One Death occurred in this House.

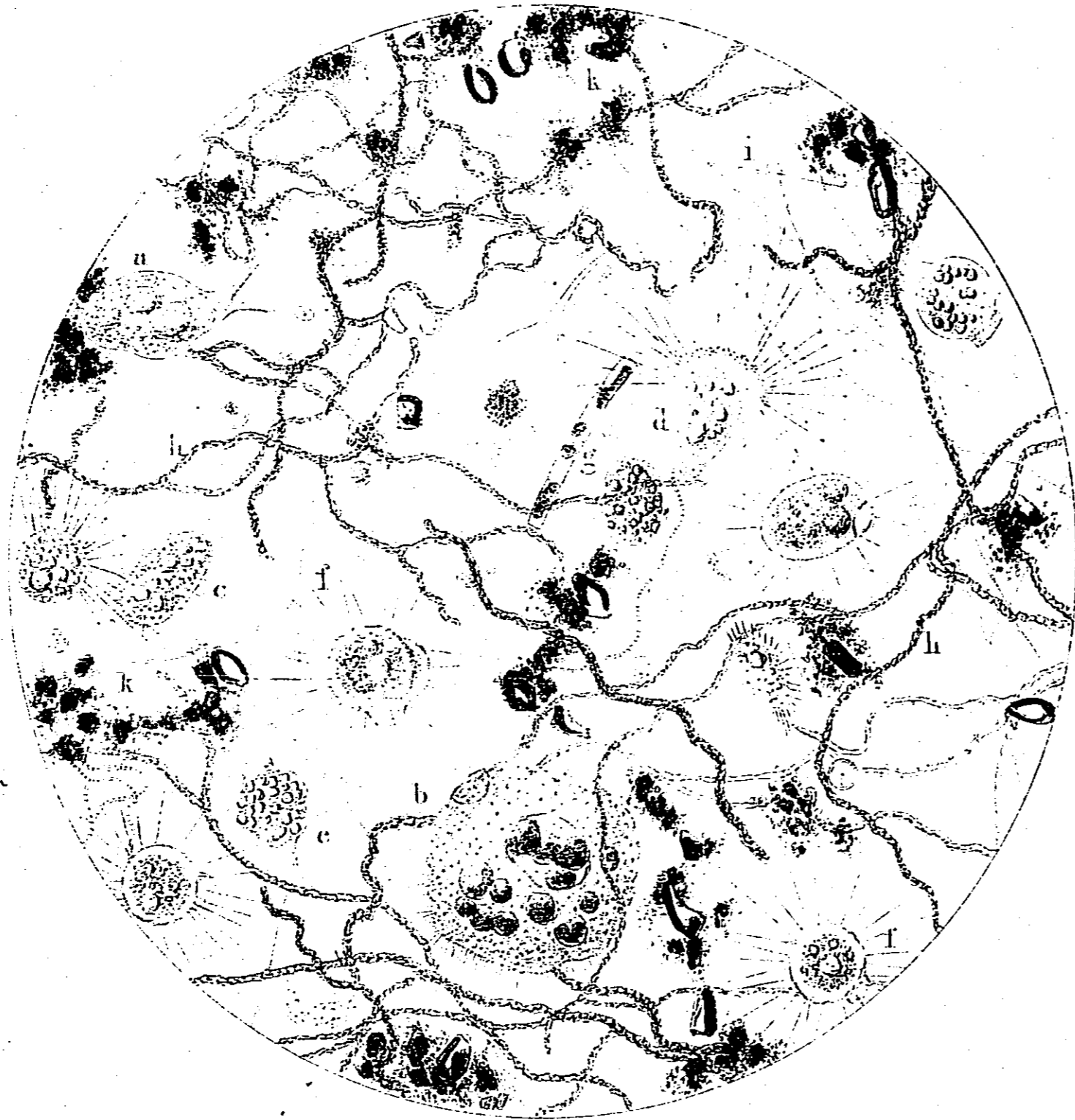
This water, on standing, deposited a rather copious sediment, which contained a great number of organic productions, living and dead; amongst the former were detected numerous infusoria, including an annelid, one or two stentors, several rotifers, one coleps, and many animalculæ of the genus amphileptus. Amongst the vegetable productions were seen various diatomaceæ belonging to different genera and species; there were observed frustules of diatoma vulgare, cocconema, gomphonema, synedra, as well as several frustules of coscinodiscus minor, and some of cymbella cuspidata; two species of scenedesmus were the only desmideæ noticed; there was also rather much slender fungus, together with a few vibriones, single and in masses, spiral vessels, and other fragments of decaying vegetable tissue, and portions of the broken shells of Cyclops.

Reservoir at Shorncliff.—Collected 21st September 1854.

The sediment from this water was rather considerable, consisting chiefly of organic matter, together with some grit. It swarmed with paramecia, and contained a few large oxytrichæ, and much of the slender fungus.

FROM WATER OF WELL AT SANDGATE
(on Mr. George's premises)

Pl.



- | | | |
|-------------------------|------------------------------|----------------------------------|
| a. Rotifer. | d. <i>Acineta tuberosa</i> . | g. Filament of <i>Conserva</i> . |
| b. <i>Bursaria</i> ? | e. <i>Vorticella</i> . | h. Stems of <i>Anthophysa</i> . |
| c. <i>Paramoecium</i> . | f. <i>Actinophrys</i> Sol. | i. Slender fungus. |
| | k. Earth & organic matter. | |

Reservoir at the Castle Hill, Sandgate.—Collected 21st September 1854.

The deposit from this water was large in quantity, and of a brownish colour; in it there were found only a few infusoria, and those for the most part of very small size, and one large oxytricha; there was also a large quantity of the ordinary slender fungus, and much gritty and earthy matter.

Main, Belle Vue, Sandgate.—Collected October 1854.

The sediment deposited from this water was very considerable indeed, and of a brownish yellow colour, due apparently to the presence of iron. It contained some infusoria of small size, but not in large number, including a few of the genus oxytricha and paramoecium, with a few spiral vibriones. There were no diatomaceæ or fragments of dead vegetable tissue present, but it contained a good deal of granular and dotted organic debris.

Tap at Belle Vue House.—Collected 6th October 1854, by Dr. Bond.

Four Deaths occurred in this House.

The water in this case threw down a large yellowish brown deposit, having much the same character as that from the water obtained from 1, Beach Cottage. In this there were only a very few small infusoria, including one or two actinophydes, a few threads of the slender fungus so frequently present in water, as well as some of the yellow branched fungus looking stems, resembling anthophysa; no diatomaciæ were seen.

Water from Tap, New Inn.—Collected 20th September 1854.

The sediment deposited from this water was not very large; there were discovered in it several paramoecia, one large oxytricha, and a good deal of the slender fungus so frequently referred to.

WELL WATER.

Residence of Mr. George.—Collected October 1854.

The residue from this water was considerable, of a brown colour, and it contained a good deal of organic debris, and many living infusoria, especially of the genera amphileptus and amœba, together with a few green sporules resembling those of a fungus, and vibriones; there was also a small quantity of the thallus of the ordinary slender fungus.

Mr. George's Residence.—Collected October 1854.

This water let fall much organic residue, in which were discovered a rotifer, a large number of actinophrydes, a few paramoecia, and other infusoria, as acineta tuberosa, vorticellæ, bursariæ, some of the pale granular spherical bodies which sometimes occur in Thames water, together with much slender fungus in threads, and a large quantity of the yellow branched stems resembling anthophysa.

Fig. 15.

Residence of Mr. Marsh.—Collected 6th October 1854, by Dr. Bond.

In this House One Person died and Four others were choleraically ill.

This water deposited a very minute quantity of sediment only; when examined with the microscope there were seen several infusoria, principally oxytrichæ, a great number of filaments of the ordinary slender fungus, as also a second species of fungus belonging to the genus dactylium, together with a few fragments of decaying vegetable tissue.

House opposite Red's Cottage.—Collected October 1854, by Dr. Bond.

There were Five Deaths in this House.

The residue of this water was rather considerable in amount, and of a brownish colour; it contained the usual annelid *anguillula fluviatilis*, two different species of paramecium, several oxytrichæ, a good many actinophrydes and vorticellæ, with numerous animalculæ belonging to the genera amphileptus, lagenella, and amœba, also many monads. There was likewise much of the slender fungus, as well as two other species of fungus, together with a good deal of the yellow branched stems resembling *anthophysa*, and granular organic matter. Fig. 16.

Pump at New Inn.—Collected 20th September 1854.

This water deposited scarcely any sediment; there were seen a few infusoria of the genus oxytricha, and a few monads, with several threads of a species of conferva resembling those of a monormia.

Stream of Mr. Bligh.—Collected 21st September 1854.

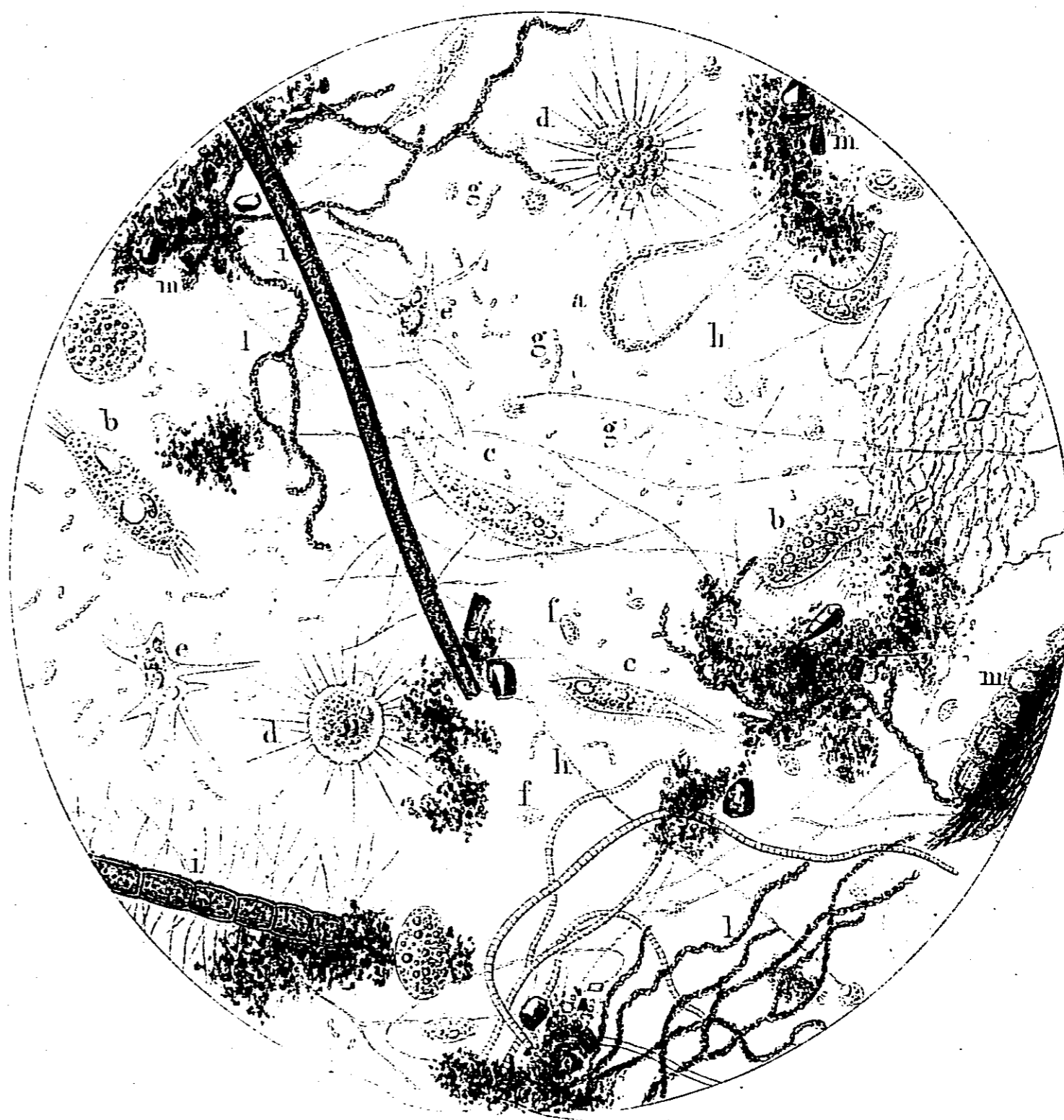
A very large residue, consisting principally of organic matter, and containing fragments of vegetable tissue, was deposited from this specimen. The number of infusoria was comparatively not large, but several oxytrichæ, belonging to two different species, were observed, as well as other small infusoria. There were no diatomaceæ present.

From the above Microscopical Examinations it appears,—
1st. That the whole fourteen samples of water examined were contaminated with organic matter, dead and living, the quantity in the majority of the samples being very considerable. The only water in a state approaching even to purity, was that from the pump at New Inn.

2d. That in none of the waters were any peculiar organic productions detected, which could be supposed to exert any direct influence in occasioning cholera.

FROM WATER OF WELL AT SANDGATE.

(from House opposite Red's Cottages)



- | | | |
|----------------------------------|-------------------------------|--|
| a. <i>Anguilla fluviatilis</i> . | e. <i>Amœba diffracta</i> . | i. Threads of Brown Fungus. |
| b. <i>Oxytricha</i> . | f. Monads. | k. Filaments of another Fungus. |
| c. <i>Amphileptus</i> . | g. Filiformes. | l. Stems resembling <i>anthophysa</i> . |
| d. <i>Actinophrys Sol.</i> | h. Threads of slender Fungus. | m. Dead and decaying organic matter, grit, and fragments of Vegetable Tissues. |

(4.) REPORT showing the RESULTS of the MICROSCOPICAL EXAMINATION of different samples of WATER obtained from the SERVICE PIPES of several of THE METROPOLITAN WATER COMPANIES.

Inasmuch as the condition of water taken from cisterns is, to some extent, dependent upon the cisterns themselves, whether they are covered or not, and whether they are regularly cleaned out, so as not to allow of accumulation, it might be considered that it was not proper to judge of the quality of the water supplied by any Company by its state as taken from cisterns. This objection, no doubt, holds good to a certain extent, but not so much as might be supposed. In order, however, to meet this objection, and to ascertain the actual condition of the waters of the several Companies, specimens were obtained from the service pipes, that is, the several waters were procured precisely as supplied for use. The results of the Microscopical Examination of these waters were as follows:—

GRAND JUNCTION COMPANY.

3, *South Row, Golden Square*.—Collected 15th December 1854, by Mr. H. Miller.

After standing the usual time this water threw down rather much sediment; there were present in it a good many monads and other infusoria, several euglenæ and oxytrichæ, together with large green moving sporules. The diatomaceæ abounded, and included several genera and species, amongst which the following were conspicuous—frustules of *cymatopleura solea*, *synedra ulna*, and a few of two other species of *synedra*, many frustules of *diatoma vulgare*, *navicula amphiscœna*, and other *navicula*, a good number of frustules of *pleurosigma hippocampus*, and very many of *coscinodiscus eccentricus*, with a few filaments of *meloseira varians* and *fragillaria capucina*. Amongst the dead organic matter were some of the brown ova cases, many spiculæ of the fresh water sponge, much organic debris, a fragment of firwood, and a good deal of decaying vegetable tissue.

13, *Marshall Street*.—Collected 15th December 1854, by Mr. H. Miller.

The sediment from this sample was about equal in quantity to that from the previous water, and consisted principally of dead and living organic matter; it also resembled, in the organic productions of which it was constituted, the water from *South Row*. Amongst the infusoria, however, there were noticed, in addition to those mentioned in the previous sample, an acarus-like entomotruncan with a red eye, and one or two large paramecia, *P. aurelia*. The diatomaceæ were equally numerous, and belonged to the same genera and species; frustules of *coscinodiscus eccentricus* were likewise observed, as well as a few of *cyclotella operculata*; there was a good deal of dead organic matter, many fragments of decaying vegetable tissue, and spiculæ of the fresh water sponge, intermixed with and growing amongst which was a considerable quantity of the usual slender fungus.

LAMBETH COMPANY.

26, Waterloo Road.—Collected 16th December 1854, by Mr. Mears.

The quantity of sediment from this water was but small, and consisted chiefly of organic matter. In it there were found one eel-like annelid and a few small infusoria, principally of the genus monas; there were a good many diatomaceæ, including several frustules of synedra ulna, two or three of a second species of synedra, a few frustules of gomphonema, and threads of meloseira varians, together with five or six green rolling sporules, and a little of the slender fungus. Amongst the dead organic matter were a great number of the brown ova cases, several fragments of decaying vegetable tissue, and two broken shells of Cyclops.

126, Waterloo Road.—Collected 16th December 1854, by Mr. Mears.

The sediment in this instance was less than in the previous sample, but its constituents were nearly similar. Amongst the infusoria were two annelidæ, a few small euglenæ, and many monads, there were several frustules of synedra ulna and other diatomaceæ, a large number of the brown ova cases, some of the slender fungus, and many fragments of decaying vegetable tissue.

WEST MIDDLESEX COMPANY.

77, Upper Berkeley Street.—Collected 28th September 1854, by Dr. Greenhow.

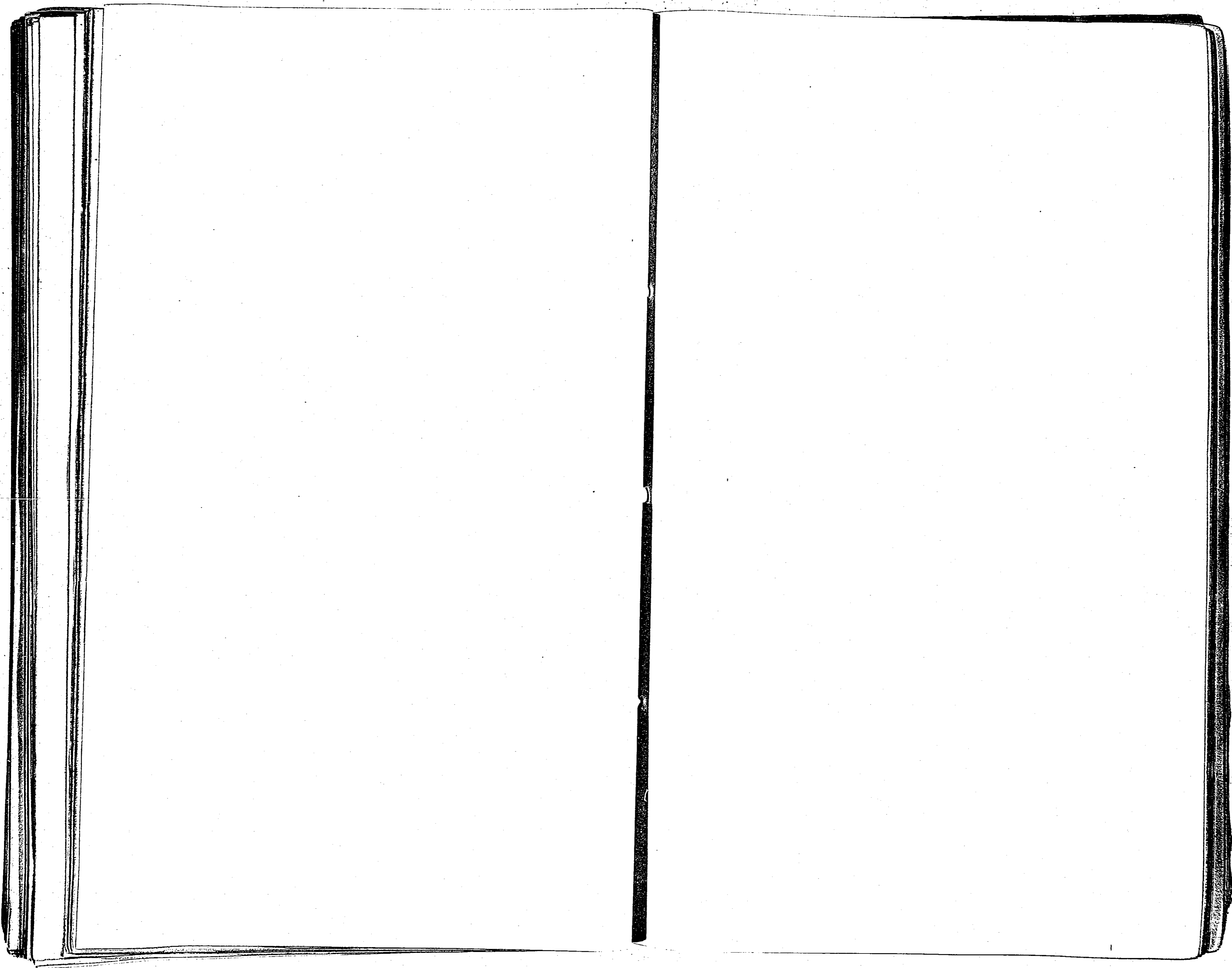
Eight or nine small infusoria were seen in this water after subsidence, as well as nine or ten entomostraceæ, Cyclops quadricornis in a peculiar condition of growth. The sediment was rather considerable, and in it the following organic and other productions were seen:—three small worms, anguillula fluviatilis, five or six loricated infusoria, a species of euchlanidota, several actinophydes, oxytricha pellionella, vorticellæ, many small paramecia, a few animalcules of the genus coleps and lagenella, five or six of the genus amphileptus, and three or four polyarthræ. Amongst the desmideæ were four or five fronds of scenedesmus quadricauda and sc. acutus, and pediatrum boryanum; amongst the diatomaceæ were many frustules of cyclotella operculata, several of Nitzschia sigma, three or four groups of frustules of synedra minutissima, frustules of meloseira varians, amphora ovalis, and of two or three different naviculæ. Amongst the dead organic matter were a great many fragments of shells of entomostraceæ, many of the exuvial masses, and other debris, intermixed with which were the green branched threads of some conferva, and the usual fungus with slender threads. In addition to the brown bottle-shaped sporules, lagenella, were other brown sporules, round and oval. Fig. 17.

FROM WATER OF WEST MIDDLESEX COMPANY.

(from Service pipe.)



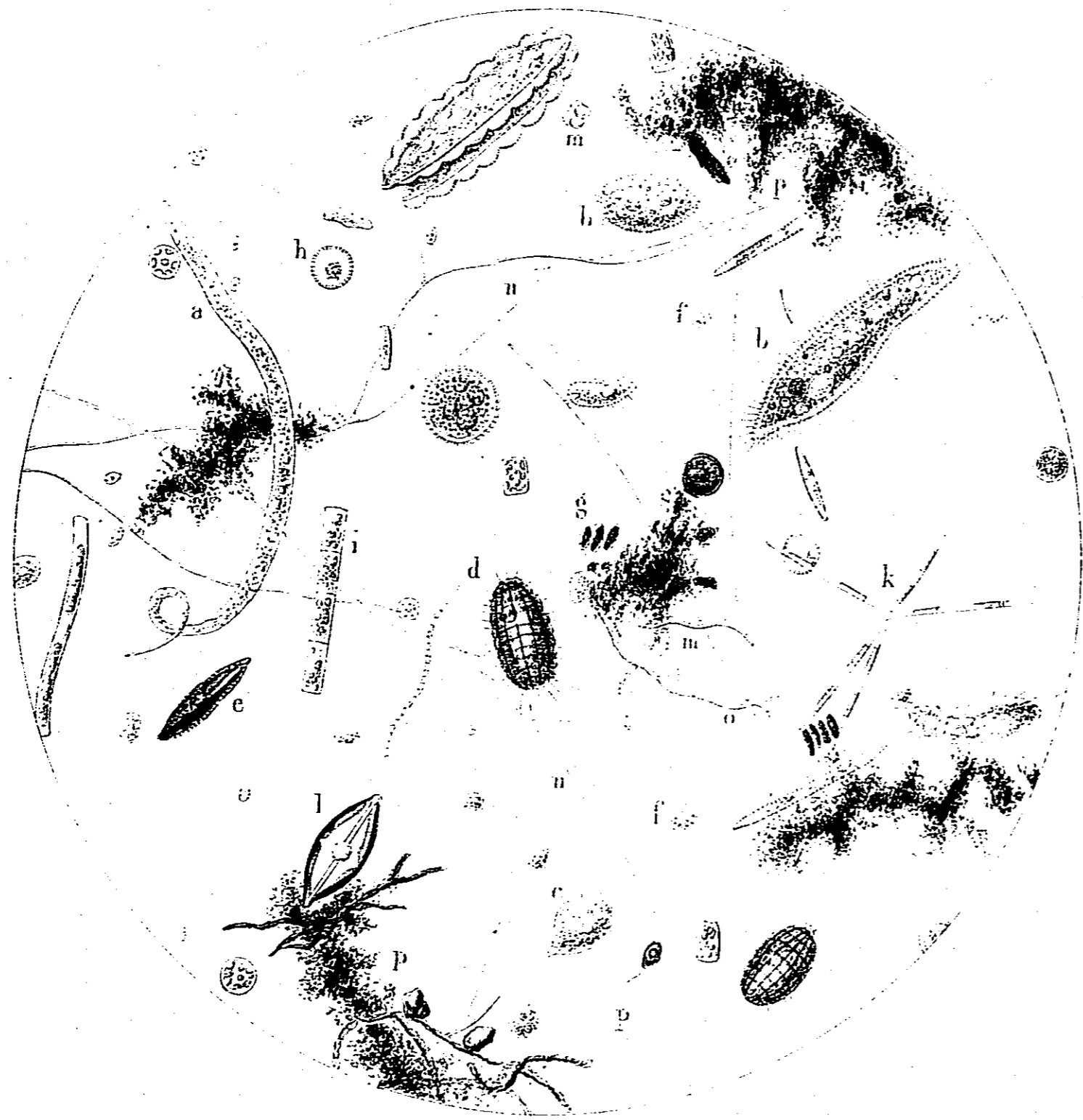
- | | | |
|----------------------------------|-----------------------------------|-------------------------------|
| a. <i>Cyclops quadricornis</i> | g. <i>Actinophrys</i> Sol | n. <i>Pleurosigma</i> ? |
| b. <i>Anguillula fluviatilis</i> | h. <i>Pediatrum boryanum</i> | o. <i>Synedra minutissima</i> |
| c. <i>Euchlanidota</i> | i. <i>Scenedesmus quadricauda</i> | p. <i>Meloseira varians</i> |
| d. <i>Paramecia</i> | k. ——— <i>acutus</i> | q. <i>Spicula of Sponge</i> |
| e. <i>Oxytricha</i> | l. <i>Amphora ovalis</i> | r. <i>Slender Fungus</i> |
| f. <i>Coleps lortus</i> | m. <i>Cyclotella operculata</i> | s. <i>Dead Organic matter</i> |



FROM WATER OF CHELSEA COMPANY

(from Service pipe.)

PL. 13.



- a. *Anguillula fluviatilis.*
- b. *Paramecia* 2 species.
- c. *Vorticella.*
- d. *Coleps hirtus.*
- e. *Euglena.*

- f. *Monads*
- g. *Scenedesmus quadricauda.*
- h. *Cyclotella operculata.*
- i. *Miosira varians.*
- k. *Synedra minutissima.*

- l. *Navicula amphibœna.*
- m. Green motionless *Sporulae.*
- n. Slender fungus.
- o. *Penicillium glaucum.*
- p. *Dead organic matter &c.*

77, Upper Berkley Street.—Collected 12th December, 1854, by Dr. Headlam Greenhow.

This water was not perfectly bright and clear, but possessed a slight degree of opalescence. After subsidence there were found, in the fluid part, a great many monads and other small infusoria. The sediment deposited from it was considerable, and consisted mainly of organic matter, dead and living. Amongst the animalculæ were numerous vorticellæ, *V. convallaria*, sometimes in groups, a few euglenæ, *panophrys chrysalis*, *paramecia*, *oxytrichæ*, myriads of monads, and a great many vibriones and masses of same. Amongst the diatomaceæ were a very few frustules of *Nitzschia sigma*, and some of *synedra minutissima*, *cyclotella operculata*, and *cocconeis placentula*; while amongst the dead organic matter were numerous fragments of decaying vegetable tissue, hairs of animals, scales of a moth, and a great many spiculæ of the fresh water sponge; growing from and intermixed with the dead organic matter were three different species of fungus; in addition to which there were many thousands of the brown ova cases, single and in masses.

CHELSEA COMPANY.

27, Lawrence Street.—Collected 13th September, 1854, by Dr. Greenhow and Dr. Hassall.

Three or four minute infusoria only were seen in this water after subsidence, and the sediment which fell from it was extremely small; but in it the following organic and other productions were detected: three small river annelidæ, *anguillula fluviatilis*, two vorticellæ, two *oxytrichæ*, several *paramecia*, three or four of a green colour, a good number of *coleps hirtus*, and a few euglenæ. The principal desmideæ belonged to the genus *scenedesmus*, of which eight or nine fronds were seen. The diatomaceæ were plentiful, and consisted of frustules of *cyclotella operculata*, several, *synedra minutissima*, *navicula amphibœna*, and *meloseira varians*; in addition to these, were green sporules, fixed and moving, the two ordinary species of fungus, a tuft of *penicillium glaucum*, and a little yellow debris. Fig. 18.

27, Turner Street.—Collected 13th September, 1854, by Dr. Greenhow.

But one rather large green animalcula seen in this water after subsidence. There was only a small quantity of deposit, which consisted principally of the yellow fungus, but amongst which were also noticed a great many infusoria of the genus *coleps*, several *actinophydes*, *oxytrichæ*, and *paramecia*, as well as rather many frustules of *cyclotella*, and a few fronds of *pidiastrum*.

SOUTHWARK AND VAUXHALL COMPANY.

From *St. Thomas's Hospital*.—Collected October 1854, by
Mr. Walker.

This water, after having stood for several hours, was still dull and opalescent, while the sediment deposited was very considerable, and in it the following organic productions were specially noticed:—several acari-like animalculæ of the class tardigrada, commonly called water-bears, seven or eight stentors, stentor mulleri, numerous rotifers, many large paramecia, bursaria, vorticellæ, oxytricha pellionella, amphileptus, and several animalcules of the genus coleps. Amongst the desmidiæ were a great many of the lunar scenedesmus, and a few pediatra; and amongst the diatomaceæ, which were very abundant, were very many frustules of the usual cyclotella and Nitzschia sigma, occasional threads of meloseira varians, and several frustules of synedra minutissima, navicula amphibœna, cymatopleura solea, and of Nitzschia dubia. Amongst the dead organic matter were a great many of the pellet-like exuvial masses of the entomostraceæ, and a few fragments of muscular fibre derived doubtless from the fœces, and fragments of dead vegetable tissue; intermixed with these and other matters was a large quantity of the slender fungus, and some of the yellow kind also. Fig. 19.

12, *Neptune Street, Spring Place, Wandsworth Road*. From Main.—
29th September 1854. Sent to General Board of Health by
Dr. Ayres.

This water smelt very offensively of sulphuretted hydrogen, and on standing at rest for some time, sufficient sediment collected at the bottom of the bottle nearly to fill two teaspoons; this was of a blackish colour, and abounded in many different kinds of organic productions. It contained all the usual elements of River Thames and Southwark and Vauxhall Company's water, worms, shells of entomostraceæ, dozens of spiculæ of sponge, eggs of zoophytes, &c. &c.; indeed, a volume might be filled with a description of the organic productions present in this water.

Main in *Crescent Road, Park Road*.—Collected 18th September 1854,
by Mr. James Frost.

The water in this case was nearly black, and threw down a large quantity of black sediment, the colour was due partly to the presence of iron, derived no doubt from the mains. It abounded in organic productions, most of them being dead when the water was examined. Many dead entomostraceæ and rotifera were discovered, a great number of diatomaceæ, especially the usual species; also vibriones, and numerous spiculæ of the fresh water sponge.

Main in *Crescent Road, Park Road*.—Collected September 1854,
by Mr. Samuel Frost.

This water was very dirty and opalescent, from the presence of a very large quantity of organic matter in solution, the smell was also



Fig. 19. 220 diam.

- | | | |
|---------------------------------|---------------------------------|--------------------------------|
| a. <i>Brachionus</i> | h. <i>Coleps hirtus</i> | p. <i>Nitzschia Signoretia</i> |
| b. <i>Stentor Mulleri</i> | i. <i>Peliosira Bergmanni</i> | r. Fragments of muscular fibre |
| c. <i>Bursaria</i> | k. <i>Scenedesmus acutus</i> | s. Starch capsules of Wheat |
| d. <i>Panamicium auctum</i> | l. <i>Meloseira varians</i> | t. Ditto coloured by iodine |
| e. <i>sp.</i> | m. <i>Cyclotella operculata</i> | u. Husk of Wheat |
| f. <i>Oxytricha</i> | n. <i>Navicula amphibœna</i> | w. Hairs of Wheat |
| g. <i>Vorticella consularia</i> | o. <i>Cymatopleura Solea</i> | x. Earthy & Organic Matter |

exceedingly offensive. The residue, which was very considerable in amount, consisted chiefly of organic matter, dead and living, and in it there were found a great number of infusoria, including dozens of rotifers, and many other rotifera, of the genus anuraea, as well as several of the large twisted paramecia; amongst the diatomaceæ were noticed especially *Nitzschia sigma* and *cyclotella operculata*; amongst the desmideæ there were a few *pediastrea*; a good many spiculæ of the fresh water sponge were likewise present.

Main in Crescent Road, Park Road.—Collected September 1854, by Dr. Hassall and Mr. Frost.

This specimen was obtained from the same locality as the two previous waters. After standing at rest for some time, the water still remained thick and opaque, and threw down a very copious sediment. In the fluid part there were discovered a great many euglenæ, frustules of *cyclotella operculata*, and a large number of sporules and beaded threads of a species of fungus. The sediment swarmed with infusoria of all kinds, including entomostracæ, a large number of the eel-like annelidæ, as well as one other annelid, resembling the blood-worm, also animalculæ of the following genera, *brachionus*, *oxytricha*, *stentor*, *actinophrys*, *euglena*, and *vorticella*, the latter being very abundant. It contained also a very large quantity of the usual slender fungus in masses, visible to the naked eye, the yellow fungus, together with many of the exuvial masses derived from the entomostracæ, numerous spicula of the fresh water sponge, and dead and decaying vegetable tissue.

NEW RIVER COMPANY.

3, Broad Street, Golden Square.—Collected 14th December 1854, by Mr. H. Miller.

There were present, in the fluid part of this water after subsidence, a few monads and other minute infusoria. In the sediment, which was small, there were monads and other minute actively moving animalculæ, as well as infusoria of other kinds, but their number altogether was not large; two rotifers, two or three actinophrydes, a few euglenæ, as well as green moving sporules, some large flat pale brown stationary sporules, as also some of another brown sporular body were seen; these latter were of a somewhat lenticular form, being convex on one side, and concave on the opposite side, with a large circular aperture. The diatomaceæ were very abundant, there being hundreds of frustules of *synedra*, of two or three different species, several frustules of *navicula binodis*, two of *gomphonema*, two or three of *cymbella*, one of a species of *coconema*, many of *pleurosigma hippocampus*, and several threads of *fragillaria capucina*; there were also a few short filaments of *oscillatoria*, and two or three fragments of decaying vegetable tissue.

9, *Hopkins Street, Golden Square*.—Collected 14th December 1854,
by Mr. H. Miller.

In this specimen the sediment was rather small, and like the previous sample, the number of infusoria was not great in proportion; they consisted of one river annelid, one actinophrys, and an oxytricha. It contained, however, a large number of vegetable productions, especially diatomaceæ, of which the chief were the different species of synedra noticed in the sample of New River water from Broad Street, including many frustules of synedra ulna; in addition to the various species of synedra, there were a great many frustules of pleurosigma hippocampus, and of a second species of pleurosigma, with nonstriated frustules, one nitzchia sigmoidea, a few frustules of the genera navicula, cocconema, and gomphonema, and several threads of fragillaria capucina. The only desmideæ seen were two or three fronds of scenedesmus quadricauda, but there were a few threads of two or three species of conferva, belonging to the genera zygnuma and vesiculifera, some green moving sporules were likewise observed, as well as a great many of the brown ova cases, and a few small fragments of decaying vegetable tissue.

EAST LONDON COMPANY.

4, *Dock Street*.—Collected 14th December 1854, by Mr. Wildbore.

The quantity of sediment deposited from this water was rather considerable, and consisted principally of organic matter intermixed with numerous gritty particles; the number of living organic productions contained in it was large, and included several species and genera of infusoria, and the same of desmideæ and diatomaceæ. The infusoria embraced the ordinary genera, as monas, coleps, paramecium, oxytricha, and polyarthra, together with one or two annelidæ. Amongst the desmideæ noticed were fronds of desmidium hexaceros, and amongst the diatomaceæ frustules and threads of meloseira varians and fragillaria capucina, frustules of pleurosigma, cocconema, and different species of synedra. In addition to these productions there were the usual species of fungi, that with slender threads and the yellow branched stalks (the quantity of this last being considerable), pieces of vegetable tissue, and fragments of granular organic debris.

1, *Back Church Lane, Whitechapel*.—Collected 13th December 1854,
by Mr. Wildbore.

The sediment deposited from this sample was rather considerable, and about equal to that from the previous water. The same productions were likewise met with, but in addition a few others were observed, including two or three rotiferæ, frustules of diatoma vulgare, synedra ulna, and cymbella cuspidata, together with threads of meloseira varians and fragillaria capucina, and a few of the brown festooned sporules. The quantity of dead and decaying organic matter which was infested with the slender fungus was considerable.



- | | | |
|---|-----------------------------------|----------------------------------|
| a. Shell of <i>Bosmina longirostris</i> | g. <i>Coleps hirtus</i> | n. <i>Closterium acerosum</i> |
| b. <i>Brachionus</i> ? | h. <i>Euglena</i> | o. <i>Asterionella formosa</i> |
| c. <i>Triphthalmus dorsalis</i> | i. <i>Lagenella</i> | p. <i>Pleurosigma acuminatum</i> |
| d. <i>Paramecia 2 species</i> | k. <i>Osillatoria</i> | r. Colourless sporules of Fungus |
| e. <i>Oxytricha</i> | l. <i>Pediastrum Nipolcanis</i> | s. Colourless sporules of Fungus |
| f. <i>Vorticella convallaria</i> | m. <i>Scenedesmus quadricauda</i> | t. Slender fungus |

HAMPSTEAD COMPANY.

47, Arlington Street, Hampstead Road.—Collected 16th September 1854, by Mr. Botteler.

This water was somewhat disagreeable to the taste and smell, and was rather turbid; the sediment deposited was considerable, and contained numerous living organic productions, amongst which were noticed several dozen animalculæ of a species of brachionus, seven or eight vorticellæ, several of the genus amphileptus, two or three oxytrichæ, several of the genera coleps and lagenella, some of the ordinary euglenæ, rather many small paramecia, four or five of a species of euglena resembling *E. longicauda*, and the same number of pandorina morum. Amongst the desmideæ were rather many pediastra and scenedesmus, and two closteria. Amongst the diatomaceæ were several asterionellas, and one or two pleurosigmas; lastly, there were rather many of the brown peculiar bodies which occurred so abundantly in the water procured from the Golden Square district, round and green sporules, rather large, and groups of bottle green sporules. The sediment which subsided not only contained the productions above enumerated, as well as many others, but was composed in great part of earthy matter, and organic debris, including many fragments of the shells of entomostraceæ, and the exuvie of the same.

47, Arlington Street, Hampstead Road.—Collected 20th September 1854, by Mr. Botteler.

A second specimen of this water presented characters nearly identical with the above. The water itself, after complete subsidence, was rather opalescent, and there were seen in it, with the microscope, a few brown and green sporules, a few desmideæ of the genus scenedesmus, and one asterionella. The residue which subsided was considerable, and of a fawn colour, and under the microscope it presented a granular texture; the number of infusoria seen was not great, but a shell *Bosmina longirostris*, a brachionus, one eel-like worm, a species of the genus euglena, twisted like the letter S, and a few lagenellæ, *L. euchlora*; the number of pediastra seen was very great, and included the following species, *P. elegans*, *P. hexactis*, *P. pertusum*, and *P. heptactis*; *closterium acerosum*, *scenedesmus quadricauda*, and *S. lunaris* were also observed, and there were a few asterionellas, frustules of *pleurosigma acuminatum*, as well as some brown and green sporules. Fig. 20.

KENT COMPANY.

From Filter.—Collected 30th September 1854, by Dr. Hassall accompanied by Engineer of Works.

Rather many monads were present in this water after complete subsidence. There was scarcely a trace of visible sediment, but

nevertheless there was sufficient to furnish the following results. There were noticed two river annelids, several of a loricated animalcula allied to rotifer, oxytrichæ, of three different species, several, a few animalcula of the genera paramecium, coleps, and euglena; one brown motionless sporule, a pleurosigma, and a navicula, a dotted duct, and some of the slender fungus.

From *Service Pipe*.—Collected 30th September 1854, by Dr. Hassall accompanied by Engineer of Works.

Four or five minute infusoria only were seen in this water after subsidence. There was scarcely a particle of sediment visible to the naked eye, but yet there were discovered, with the microscope, more than a dozen of the loricated rotifer-like animalcula, nine or ten very small eel-like annelids, *anguillula fluviatilis*, three animalcules of the genus *polyarthra*, two *euglenæ*, several monads, two or three frustules of diatomaceæ, including *meloseira varians*, and a little of the slender fungus. Fig. 21.

The following *conclusions* may be deduced from the preceding examinations of specimens of Water procured from the SERVICE PIPES of the different Metropolitan Water Companies:—

1st. That the samples of water procured from the service pipes of the *Southwark and Vauxhall Company* abounded, like those from the cisterns supplied by the same Company, in organic matter, living and dead, animal and vegetable, including entomostracæ, annelidæ, infusoria, desmideæ, diatomaceæ, fungi, fragments of decaying and dead vegetable tissue, as the hairs and husk of wheat and other vegetable substances, starchy matter, and in some cases even fragments of altered muscular fibre, derived from the faecal matter poured into the river from the sewers.

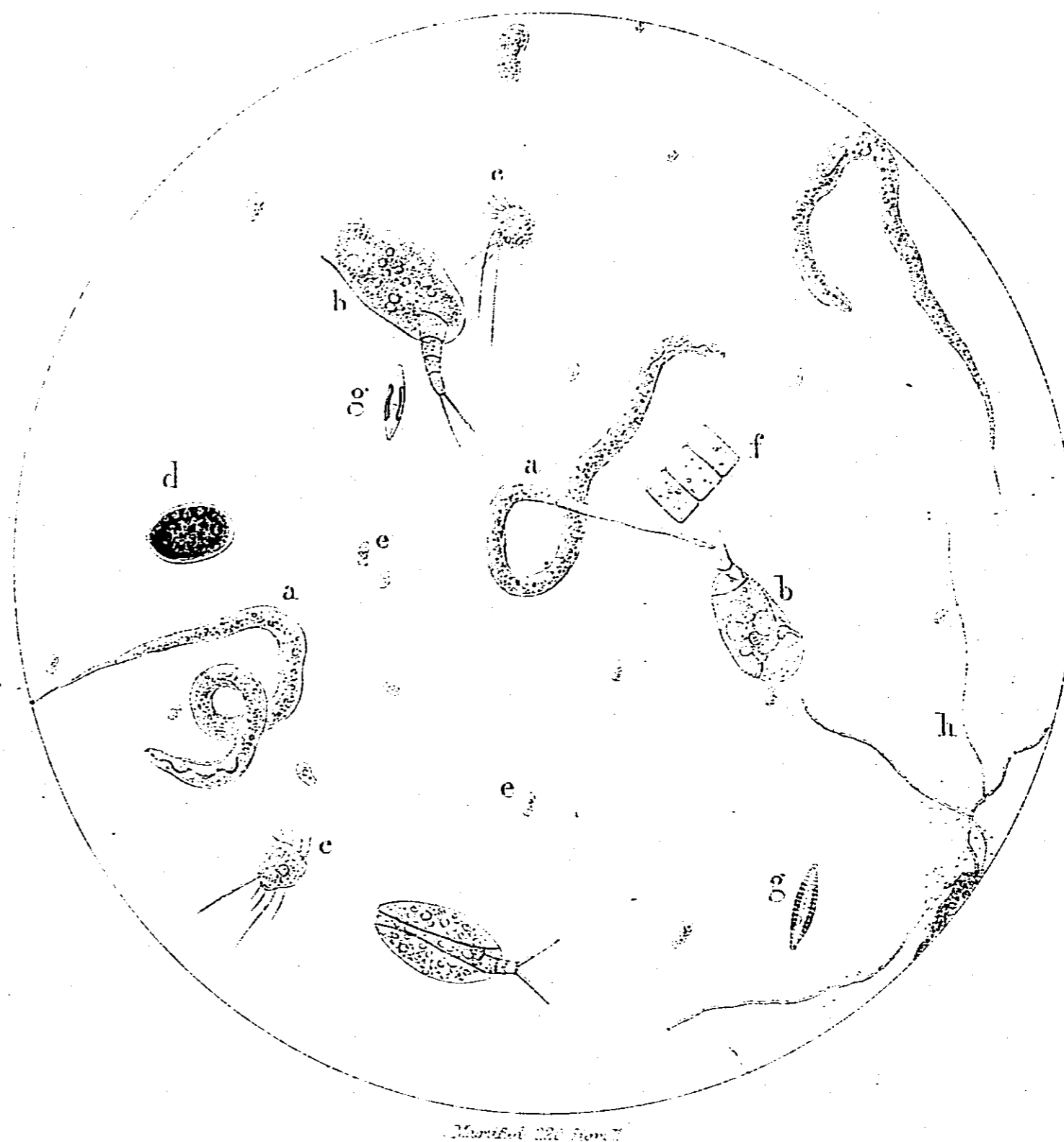
2d. That many of the same species of productions were detected in the water of the *Chelsea Company* as were present in that of the *Southwark and Vauxhall Company*, although in greatly diminished numbers. This difference is attributable, as already pointed out, to the circumstance that a tolerably efficient method of filtration of this water is adopted previous to its distribution.

It has been declared that the water supplied by the *Southwark and Vauxhall Company* is filtered previous to distribution. From the results derived from its examination we can scarcely believe that it undergoes any process of filtration whatever before delivery. If it be filtered, it is very certain that the method adopted is all but useless, for between it and the water of the Thames, as taken from the river at the spot at which the *Southwark and Vauxhall Company* obtains its supplies, there is only that amount of difference which would arise from mere subsidence.

The organic productions contained in the water of the *Southwark and Vauxhall Company* as supplied correspond exactly with those of Thames water itself, and their number is nearly as great; indeed, so abundant and peculiar are the productions contained in Thames water, near the bridges, that by the microscope alone this water and

FROM WATER OF KENT COMPANY
(from Service pipe.)

Pl. 21.



a *Anguillula fluviatilis*.
b *Rotifera*.

c *Polyarthra*.
d *Euglena*.
g *Navicularia*.

e *Monads*.
f *Meloseira varians*.
h *Threads of slender fungus*.

that of the Companies which take their supply from the river Thames near the metropolis may be readily and most certainly distinguished. We have already referred to the fact of the occurrence in Thames water near the bridges, as well as in the waters of those Companies which obtain their supply from the same part of the Thames, of certain species of diatomaceæ, found only in brackish water, a remarkable and important fact which, independent of other considerations, is sufficient to show that this water ought never to have been employed for the supply of the metropolis.

3d. That the quantity of organic matter and number of living organic productions contained in the water of the *West Middlesex Company* was very considerable, so much so, indeed, as to make it exceedingly doubtful whether the water which it supplies is filtered before delivery or not, and, if filtered, it is evident that the process is far from effectual.

4th. That the water of the *Hampstead Company* as supplied, likewise abounded in a great variety of organic productions, several of the species being different from those contained in the River Thames waters. It is, therefore, very doubtful whether this water is filtered. Some of the samples examined have been distinctly coloured, and have even emitted a somewhat offensive smell.

5th. That the waters of the *New River* and *Grand Junction Companies*, the one taking its supply from the New River, the River Lea, &c., the other from the Thames at Brentford, both contain a considerable amount of organic matter, and many forms of animal and vegetable life. The water of the Grand Junction Company was distinguished especially by the large number of asterionellas which it contained, the same diatoma was likewise present in the water of the Hampstead Company, part of the supplies of which are said to be sometimes derived from either the Grand Junction or West Middlesex Company, we believe from the former.

The New River Company, as already stated, does not filter the water which it supplies, and the condition of the water of the Grand Junction Company renders it probable that this also is the case with respect to it.

6th. That the amount of organic matter and the number of organic productions was very much less in the waters supplied by the *Lambeth*, *East London*, and the *Kent Companies*. This is explained by the circumstance that these three Companies now supply filtered water. Living infusoria and other organic productions were, however, present in every sample of the water of the above three Companies subjected to examination, sufficient clearly to establish the fact that these waters were not of that degree of purity which is so desirable. The waters supplied by these three Companies are all river waters, and as such they are exposed to numerous sources of contamination.

(5.) RESULTS of the MICROSCOPICAL EXAMINATION of WATER stored in CISTERNS, BUTTS, and TUBS, with REMARKS on the State of those RECEPTACLES, and their influence on the PURITY of the WATER.

There is great variety in the kind and size of the receptacles used for the storage of water. In the larger houses the water is, of course, received into cisterns, which are either made of lead or slate. To the use of lead for cisterns there are certain objections, into which it is not necessary to enter here. One of the evils attending the use of cisterns is the position in which they are too often placed; sometimes they are situated so awkwardly that they can be reached only with great difficulty, thus offering a considerable obstacle to their being regularly cleaned; in some cases they are placed immediately over the water-closet, so that the water imbibes the emanations which proceed from it. Another evil attending the use of cisterns is that they are often out of condition or repair; very frequently the ball-tap will not act, or is altogether removed, a great waste of water, with inundation of the premises being the consequences; what is of still more importance, the lid of the cistern is often taken away, or sometimes it is not provided with a lid at all, the water is thus exposed to air and light, and the generation and development of animalcula and other organic productions greatly promoted: in other cases the lids are fastened down, so that it is impossible to clean out the cisterns at all, we have seen several instances of this kind, and this where a whole court is supplied by the same tank. Examples without end might be cited of cisterns in all the conditions above described, but the particulars referred to are so well known as to render this unnecessary.

In the houses and cottages of the middling and poorer classes the water is, for the most part, stored in butts, tubs, and pans; these commonly have no lids, and they are unprovided with waste pipes, so that it is not only a matter of difficulty to clean them, but the water is very apt to flow over at the top, and saturate the soil around the house; the position of many of the butts and tubs is also often as objectionable as that of the cisterns. Again, in many cases the size of these receptacles is so small that they do not afford anything like a proper supply of water.

In a great many houses the water is not laid on at all, consequently there is no provision for the storage of water, but the daily supply is procured out of the house, and is kept in any jugs, dishes, or pans which the people may happen to possess, and which are usually placed in the single room which serves as kitchen, sitting-room, and bedroom.

Having thus briefly referred to some of the objections attached to the different kinds of vessels in which the water is stored, we will now proceed to notice the character and quality of the water contained in them.

In the report on water from cholera-houses, we have already given the results of the microscopical examination of a great number of samples obtained from cisterns. The general results of those

examinations went to show that those waters were, for the most part, largely contaminated with organic matter, dead and living. I shall, therefore, now only state the results of a few additional examinations; and before doing this, I shall proceed to notice certain general facts, which have fallen under my own observation, with reference to the condition of water stored in cisterns.

A very great evil connected with cisterns is that the organic matter contained in the water supplied to them does not find a ready egress, but subsiding from day to day, goes on accumulating at the bottom of the cistern; this is owing to the tap not being inserted into the bottom of the cistern, but some little distance up the side; this liability to accumulation shows the extreme necessity that exists for the frequent cleansing of cisterns; there is, in this respect, a most lamentable neglect on the part of occupiers of even superior houses; it is no uncommon thing for these receptacles not to be cleaned out for months, or even years. The consequence of this accumulation is, that the water present in cisterns, from faults of construction and the neglect of cleansing, usually contains a much larger amount of organic matter than that poured into them from time to time.

Another bad effect of the storage of water in cisterns is, that when the lids are off, which is so frequently the case, the organic matter contained in the water is placed under the conditions most favourable to its development, and this development is not confined to animalculæ and other invisible forms of infusorial life, but includes a large number of living animal and vegetable productions, but too plainly visible to the unaided sight, as the fresh water shrimp, entomostraceæ of various genera and species, hydræ and other zoophytes, different species of mollusca, and conchifera, blood worms, and several other annelidæ; while different species of confervæ and diatomaceæ are often seen growing on the sides of the cisterns, and may often be collected in handfuls. We have seen dozens of cisterns half filled with green conferva and other vegetable and animal productions. Some of the confervæ and diatomaceæ being attached by roots, and the hydræ and mollusca, which hold on to these, seldom escape with the water from the cistern; this is also the case with the red worm and the other annelidæ, but for a different reason, since most of these are imbedded in the sediment at the bottom of the butt; nevertheless, they do sometimes escape. The entomostraceæ, commonly known by the name of water fleas, moving freely and actively about the whole water, pass out readily through the tap, and may frequently be seen in dozens, especially in the warm weather of summer, in every jug of the water drawn. Now the entomostraceæ are carnivorous, and their appearance in water implies the presence of other creatures, more minute than themselves, upon which they prey. Sometimes large dark spongy looking masses are to be seen in the water of cisterns, floating on the surface; these consist of the polypodom of certain species of fresh water zoophytes, entangled amongst which are usually hydræ, annelidæ, and a great variety of other organic productions. I forwarded the polypodom of two zoophytes met with in a cistern to Professor Allman, of Dublin, and he identified one as paludicella Ehrenbergii, and the other was

almost to a certainty *plumatella fruticosa*. A bottle, containing a large mass of these zoophytes, was brought to me by Mr. Walsh, it was taken from a cistern; while a pickle-jar full of the same was left at the General Board of Health by Dr. Paris; these zoophytes were observed to make their appearance suddenly in the cisterns, and therefore in all probability were not developed in them. On mentioning the sudden appearance of these masses in cisterns to the engineer of the Kent Water Company, he informed me that they were frequently developed to an enormous extent in the iron mains, and this under great pressure, and notwithstanding that light is totally excluded; their sudden presence, therefore, in cisterns is, in most cases, probably owing to the dislodgement of some large mass from the main, and which, becoming broken up, is discharged simultaneously into a number of different cisterns.

Although a great deal of ignorance is too often met with on the subject of water, yet this is not always the case, and many persons are fully alive to the importance of obtaining pure water, are tolerable good judges of its quality, and do their utmost to obtain it in as pure a state as possible by attention to the condition of the cisterns, &c. We have already referred to the practice which prevails extensively in the districts supplied by the Southwark and Vauxhall Company, of tying over the service pipes pieces of muslin, flannel, and even old stockings, for the purpose of intercepting some of the impurities contained in the water; this practice is still more commonly adopted with the tap of the cistern, the quantity of dirt and organic matter obtained in this way in a short time is often perfectly surprising, and clearly shows that the water supplied by this Company cannot possibly be filtered.

The condition of the water, as contained in any cistern or other receiver which is uncovered and exposed to air and light, may be judged of to some extent by its appearance as presented to the eye alone. We have constantly observed that if the water supplied to the cistern itself is comparatively pure, it continued so for some time as contained in the cistern; but if, on the contrary, it was impure, it speedily became still more so after being received into the cistern. In this way the water of the Southwark and Vauxhall Company contained in cisterns could almost invariably be distinguished by the eye alone from that of the Lambeth Company.

So long as cisterns continue to be used, and it is to be hoped that they will not be employed very much longer, it is important that the water should be supplied daily, instead of, as it is in too many cases at present, every second day, or three times a week; for the mere motion and agitation attending its fall into the cistern has a great effect upon its purity, probably owing to some of the dead organic matter becoming broken up and oxydized.

In the preceding brief observations sufficient has been advanced to show that many serious evils are associated with the use of cisterns and other receptacles for the storage of water. These evils can only be effectually obviated by their abandonment, and by the adoption of the constant, in place of the intermittent, method of supply.

RESULTS of the MICROSCOPICAL EXAMINATION of Six additional Samples of CISTERN WATER.

LAMBETH COMPANY.

126, *Waterloo Road*.—Collected 5th September 1854, by Dr. Hassall and Dr. Thomson.

This water was clear and bright, and in it, after subsidence, there were discovered only three or four minute infusoria. A very small quantity of sediment only was deposited, which contained scarcely any infusoria, there were a few spiculæ of fresh water sponge and frustules of a species of *navicula*, of *cyclotella* and of *synedra*; also a few exuvial masses, and part of a dotted duct or vessel.

This sample of water may be regarded as a very favourable one of Lambeth water as now supplied.

WEST MIDDLESEX COMPANY.

77, *Upper Berkeley Street*.—Collected 28th September 1854, by Dr. Headlam Greenhow.

This water was somewhat dull and opaque; it was found to contain, after subsidence, one or two *paramecia*, a good many infusoria, and one *polyarthra*. The residue was rather considerable, and contained numerous infusoria, including one *oxytricha* and many *vorticellæ*, a few *amœbæ*, and a good number of *actinophrydes*, apparently of two species, two or three *animalculæ* of the genus *rotifer*, the stems or *polypedom*s of some fresh water zoophyte, frustules of *cyclotella operculata*, and some of the slender fungus, with much dirt and sandy matter.

CHELSEA COMPANY.

12, *Lawrence Street, Chelsea*.—Collected 17th September 1854, by Dr. Headlam Greenhow.

The residue from this water was rather considerable, and of a yellowish colour; it consisted in good part of the yellow fungus so often before referred to, and it did not contain many infusoria, but the following organic and other productions were noticed in it: fragments of shells of *entomostracæ*, two or three infusoria of the genus *amœba*, and a few monads, *scenedesmus quadricauda*, brown granular corpuscles, a few threads of slender fungus, and several of the pellet-like exuvial masses derived from *entomostracæ*.

This water was taken as a fair specimen of the Chelsea water kept in tanks.

SOUTHWARK AND VAUXHALL COMPANY.

Cistern at St. Thomas's Hospital.—Collected October 1854, by Mr. Walker.

The residue in this instance was derived from the subsidence of five gallons of the water, and was so considerable that it would probably have weighed nearly two drachms. It contained numerous large red worms nearly an inch in length, as well as many dozens of smaller annelidæ, of which two species were made out, and several entomotracheæ, also the exuvia, skins, and shells of the same. It contained likewise hundreds of rotiferæ and vorticellæ. Amongst the vegetable productions, were *scenedesmus quadricauda*, *Sc. lunaris*, and several species of *pediastrea*; the diatomaceæ belonged chiefly to the genera *Nitzschia* and *cyclotella*. Amongst the dead organic matter were fragments of vegetable tissue, and numerous pieces of altered muscular fibre, these last being doubtless derived from the fœcal matter poured into the river.

Cistern at St. Thomas's Hospital.—Collected October 1854, by Mr. Walker.

Another sample of this water presented the same characters and contained the same abundance of the different kinds of organic matters, dead and living, animal and vegetable, as were noticed in the previous sample.

HAMPSTEAD COMPANY.

47, *Arlington Street.*—Collected 10th September, 1854, by Dr. Hassall.

This water, like those obtained from the service pipe of the same cistern from which this sample was procured, possessed a yellowish tinge, and deposited a considerable amount of sediment; this contained a large quantity of organic productions, for the most part of the same genera and species as those present in the specimens from the service pipe; those which were most abundant were two or three different species of *pediastrea* and *scenedesmus*, *asterionella formosa*, a species of *lagenella*, and two or three species of brown moving sporules.

The general results of the Microscopical Examination of the various specimens of *Cistern Water* have already been stated. The principal conclusion is that the whole of these waters in use in the metropolis abound in organic matter, animal and vegetable, dead and living, their condition being even worse than that of the water as procured from the service pipes.

(6.) RESULTS of the MICROSCOPICAL EXAMINATION of WATER procured direct from the NEW RIVER, the RIVER LEA, and the THAMES, and taken at different points.

RIVER THAMES.

The samples were procured from the river at the following situations:—

Thames Ditton.—This being the highest point from which, at present, any of the Metropolitan Water Companies obtain their supplies.

Chelsea Reach, from which point the Southwark and Vauxhall and the Chelsea Companies still continue to take the water which they supply.

Hungerford Bridge.

London Bridge, and

Greenwich, within a few yards of the Hospital Ship, the Dreadnought.

Thames Water from Thames Ditton.—Collected 3rd September 1854, by Dr. Hassall.

This water was comparatively bright and clear, possessed no appreciable odour, but was somewhat disagreeable to the taste.

In the supernatant liquid there were discovered, by means of the microscope, a considerable number of infusoria; one, and this was the most abundant, was remarkable for the sudden leaps and darts which it took, and belonged to the genus *polyarthra*; a second kind of animalcule, which was not uncommon, was a species of *paramecium*; several of each of these, as well as sometimes other infusoria, were contained in nearly every drop of this water, no matter at what depth, as it stood in a half gallon bottle, it was taken for examination.

The deposit which subsided was much less considerable than that from all the other samples examined. Subjected to examination with the microscope, however, it was found to abound in a great variety of forms of infusoria and diatomaceæ, as well as different kinds of fungi; amongst the infusoria may be mentioned species belonging to the genera *rotifer*, *oxytricha*, *paramecium*, and *uvella*, and amongst the diatomaceæ, broken threads of *fragillaria*, *diatoma*, and *meloseira*.

Hammersmith.—Collected August 1854, by Dr. Hassall.

This water was somewhat dull and opalescent, even after standing twelve hours, but less so than the remaining samples; it was of a faint yellow tint, and its taste was disagreeable.

The supernatant liquid was found to contain numerous animalculæ, many more indeed than the previous sample, and especially a minute *paramecium* which occurred in greater or less numbers in all the waters examined. There were also present other kinds of infusoria, principally belonging to the genera *uvella* and *euglena*, a few diato-

maceæ, principally meloseira varians, and several fronds of pediatrum.

The deposit was many times greater than that from the Thames Ditton water, and it contained a good many infusoria, chiefly of the genera oxytricha and paramecium; it abounded with diatomaceæ, especially naviculæ, and cells of cyclotella operculata and meloseira nummuloides, and there were also discovered in it hairs of wheat fragments of decaying vegetable tissue.

Chelsea Reach.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

After having stood the usual time, the water remained decidedly turbid and opalescent, much more so than the previous sample; it was of a yellow colour, and disagreeable both to the taste and smell.

In every drop of the fluid portion examined, numerous living animal and vegetable productions occurred; the infusoria belonged chiefly to the genera paramecium, coepls and uvella, a few of the peculiar jumping animalculæ already noticed, polyarthra, also occurred, while there were many green and brown sporules, probably of conferva and diatomaceæ, as well as a few frustules of cyclotella operculata.

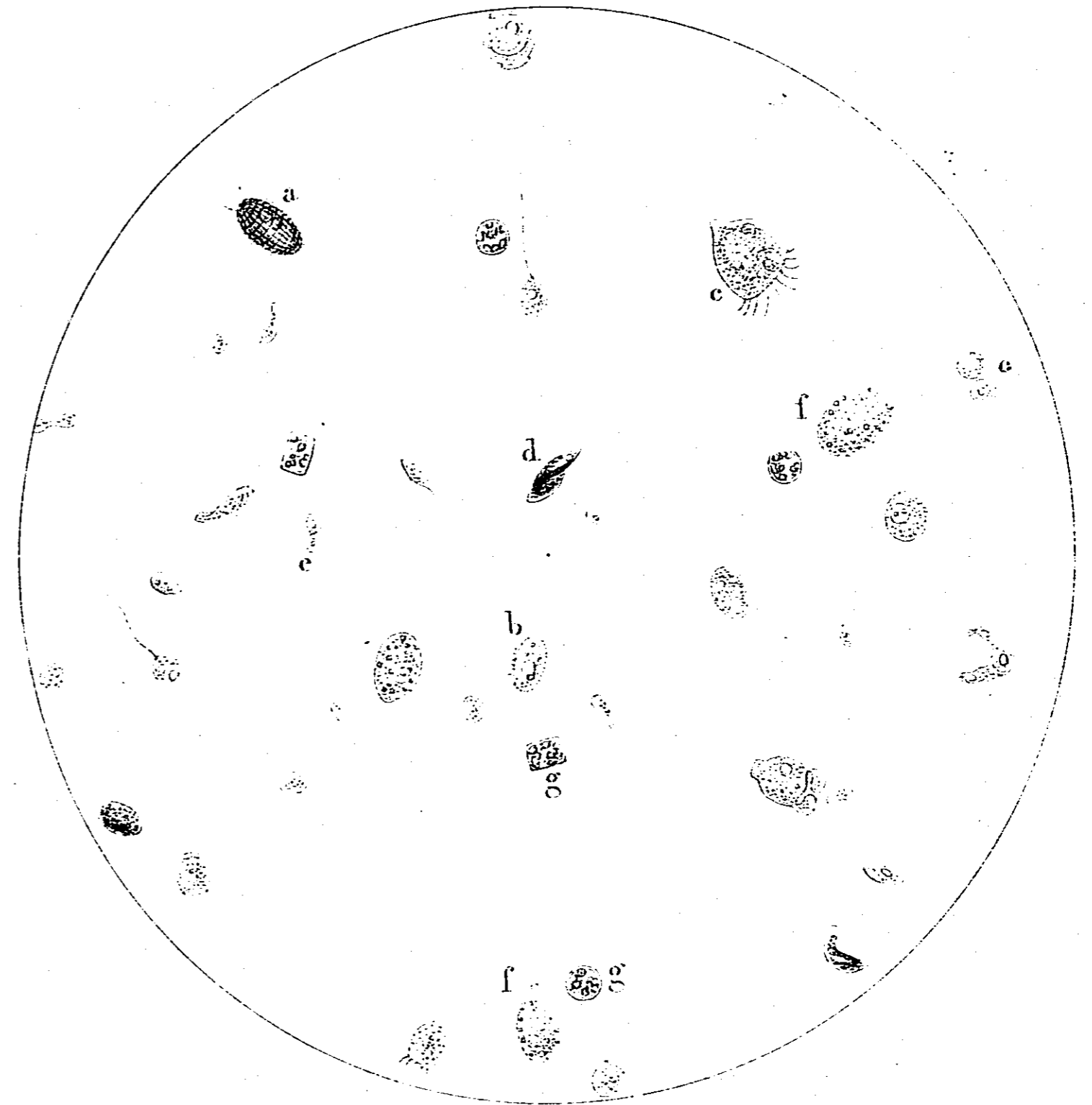
The deposit was of a light brown colour and large in quantity, very many times larger than that of the Hammersmith water; it consisted, like that of the remaining samples, in great part of earthy matter mixed with various organic substances. There were detected in it rather many infusoria, chiefly vorticellæ, oxytricha pellionella, paramacia, actinophrides, and rotifera, also coepls hirtus, acineta mystacina, and euglena viridis; a great many diatomaceæ, especially Nitzschia sigma, meloseira varians, M. nummuloides, synedra minutissima, cyclotella operculata, and navicula amphisœna; amongst the desmideæ closterium Ehrenbergii, and pediatrum pertusum were noticed; lastly, much fungus, hairs of animals, of the husk of wheat, and fragments of dead vegetable tissue were present. Figs. 22 and 23.

Hungerford Bridge.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

This water was certainly still more opalescent than the Chelsea water, it was more deeply coloured, and smelt and tasted more disagreeably.

The number of living organic productions contained in this water was less than that from Chelsea, although a single drop of it, even after subsidence, could not be taken without some being discovered; there were observed numerous green and brown sporules, animalculæ belonging to the genus euglena, and a few of the polyarthra already noticed.

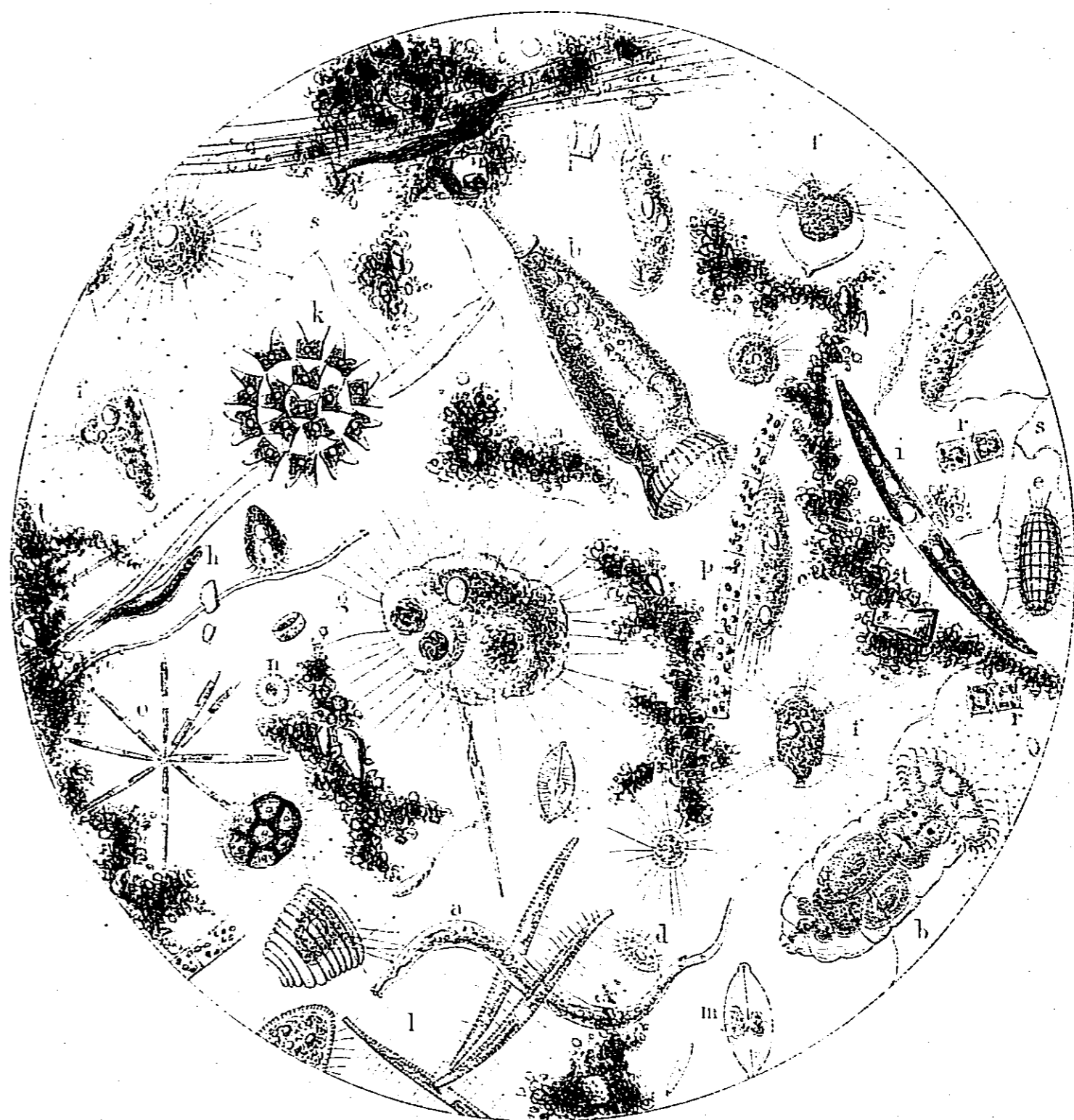
The deposit contained but few infusoria, but many diatomaceæ, chiefly cyclotella operculata, Nitzschia sigma, meloseira nummuloides, with a few naviculæ; there were also discovered in it fragments of vegetable tissue, husks of wheat, a few pieces of altered muscular



a. *Coleps hirtus*
b. *Paramecium*

c. *Polyarthra*
d. *Euglena*

e. *Monads*
f. *Granular rolling bodies*
g. *Frustules of Cyclotella operculata*



Microscop. Tab. 23. 1851.

- | | | |
|--------------------------------|---------------------------------|--|
| a <i>Anguillula fluxivalis</i> | g <i>Actinoparys Sol</i> | w <i>Cyathella coronata</i> |
| b <i>Rotifera</i> | h <i>Euglena viridis</i> | x <i>Synedra minutissima</i> |
| c <i>Hydricha</i> | i <i>Closterium Ehrenbergii</i> | p <i>Melastoma varians</i> |
| d <i>Paramecium</i> | k <i>Palaestoma pertusum</i> | r ——— <i>nummuloides</i> |
| e <i>Coleps hirtus</i> | l <i>Nitzschia signa</i> | s <i>Slender Fungus</i> |
| f <i>Acinetus nopsacina</i> | m <i>Novacula Amphiborea</i> | A <i>Gen. Schwajginge copious matter</i> |

fibre, and some of the black carbonaceous matter derived from the sewers. This water was evidently contaminated with sewage; the deposit was greater from this than from any of the other samples.

London Bridge.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

This water was also opalescent after standing the usual time, and its smell and taste were disagreeable; it contained nearly as many infusoria as the Chelsea water.

The deposit was less considerable, and there were present in it a good many diatomaceæ and infusoria. The animalculæ belonged to the genera paramecium, oxytricha, and actinophrys; the diatomaceæ principally to cyclotella, Nitzschia, and navicula. There were observed in addition one or two of the small river annelid, anguillula fluviatilis, several desmideæ of the genus pediastrum, and filaments of fungus.

The surface of this water, after having stood for some time, became covered with an inidescant pellicle, derived most probably from decomposed organic matter.

Greenwich.—Collected August 1854, by Dr. Hassall and Dr. Thomson.

This water, like the others obtained in the vicinity of the metropolis, was opalescent and of disagreeable taste and smell; it contained a great many animalculæ, though not so many as the Chelsea water.

There were present in the deposit, which was less considerable than that of the waters from Chelsea, Hungerford, and London Bridge, plenty of animalculæ of the genera rotifer, vorticella, actinophrys, and paramecium, a great many diatomaceæ, chiefly of the genera Nitzschia and cyclotella, especially *N. sigma* and *C. operculata*, navicula, meloseira, particularly *M. nummaloides*, and likewise many desmideæ of the genera scenedesmus and pediastrum; lastly, two or three fragments of altered muscular fibre were discovered, and portions of decaying vegetable tissue.

NEW RIVER COMPANY.

River at Sadler's Wells.—Collected 7th October 1854, by Dr. Hassall.

In this water after subsidence there were discovered a few monads, one group of green sporules, not in motion, and a minute fragment of a dotted duct. After standing at rest, it threw down a large deposit, and there were detected in it a great number of infusoria of various kinds, including two rotiferæ, and a broken shell of same; several euglenæ, one amœba, several small paramecia, a few of a large species, probably paramecium chrysalis, and a great many monads. Amongst the diatomaceæ were frustules of synedra ulna, and of other species of synedra, a few of two different species

of *surrella* and *pleurosigma*, together with filaments of *oscillatoria*; there was also found some of the usual slender and yellow fungi, spiculæ of the fresh water sponge, and several fragments of husk of wheat.

The threads which we have usually described as those of a yellow fungus bear considerable resemblance, as already remarked, in colour, mode of branching, and in their tapering form, to the stems of the production described by Ehrenberg under the name of *anthophysa*; it is difficult to identify the genus, in consequence of the absence of the animal; in one or two cases, however, we have seen the uvella-like animalcula attached to the stems.

RIVER LEA.

From New Canal just above the Water Works of the East London Water Company, Bow.

Collected 7th October 1854, by Dr. Hassall and Dr. Thomson.

The fluid part of this specimen of water contained two euglenæ and many infusoria of the genus *monas*. In the sediment there were discovered a large number of organic productions, living and dead, animal and vegetable. Amongst the animalculæ noticed were two polyarthræ, many euglenæ, and an animalculæ bearing a resemblance to a species of halteria, together with a few paramecia, one oxytricha, and numerous monads. The vegetable productions consisted of diatomaceæ principally and fungi, the former embracing the genera *navicula*, *cymbella*, *coconema*, *pleurosigma*, (including one frustule of *P. hippocampus*), also a thread of *meloseira varians*; two *pediastra* and one *closterium* were the only desmideæ seen. Of the fungi three species were found, one in germinating sporules, the usual slender fungus, and the yellow branched production above referred to. Amongst the dead organic matter were portions of the shells of entomostraceæ, and pieces of decaying vegetable tissue.

The following *conclusions* may be deduced from the foregoing Microscopical Examinations of the waters of the Thames, New River, and Lea:—

That organic matter, both dead and living, animal and vegetable, was present in very considerable amount in the whole of the waters subjected to examination.

That in all the waters living animal and vegetable productions were discovered in considerable numbers, and these not merely in the deposit, but in nearly every drop of each of the waters after they had stood the usual time, and after all but the lightest solid matter and the more active living infusoria had consequently subsided.

That nearly all, if not the whole of the living productions noticed, infusoria, diatomaceæ, and desmideæ, belonged to genera and species which have been long known, and which have been described in

systematic works for years; moreover the great majority of them are present in impure waters at nearly all times and seasons.

That amongst the organic productions in the waters of the West Middlesex, Chelsea, and Southwark and Vauxhall Companies were several species, principally diatomaceæ, which occur only in brackish water, as *Nitzschia sigma*, and *meloseira nummuloides*. This fact clearly shows that a certain portion of sea water finds its way into the Thames as high up as the sources from whence the above Companies take their supplies. The number of these productions is far less in the water of the West Middlesex Company, and still higher up, as at Kew, they appear to be nearly lost all together. When we consider that a few miles lower down the river, as at Gravesend, the water is quite salt, the fact that Thames water near London should be thus affected need hardly occasion surprise.

That in none of the waters was anything observed which could be supposed to exert any specific effect in the production of cholera.

That the presence of all these various living productions in such large numbers clearly demonstrates the very impure character of the whole of these waters, especially that of the Thames, as taken from the river. Between the samples of water taken near the bridges and that from Thames Ditton a very marked difference was, however, observed.

That two of the samples examined were demonstrably contaminated with sewage was shown by the presence of the black carbonaceous matter so abundant in sewer water, and the fragments of altered muscular fibre.

It should be stated that the several samples examined were procured at low water, there not having been any rain for some days.

There still remains one or two particulars of an interesting character in connexion with Thames water, which may now be referred to. The effect of the incessant traffic of steamers on the river is to keep the water in a state of perpetual commotion, which no doubt assists in breaking up and dissipating the dead organic matter contained in it, and thus powerfully promotes purification. Another consequence of the river traffic is that it stirs up the finer particles of earth, and diffuses them throughout the water; they are thus brought into contact with the fragments of organic matter derived mainly from the sewers, and to which fragments they adhere. Now, there is but little question that the decomposition of the organic matter is greatly modified by this intimate blending with earthy matter, the deodorizing and purifying powers of which have been recently shown to be so great. When Thames water, taken near the metropolis, is held up to the light, it is seen to be studded with particles resembling sand, these do not consist of sand, however, but are really fragments of organic matter, with very fine earthy matter adhering to them; this is shown by the circumstance that if you press these particles, unlike sand, they are found to be quite soft and yielding. Thames water, taken higher up the river, does not present any such appearances.

Some idea of the quantity of organic matter present in the water of

the Thames, near London, may be obtained in the following simple manner:—if a little of the sediment, after being well dried, be held up for a minute or two over the flame of a candle it will emit an odour which is most disagreeable and disgusting, arising from the evolution of gases from the decomposition of the organic matter.

I have already referred more than once to the occurrence in Thames water, near the metropolis, of productions which belong to salt or brackish water, a fact which shows that a certain quantity of that water must actually make its way up the river considerably beyond Chelsea. This one circumstance, independent of all other considerations, is sufficient to condemn the River Thames in this part of its course as a source of supply. The fact that chlorides are frequently present in water near the metropolis in considerable amount has often been noticed. It has hitherto been considered that these were derived almost entirely from the sewage poured into the river, and although there is no doubt but that this is so to some extent, yet unquestionably in many cases the principal part of those chlorides is introduced through the portion of sea water brought up by the tide.

(7.) RESULTS of the MICROSCOPICAL EXAMINATION of some of the DEEPER SPRING and WELL WATERS, principally in and near LONDON.

The position assumed in the remarks made introductory to the report on water being correct, viz., that the presence of organic productions, and especially of infusoria, is to be regarded as a sign of impurity, and as an evidence of contamination, then the deeper well and spring waters which have not been exposed to any source of impurity, as by proximity to cesspools or privies, ought to be free, or nearly so, from those evidences of contamination, and they should not contain organic productions, either dead or living, especially the latter, of any kind or description.

In order to ascertain if this be so or not, we have procured specimens of some of the deeper well and spring waters, obtained for the most part in and near London. The results of the microscopical examination of these waters we shall shortly proceed to state.

There are a few precautions which should be observed in the collection and examination of these waters; the bottles should be Winchester quarts, they should be thoroughly cleansed, and they should not have been used for the same purpose before, lest animalculæ or other matters should have been left behind from the previous water.

The sediments or residues, if any, should be separated as in other cases, but the greatest care is requisite that the glasses used for subsidence should be scrupulously clean; lastly, the cells and glass covers used in the microscopical examination of the waters should be new, and should not have been previously employed for the same purpose.

Should it appear as the result of the following examinations, that these waters are free, or nearly so, from living organic productions, then very valuable results will have been arrived at, for standards will have been obtained, by which all waters may be compared as regards their purity and freedom from organic matter, the principal and most injurious contamination to which water is subject.

Further, the fact will be established that there are in nature waters furnished in abundance, and capable of being supplied for domestic use, which are for the most part free from contamination with solid organic matters, and which, if present at all, are usually so in quantities scarcely recognisable with the highest powers of the microscope.

Well in Trafalgar Square.—Collected 25th November 1854, by Mr. J. H. Sandwell.

After prolonged examination, not a vestige of solid organic matter was detected in this water.

Artesian Well, Piccadilly.—Collected 16th December 1854, by Mr. Miller.

A very small quantity of sediment, of a yellowish colour, was deposited from this water, but more than might have been anticipated. The infusoria present consisted of one wheel animalcula, rotifer vulgare, and two of the eel-like annelid. In addition, there was a little of at least two different species of fungi, one belonging to the genus dactylium, three pieces of dotted ducts, a fragment of fir-wood, a piece of straw, four or five of the brown ova cases, together with a little grit.

It is evident, from the contents of this water, that it is exposed to some slight source of contamination, probably some of the waste and rain waters may make their way into the well through the grating beneath the pump.

Pump in Vigo Street.—Collected 16th December 1854, by Mr. H. Miller.

There was scarcely a particle of sediment from this water visible to the unaided eye. No infusoria of any kind were present in it, but it contained a good many of the brown ova cases, single and in masses, one bunch of threads of the slender fungus, several minute fragments of decaying vegetable tissue, and a little gritty matter.

Spring in Kensington Gardens.—Collected 25th November 1854, by Mr. J. H. Sandwell.

In this water but one minute animalcule was seen, two or three sporules of a species of fungus, and a little organic debris.

Spring in Hyde Park.—Collected 11th December 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 16.5°.

No sediment was deposited from this water, neither were any living organic productions discovered by means of the microscope.

Well in Camden Town.—Collected 30th November 1854, by Mr. J. H. Sandwell.

There were detected with the microscope in this water only five or six minute monads, and a very few yellow fragments, composed, probably, of decayed organic matter.

Well at Messrs. Barclay and Perkins'.—Collected 23d November 1854, by Mr. J. H. Sandwell.

After having stood some time, this water deposited a few brownish fragments, composed apparently of decayed organic matter, together with a minute fragment or two of decaying vegetable tissue; the only living productions discovered were two minute infusoria, about the size of monads.

Well at Messrs. Combe, Delafield, and Co.'s—Collected 24th October 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 5°.

In this water but two minute infusoria were seen, and a very few crystals of carbonate of lime.

Well at Messrs. Meux and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

A very minute quantity of sediment subsided from this specimen, which consisted of brown amorphous matter, with a little grit, no organic productions seen, except a few stationary vibriones in clusters.

Well at Messrs. Whitbread and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

Scarce a trace of sediment subsided from this water, all that could be discovered was a very minute quantity of yellowish matter, and a few particles of grit. Not a single animalcule of any description was present.

Well at Messrs. Reid and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

Not a particle of sediment nor a single organic production could be detected in this specimen of water.

Well at Messrs. Calvert and Co.'s—Collected 27th November 1854, by Mr. J. H. Sandwell.

After standing for some time, a little brownish amorphous matter was deposited; in this was discovered, with the microscope, one eel-like annelid, a single thread of oscillatoria, a little slender fungus, and a few minute fragments of decaying vegetable tissue.

Well at St. Bartholomew's Hospital.—Collected November 1854, by Mr. J. H. Sandwell.

A very minute quantity of sediment was deposited from this water, Amongst the infusoria found in it were six or seven of a species of eel-like annelid, differing from the ordinary river worm in the form of the tail, which was prolonged into a kind of hair or bristle, a rotifer, and several small oxytrichæ. Amongst the vegetable pro-

ductions, one large thread of a green conferva, a navicula, and some of the slender fungus were seen; it also contained a piece of firwood, and rather many other fragments of dead and decaying vegetable tissue, and a little gritty matter.

Well at Tottenham.—Collected 29th November 1854, by Mr. J. H. Sandwell.

This specimen of water at first presented a slightly reddish tinge, and threw down, after standing for a time, a considerable deposit, also of a reddish colour, and which was gritty, the colour was probably due to the presence of carbonate of iron. Not a single animalcule seen, or any other description of organic production.

Well at Tooting.—Collected 30th November 1854, by Mr. J. H. Sandwell.

This water presented a dull and opalescent appearance, but not a single living production of any kind or description was discerned in it.

Spring at Watford.—Collected 24th November 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 18.5°.

This water was perfectly clear and bright, and after having stood the usual time, the only organic productions found in it were five or six minute infusoria, about the size of monads, no other solid matter of any description was seen in this water, with the exception of a few groups of crystals of carbonate of lime.

Surface water at Farnham.—Collected 6th December 1854, by J. M. Paine, Esq.

In this water there was observed, with the naked eye, a small quantity of debris, of a reddish colour. After subsidence, rather many infusoria of the genus monas were detected, and five or six larger species of infusoria, together with four of the eel-like annelid, *anguillula fluviatilis*; there was present in it also a small quantity of the thallus of a fungus, and two or three fragments of decaying vegetable tissue.

The same, from tap at Mr. Paine's House.—Collected 16th December 1854, by J. M. Paine, Esq.

After standing at rest, this water threw down rather much sediment of a dirty brown colour, in which were seen several organic productions. Amongst the living ones were found a stentor, three rotifera, the same number of vorticellæ, two or three oxytrichæ, a paramecium, a few monads and some vibriones, together with threads of the slender fungus; the dead organic matter consisted of numerous pieces of decaying vegetable tissue.*

* These two waters, being nether spring nor well waters, but surface water, are exceptional, and ought scarcely to have been described in the same Report as the other waters.

Spring at Waddon Farmyard, adjoining Beddington.—Collected 23d November 1854, by Mr. J. H. Sandwell.

Degree of Hardness, 12°.

This water let fall a small quantity of brown sediment, chiefly organic. In this, only three infusoria were seen, viz., two annelidæ and one other rather large animalcule. It abounded, however, in vegetable productions of different genera and species, as follows:—numerous threads of confervæ, embracing two species of vesiculifera threads of oscillatoria, zygnum and lyngbya. Of the desmidæ, three fronds of pediastra only were seen, but a good many diatomaceæ, which included especially meloseira, two species, as *M. varians* and *M. arenosa*, navicula, pinnularia, nitzschia, and fragillaria, with a few frustules of two or three species of synedra.

Amongst the dead organic matter were broken pieces of shells of daphnia, many fragments of spiral vessels, and other decaying vegetable tissue.

Well at Messrs. Allsopp's, Burton-on-Trent.—Collected 30th November 1854.

After subsidence, not a single animalcule, even a monad, could be discovered in this water. The only solid contents which were present were a few simple and aggregated vibriones, and the threads and sporules of a fungus, one small piece of firwood, and three or four fragments of decaying vegetable tissue.

Well at Messrs. Allsopp's.—Collected 30th November 1854.

A second specimen of Burton water was subjected to microscopical examination, and this was found to be equally free from animalcula or infusoria.

Mr. Allsopp, in a letter, gives the following account of the Burton wells:—"They are not more than 32 feet in depth and about 21 feet in diameter; they take their source from some hills in the neighbourhood, which abound in gypsum, and the water passes through gravel and a stratum of quicksand, which often impedes the operations of the borer."

Well at Messrs. Bass and Co.'s, Burton-on-Trent (Old Brewery).—Collected 1st December 1854.

A minute quantity of sediment visible to the naked eye subsided from this water; in it there were discovered several infusoria, embracing the following genera:—two of the eel-like annelid, eight of the usual species of vorticella, also one of another species, and five or six monads; it likewise contained sporules and threads of fungi, some of the brown ova cases before referred to, five or six very small fragments of decaying vegetable tissue and some yellow organic debris.

Well at Messrs. Bass and Co.'s, Burton-on-Trent (New Brewery).—Collected 1st December 1854.

This specimen of water was procured from another well on the premises of Messrs. Bass and Co. The only living productions discovered were one monad and three or four threads of the slender fungus.

The following are Samples of the Water of the WOOLWICH, PLUMFSTEAD, and CHARLTON COMPANY.

Covered Reservoir.—Collected 16th December 1854, by Dr. Hassall and Professor Clark.

Degree of Hardness, 8·25°.

Not the smallest particle of organic matter of any description was present in this water, but only a minute deposit of microscopic crystals of carbonate of lime.

Tap of House of Mr. Rickston, Woolwich.—Collected 16th December 1854, by Dr. Hassall and Professor Clark.

Degree of Hardness, 8·25°.

The only evidence of the existence of organic matter discovered in this water was a single infinitesimal animalcule; minute crystals of carbonate of lime were rather more abundant in this than in the previous sample.

Well.—Collected 16th December 1854, by Dr. Hassall and Professor Clark.

Degree of Hardness, 21·75°.

Not a single living organic production or other solid trace of organic matter could be discovered in this water; the deposit of carbonate of lime was two or three times more considerable in this than in either of the two previous specimens.

The results of the examination of the three waters above described, obtained from the works of the Woolwich, Plumstead, and Charlton Water Company, are satisfactory in a high degree, because they afford convincing proof of what may be actually and practically accomplished, as relates to the presence of infusoria and other organic matter in water. Here we have an example of a deep well water free from organic matter as taken from the well, equally so as furnished to the consumer. These results are the more satisfactory since they are obtained without having recourse to filtration; the natural purity of the well water, together with the effect of the softening process, being such as to render filtration unnecessary, there being, in fact, nothing to separate from the water by filtration. The case of this Water Company affords satisfactory evidence of the utility of Professor Clark's softening process. This water, Professor Clark states, as it comes from the well, has a hardness of about 21·75 degrees, and this, after softening, is reduced to 8·25 degrees, all of which, with the exception of 1·6 degree, is due to neutral salts.

With a view to obtain a further proof of the comparative freedom of this water from organic matter, I examined some of the chalk which was deposited after the addition of the hydrated lime; I found it to be perfectly white, to exhibit no evidence of organic matter under the microscope, and to evolve no odour of organic matter when burned.

The contrast between this chalk and that which is deposited in kettles, boilers, &c., after the boiling of Thames water is remarkable,

the one being as white as the purest chalk, and the other of a deep and dirty yellow colour.*

It thus appears from the above examinations of SPRING and WELL water:—

That the majority of the different specimens of deep well and spring waters examined were remarkably free from organic matter. In many, not a single living organic production of any kind was to be discovered; while in the remainder, with the exception of the Wadden water and one of the two samples of Farnham water, the number of organic productions was exceedingly small.

That in none of the waters, with the exception of that from Wadden, were any organic productions found belonging to the orders *conferveæ*, *desmideæ*, and *diatomaceæ*, and rarely any belonging to the class of fungi, so many species of which are almost invariably present in nearly all the river waters in use in the metropolis.

That in those cases in which organic matter, or living organic productions, were discovered, their presence was readily to be accounted for, by reference to special circumstances connected with each case. Thus, the water from the Wadden spring is in immediate communication with a shallow pond full of plants, weeds, &c., and the productions found in this water were, therefore, no doubt derived from the pond in question. In other cases, much of the organic matter present consisted of fragments of decaying vegetable tissue and of other matter which had evidently been introduced into the water from without, the surface of the wells being, in many instances, uncovered and exposed.

Had certain of these waters not been exposed to these comparatively slight sources of contamination, and had, perhaps, still greater care been exercised in the method of procuring them, we have good reason for believing that scarcely a single organic production of any kind would have been found in any one of the well and spring waters subjected to microscopical examination.

We have thus then obtained convincing and positive evidence that THE DEEPER WELL AND SPRING WATERS ARE, FOR THE MOST PART, AND WHOLLY WHEN NOT EXPOSED TO SOURCES OF CONTAMINATION, FREE FROM ORGANIC PRODUCTIONS OF EVERY DESCRIPTION.

It is interesting to contrast the results of the examination of the above waters with those furnished by the waters of the different Companies which take their supply from the Thames, especially the Southwark and Vauxhall Company. While, in the case of many of the former, not a single organic production was to be dis-

* There are two other circumstances which have been reported to me in reference to the Plumstead water which may here be mentioned. One is that the softening process exerts a marked effect over the growth of vegetation in the water when subjected to exposure. In the unsoftened or partially softened water a green vegetation is apt to appear, while in that which has been softened no such growth occurs. The second particular is that the water when pumped up from the well has a temperature of about 45° Fahr., and being kept first in deep, open, softening reservoirs, and afterwards being stored in covered receptacles, it becomes but little reduced in temperature. The consequence of this is that it scarcely ever freezes even in the coldest weather when in the reservoirs, and is much less apt to do so in the distributing pipes than ordinary river water, a source of very great inconvenience being thereby to a great extent avoided.

covered; in the latter, dozens of species belonging to different classes and orders of living organic productions were commonly to be met with in abundance.

It is, therefore, entirely unnecessary that the waters supplied for domestic purposes should contain animalculæ or any other organic productions. The majority of nearly all the spring and well waters which are not specially contaminated are, as has already been shown, free from them, as is also rain water, the water derived from the melting of snow and hail, and fresh distilled water.

If impure water be a source of disease, especially epidemic disease, there is no question but that it is so principally through the organic matter contained in it, and hence the importance of supplying water which is, as near as practicable, free from organic matter.

The only objection to certain well and spring waters is their hardness; this, however, can scarcely, under any circumstances, be a source of epidemic disease, although it is possible in some cases, where the water has been very hard indeed, and where it has been long used, that it may be productive of certain urinary affections.

On the other hand, a great many well waters are not hard at all; moreover, the quality of hardness is one that admits of remedy.

A very striking proof of the difference in the keeping properties of pure and impure waters is shown by the following simple proceeding:—If two wide-mouthed glass jars, holding each about a gallon, be filled, one with pure well water, and the other with river water, and loosely covered and exposed to the air, light, and sun, one will usually remain without perceptible change for weeks, and even months, while the sides of the other glass will become coated with green and brown, owing to the development of *conferveæ*, *desmideæ*, and *diatomaceæ*. This difference is mainly explained by the freedom of the well water from organic matter, the river water not only containing organic matter, but also the seeds or germs of a variety of organic productions, ready to become developed the moment that circumstances concur favourable to their growth.

I am informed, however, by Professor Clark, that vegetable productions are apt to become developed in hard chalk waters when exposed to air and light, but that no development of them takes place for weeks, and even for months, in the water, after having undergone the softening process.

CONCLUDING REMARKS.

FROM all that has now been advanced in reference to the condition of the water supplied by the different Metropolitan Water Companies, it appears that, during the period of this inquiry, when the cholera epidemic prevailed, as well as subsequently, the waters furnished by those companies were very far from possessing the requisite purity, in consequence of the large quantity of organic matter (which is the worst contamination to which water can be subjected) contained in them. Even in the water supplied by the Lambeth Company, which is comparatively the purest of the whole,

organic productions, dead and living, animal and vegetable, are found in not inconsiderable numbers, and this water furnishes the type of that with which, in 1855, the greater part of London and its vicinity will be supplied, in accordance with the recent Act by which the water supply of the metropolis was regulated.

The metropolis, then, after that year will still continue to be supplied with river waters containing various kinds of organic matter, including numerous living productions. Now, that there is no necessity that this should be, has been clearly proved by the case of the Woolwich, Plumstead, and Charlton Water Company, which supplies a water entirely free from living organic productions of every description, as also by the condition of most deep wells and spring waters.

The present condition of the water supply of the metropolis not being satisfactory, and it being but little probable that it will be so at the expiration of the period above referred to, it may be well to bestow a few remarks upon the further steps which might be taken with a view to its increased improvement. One step which should certainly be adopted is the substitution of the constant for the intermittent system of supply, as that would entail the abolition of cisterns, butts, tubs, &c., with all their great and concomitant evils; I trust that the legislature will insist upon the fulfilment of this important proviso of the recent Metropolitan Water Act.

It is questionable whether by any process river water can, under any circumstances, be supplied of the requisite degree of purity, owing to the thousand sources of contamination to which this description of water is subject. To afford even a prospect of its being so, it is necessary that a method of filtration should be practised much more effectual than that at present adopted. It is further well worth full consideration as to whether benefit would not result from the employment of Clark's softening process; by this means, especially if combined with filtration, a great portion of the organic matter contained in river waters might undoubtedly be got rid of.

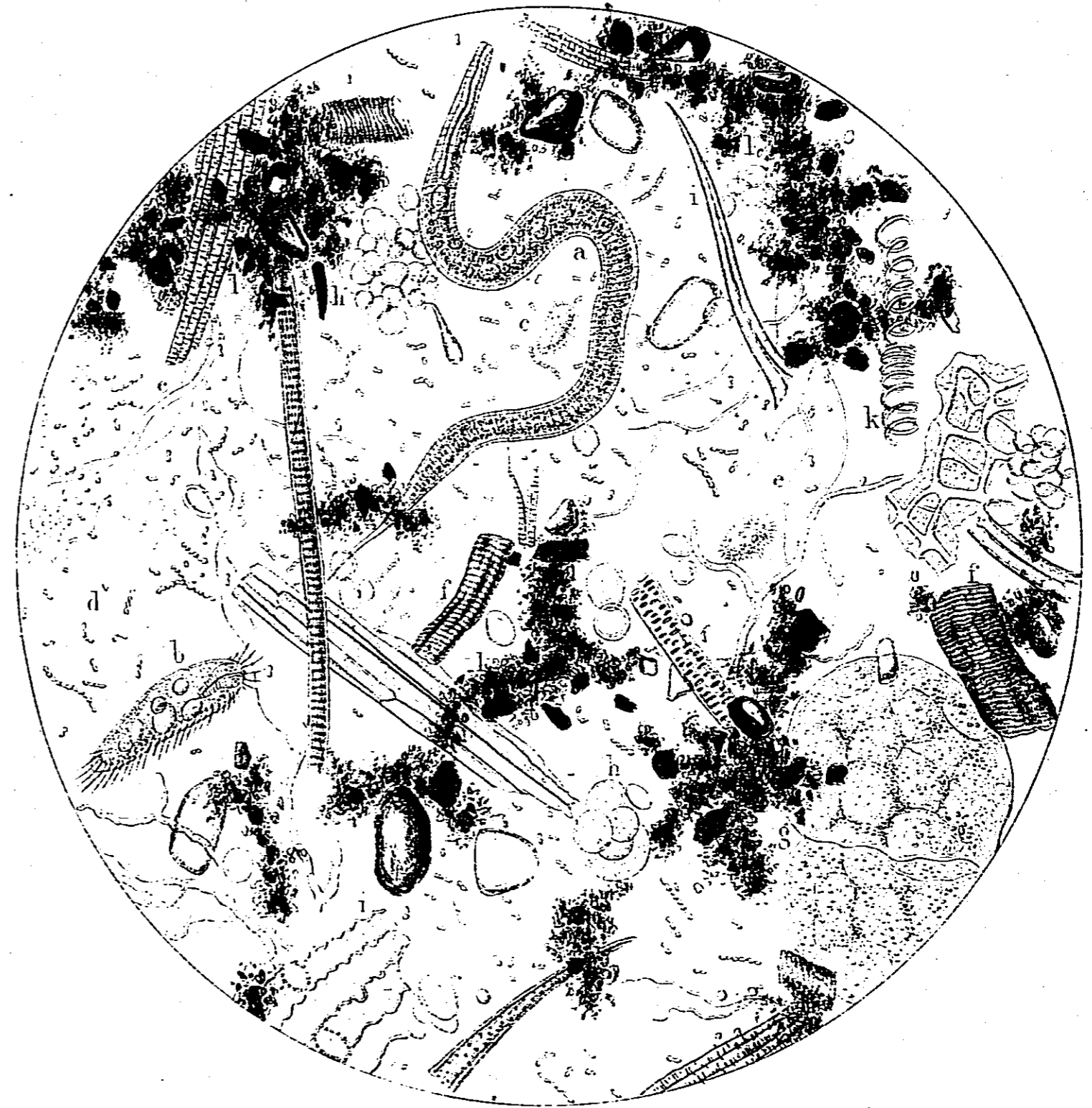
If the metropolis had to be supplied with water anew, rivers ought not to be had recourse to at all. A large supply of water of the purest description may undoubtedly be obtained from deep wells and springs, and be delivered to the consumer on the constant system of supply, free from every description of solid organic impurity.

Having frequently noticed a great difference in the quantity of living organic productions contained in different samples of the water of the same Company, professing to supply only filtered water, I am led to make the inquiry, Whether is it possible for a Company to supply water at one time filtered and at another not? Whether, in fact, are the works so constructed as to render such a thing possible? If it be possible, then have the public no guarantee that they will invariably be supplied with filtered water, even by those Companies which have undertaken to furnish filtered water only. It is of consequence that this point should be clearly ascertained.

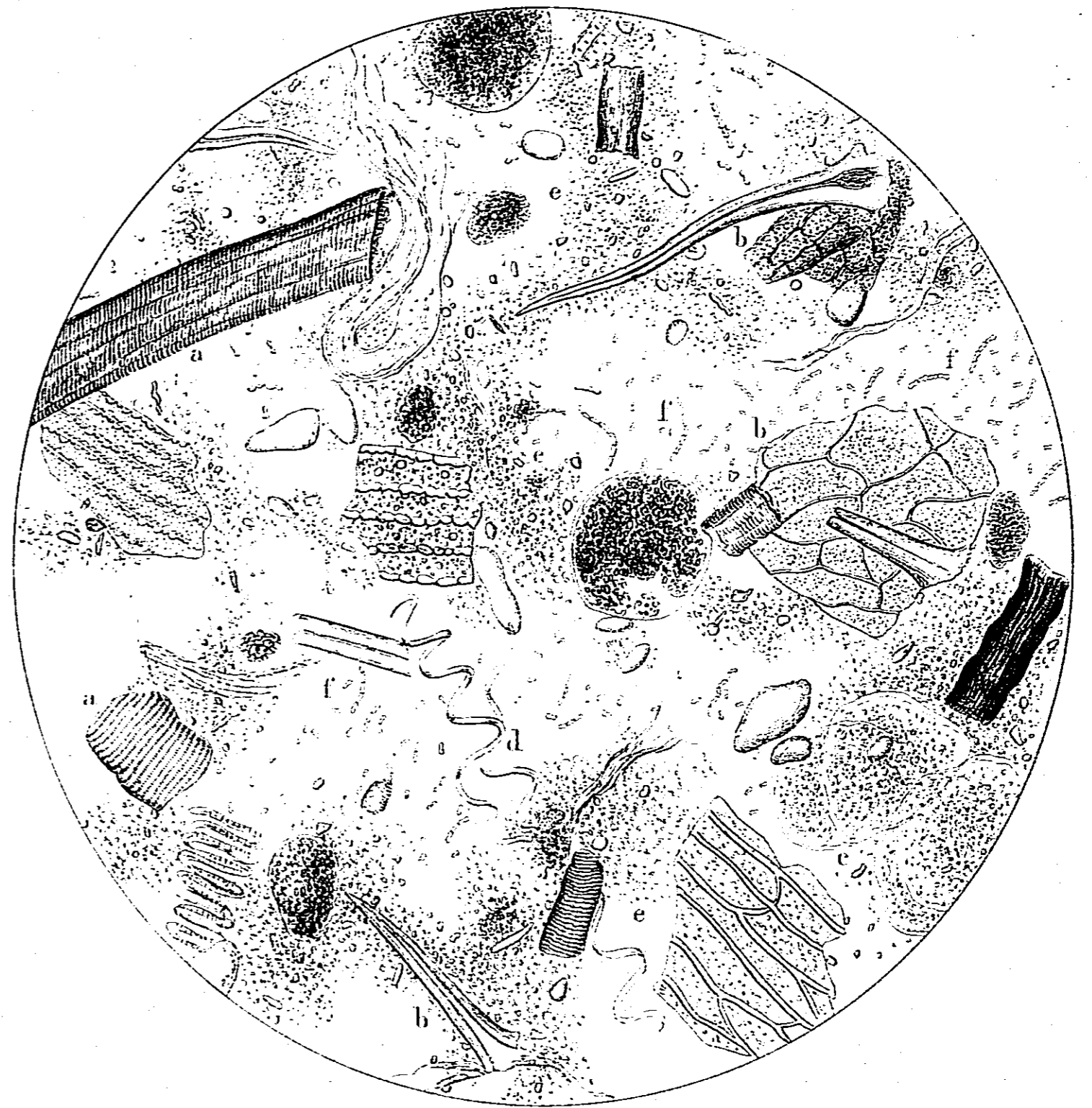
ARTHUR H. HASSALL, M.D., F.L.S.

21st Dec. 1854.
Bennett Street, St. James' Street.

(Taken from the Sewer in Silver Street.)



- | | | |
|---------------------------------|--------------------------------|-------------------------|
| a. <i>Amphitela Chloridites</i> | c. Fragments of Stender Fungus | — Hair and Integuments |
| b. <i>Chlorella</i> | f. Fragments of Mascular Fibre | of Wood. |
| c. <i>Paramecium</i> | g. Cells of Potato | k. Spiral Vessels |
| d. <i>Vibrio</i> | h. Starch granules of Wood | l. Dead & Dying organic |
- matter as detailed under last Column, and is &c.



Magnified 500 diameters

aa Fragments of Muscular fibre. cc Cells of Potato ee Granular matter.
bb Portions of Husks & Hairs of Wheat. dd Spirals unrolled. ff Vibriones.

TABLES.

TABLE I.
RESULTS of the MICROSCOPICAL EXAMINATION of different WATERS obtained from HOUSES, one or more of the OCCUPANTS of which were either affected or had died of CHOLERA.

Company.	Address.	Cases of Cholera.	Result of Examination.
GRAND JUNCTION COMPANY.	3, South Row, Golden Square.	3 Deaths.	These waters all contained much dead and living organic matter of various kinds, in the solid form. The living productions met with belonged to several distinct classes and genera, and included annelidæ, entomostracæ, infusoria, desmidiæ, diatomacæ, and fungi. Amongst the most abundant productions met with were pandorina morum, asterionella formosa, and a brown rolling lenticular body, which was very abundant in all the waters of the Golden Square district.
	5, South Row, Golden Square.	3 Deaths.	
	39, Broad Street, Golden Square.	3 Deaths.	
	13, Marshall Street, Golden Square.	4 Deaths and 2 other cases.	
	14, Cambridge Street, Golden Square.	2 Deaths.	
	23, Peter Street, Golden Square.	6 Deaths.	
	9, Hopkins Street, Golden Square.	8 Cases.	
	11, Hopkins Street, Golden Square.	3 Deaths and 2 other cases.	
	5, Berwick Street, Golden Square.	5 Deaths and 2 other cases.	
	3, Broad Street, Golden Square.	3 Deaths.	
NEW RIVER COMPANY.	10, Portland Mews, Golden Square.	3 Deaths and 2 other cases.	The above observations apply equally to these waters, being fully as great. There was this difference, however, that some of the species present in the waters of the Grand Junction Company, as asterionella formosa and pandorina morum, were absent from these, which contained, however, other species not present in the water of the Grand Junction Company, as nitzschia sigmoidea and pleurosigma acuminatum. The brown lenticular bodies were equally abundant in the waters of both Companies.
	9, Broad Street, Golden Square.	6 Deaths.	
	3, Allen Street, Clerkenwell.	5 Deaths.	
	6, Allen Street, Clerkenwell.	2 Deaths.	
	13, Broad Yard, Clerkenwell.	1 Death.	
	15, Broad Yard, Clerkenwell.	1 Death.	

LAMBETH COMPANY	107, Cornwall Road, Waterloo Road.	1 Death.	Living organic productions were present in the whole of these waters, including annelidæ, entomostracæ, infusoria, desmidiæ, diatomacæ, and fungi; their numbers were not, however, so great as in the waters of the Grand Junction and New River Companies. The Lambeth Company now obtains its supply of water from the Thames at Thames Ditton, to which source several of the other Metropolitan Water Companies are about to have recourse; the fact, therefore, of the presence in this water of various kinds of living organic productions is of very great importance, because it shows that, even when the provisions of the recent Metropolitan Water Bill are carried into effect, London will still continue to be supplied with water of an impure character.
	111, Cornwall Road -	1 Death.	
	17, Commercial Road, Waterloo Road.	1 Death.	
	66, Wootton Street, Waterloo Road.	1 Death.	
	4, Little King Street, Kent Road.	2 Deaths.	
	21, Bollinbrooke Row, St. Peter's, Walworth.	2 Deaths.	
	1, Bedford Court, St. James's Buildings.	3 Deaths.	
	22, Carter Street, Walworth -	1 Death.	
	154, Waterloo Road -	1 Death.	
	SOUTHWARK AND VAUXHALL COMPANY.	131, Waterloo Road -	
15, Eaton Street, Waterloo Road.		1 Death.	
29, Wootton Street, Waterloo Road.		1 Death.	
10, Berkeley Terrace, St. Peter's, Walworth.		2 Deaths.	
25, Bollinbrooke Row, Walworth.		2 Deaths.	
Flora Cottage, Bermondsey -		2 Deaths and 5 other cases.	
Batchelor's Guano Manufactory, Bermondsey.		2 Deaths.	

TABLE I.
Results of the Microscopical Examination of different Waters, &c.—*continued.*

Company.	Address.	Cases of Cholera.	Results of Examination.
CHELSEA COMPANY	9, Prospect Row, Bermondsey. 13, Clanden Street, Newington.	2 Deaths. 2 Cases of Cholera, and 2 of Diarrhoea.	wholly unfit for use as a beverage. In some of the samples examined portions of husk of wheat, cells of potato, and other vegetable substances, starchy matter, and fragments of striped muscular fibre, were met with, demonstrating clearly the fact of the contamination of this water with fecal matter derived from the sewers.
	28, Clanden Street. 29, Clanden Street.	1 Death, and 1 case of Diarrhoea. 2 Deaths, and 1 case of Diarrhoea.	
	3, Eatley's Buildings, Chelsea.	1 Case of Cholera and 4 of Diarrhoea.	The whole of these samples contained living organic productions of various kinds, the species being for the most part the same as those present in the water of the Southwark and Vauxhall Company, although in greatly diminished numbers. This result is just what might have been anticipated when it is remembered that the Chelsea Company obtains its supplies from nearly the same part of the river as the Southwark and Vauxhall Company, but that it filters the water previous to distribution.
	53, Queen's Road West, Chelsea.	2 Deaths and 2 cases of diarrhoea.	
	4, Bolton's Gardens, Chelsea. Wink's Court, Chelsea.	5 Deaths; Diarrhoea general.	
EAST LONDON COMPANY.	Allen's Cottages, Whitechapel. 25, Willis Street.	1 Death. 1 Death.	Contains various forms of living organic productions belonging to different classes and genera.
KENT COMPANY -	5, Dulke Street, Deptford.	1 Death.	Contains various forms of living organic productions belonging to different classes and genera, but on the whole fewer than the water of the East London Company.
	97, New Street, Deptford.	6 Deaths.	

Nearly all the organic productions met with in these waters belonged to genera and species which have long been known, and the descriptions of the majority of which are to be found in various systematic works treating of different branches of Natural History. In none of the many specimens examined was any peculiar living production met with which could be supposed to exert any direct or specific effect in the production of Cholera. The whole of the waters subjected to microscopical examination were undoubtedly impure, and this impurity, there is much reason for believing, was not without effect in giving rise in some instances to Cholera. The inquiries made in relation to the condition of the water of the Southwark and Vauxhall Companies, and the occurrence of Cholera, appear to bear out this conclusion.

The only productions met with in any of the waters examined which excited any degree of suspicion that they might possibly have some connexion with Cholera were the brown, lenticular, actively moving bodies, found in nearly all the waters from the Golden Square district, and the vibriones which were noticed in some of the waters.

With regard to the bodies first referred to, it is sufficient to state, in order to disprove the idea of their connexion with Cholera, that they were not found in many other waters procured from Cholera houses, while in one or two cases they were met with in waters the use of which had been unattended with the occurrence of Cholera. With respect to the vibriones, these are to be found in impure water nearly at all times and seasons; the fact of these occurring in such numbers in the rice-water evacuations of Cholera, appeared at first to give some countenance to the idea that their occurrence in water might not be without importance in relation to Cholera.

For further particulars, see page 232.

TABLE II.

RESULTS of the MICROSCOPICAL EXAMINATION of different SPECIMENS of WELL and PUMP WATER procured in Neighbourhoods in which CHOLERA was prevalent.

Address.	Results of Examination.
Pump, White Hart Court, Chelsea. Pump, Sun Court, Chelsea. Pump, Broad Street, Golden Square. Wilderness Row, Goswell Road. Well in Bayley's Yard, Clerkenwell. Pump in Cock's Buildings, Putney. Pump in Price's Folly, Putney. Pump, 19, Stratford Grove, Putney. Well at Sevenoaks, Brasted. Well, Miller Corner, Hadley. Well, Newton, Wisbeach. Well, Newton, Wisbeach. Well, Romsey. Pump, Reading Room, Romsey.	<p>The whole of the samples of well and pump water subjected to microscopical examination without a single exception were of a highly impure character. They all contained living organic productions of various kinds, and in the majority of the specimens these were particularly abundant. The organic productions met with belonged principally to the orders entomostracea, infusoria, and fungi. Desmidiæ were for the most part absent, and diatomaceæ present in five only of the waters, and in but two specimens were they at all abundant. At least four of the waters were obviously contaminated by infiltration from neighbouring cesspools. The microscopical examination of the water from the Broad Street pump furnished no very striking or important result, but the chemical analysis of Dr. Thomson shows that the impurity of this water was very much greater than from its bright and colourless appearance would have been supposed. It thus appears that a very large proportion of the well and pump waters in use are in a very impure state, and that they require attention quite as much as the water furnished by the metropolitan water companies.</p> <p>For further particulars, see page 239.</p>

TABLE III.
RESULTS of the MICROSCOPICAL EXAMINATION of WELL, PUMP, and other WATERS from SANDGATE, obtained during the PREVALENCE of CHOLERA in that Locality.

Name of Company.	Address.	Cases of Cholera.	General Results of Examination.
CHERTON WATERWORKS	Mr. Bateman's, 1, Birch Cottage. Residence of Mr. George.	5 Deaths. 1 Death.	<p>In all, fourteen samples of water from Sandgate were subjected to examination; the whole of these were contaminated with organic matter, dead and living, the quantity in the majority of the specimens being very considerable. The waters examined included several well and pump waters, as also specimens of that supplied by two different water companies.</p> <p>In none of these waters was any peculiar production met with which could be supposed to exert any direct or specific effect in giving rise to Cholera.</p> <p>See page 242.</p>
FOLKESTONE COMPANY	Residence of Mr. Penrith. Reservoir at Shorncliff. Reservoir at Castle Hill, Sandgate. Main, Belle Vue, Sandgate. Tap at Belle Vue House. Tap, New Inn. Well, Residence of Mr. George. Well, Residence of Mr. George. Well, Residence of Mr. Marsh. Well, House opposite Rose Cottage. Pump at New Inn. Stream of Mr. Bligh.	1 Death, and 4 ill. 5 Deaths.	

TABLE IV.

RESULTS of the MICROSCOPICAL EXAMINATION of different SAMPLES of WATER, obtained from the SERVICE PIPES of several of the METROPOLITAN WATER COMPANIES.

Company.	Address.	General Results of Examination.
GRAND JUNCTION COMPANY -	3, South Row, Golden Square, 13, Marshall Street.	The general results of the examination of these waters agree closely with those which followed from the examination of the samples of water of the several companies taken from cisterns; the water from service pipes represents the condition of the waters as supplied by the companies, while that from the cisterns the state in which it is actually consumed by the public. Organic productions, dead and living, animal and vegetable, were met with in considerable numbers in the whole of the companies' waters, even in that which is comparatively the purest, being the water supplied by the Lambeth Company, taken from the Thames at Thames Ditton. The condition of the water supplied by the Southwark and Vauxhall Company was by far the worst, not merely abounding in a great variety of organic productions of various kinds, but it being contaminated with fecal matter, derived from the sewers, as shown by the presence of the hairs and husks of wheat, cells of potato and other vegetables, and fragments of striped muscular fibre. Further, the water of this company, of the Chelsea, West Middlesex, and even the Grand Junction Company, were deteriorated by admixture with salt water, as shown by the presence of several living organic productions, chiefly diatomaceæ, which are ordinarily found only in salt or brackish water. The chemical analyses of these waters, as made by Dr. Thomson, supports the correctness of these conclusions, by showing the presence of large quantities of chlorides. The analyses of the water of the Chelsea, West Middlesex, and Hampstead Companies show that they are all of a very impure description, although, with the exception of the Chelsea Company, less so than the water of the Southwark and Vauxhall Company.
WEST MIDDLESEX COMPANY -	77, Upper Berkeley Street. 77, Upper Berkeley Street.	
CHELSEA COMPANY -	5, Lawrence Street. 27, Turner Street.	
SOUTHWARK AND VAUXHALL COMPANY.	St. Thomas's Hospital. 12, Neptune Street, Wandsworth Road. Main Crescent Road, Park Road. Main Crescent Road, Park Road.	
NEW RIVER COMPANY -	3, Broad Street, Golden Square. 9, Hopkins Street, Golden Square.	
EAST LONDON COMPANY -	5, Dock Street, Whitechapel. 1, Back Church Lane, Whitechapel.	
HAMPSTEAD COMPANY -	47, Arlington Street, Hampstead Road. 47, Arlington Street.	
KENT COMPANY -	Company's Filter, Service Pipe at Works.	

For particulars, see page 36.

TABLE V.
RESULTS of the MICROSCOPICAL EXAMINATION of CISTERN WATERS.

In the Report on Water from Cholera Houses, the results of the examination of forty-four samples of cistern water are recorded. It is unnecessary to repeat in this place either the names of the several companies, or the addresses from which the samples were procured. Six other specimens of cistern water were examined, procured from the localities specified in the Table.

Name of Company.	Address.	General Results of Examination.
LAMBETH COMPANY -	126, Waterloo Road.	Every one of the fifty specimens of water from cisterns contained living organic productions, animal and vegetable; and in the great majority of the samples the numbers present were very great. The relative impurity of the several waters corresponds with that of the water of the company by which the cisterns were supplied, with this difference, that in some cases the condition of the waters in the cisterns was even worse; this arising partly from accumulation of organic matter in the cisterns, and partly from the development of other forms of organic productions, particularly entomostreacæ, in those receptacles. The productions met with were for the most part the same as those present in the waters of the different companies as procured from service pipes. See pages 252 and 256.
WEST MIDDLESEX COMPANY -	77, Upper Berkeley Street.	
CHELSEA COMPANY -	12, Lawrence Street.	
SOUTHWARK AND VAUXHALL COMPANY.	St. Thomas's Hospital.	
SOUTHWARK AND VAUXHALL COMPANY.	St. Thomas's Hospital.	
HAMPSTEAD COMPANY -	47, Arlington Street.	

TABLE VI.
RESULTS of the MICROSCOPICAL EXAMINATION of WATER procured direct from the NEW RIVER, the RIVER LEA,
and the THAMES, taken at different Points.

River.	Address.	Condition.
THAMES	Thames Ditton. Hammersmith. Chelsea Reach. Hungerford Bridge. London Bridge. Greenwich.	These waters, including even that of the Thames from Thames Ditton, of the New River, and of the River Lea, abounded in organic matter, dead and living, animal and vegetable, belonging to different and widely dissimilar orders of productions. The condition of the water of the Thames from Hammersmith to Greenwich was of course much the worst, it containing the greatest number and variety of living productions, and it being moreover, especially near the Bridges, demonstrably contaminated with faecal and other matters from the sewers, and it also being further deteriorated by admixture with sea water. The number of productions in the water of the New River and River Lea was very great, and the variety of kinds very considerable. See page 260.
NEW RIVER	At Sadler's Wells.	
RIVER LEA	Canal near Bow.	

TABLE VII.

RESULTS of the MICROSCOPICAL EXAMINATION of some of the deeper
SPRING and WELL WATERS principally in and near LONDON.

Address.	General Results of Examination.
Artesian Well near Trafalgar Square. Artesian Well, Piccadilly. Pump in Vigo Street. Spring in Kensington Gardens. Spring in Hyde Park. Well in Camden Town. Well at Messrs. Barclay's. Well at Messrs. Coombe's. Well at Messrs. Meux. Well at Messrs. Whitbread's. Well at Messrs. Calvert's. Well at Messrs. Reid's. Well at St. Bartholomew's Hospital. Well at Tottenham. Well at Tooting. Spring at Watford. Surface water at Farnham. The same from tap, Farnham. Spring at Weddon, near Bellington. Well at Messrs. Bass'. Well at Messrs. Allsopp's. Well at Messrs. Allsopp's. Well at Messrs. Bass'. From Well belonging to the Woolwich, Plumstead, and Charlton Water Company. From covered Reservoir belonging to the same Company. From House of Mr. Rickson, supplied by the same Company.	The results of the microscopical examination of these waters are satisfactory in the highest degree. It appears, as might have been anticipated, that the deeper well and spring waters, when not exposed to special sources of contamination, and they rarely are so, are absolutely free from living organic productions of every kind and form. Thus there exist in nature waters in abundance, and easily procurable, which are not open to the serious sanitary objections which attach to nearly all the waters by which the Metropolis is at present supplied. Further, the case of the Woolwich, Plumstead, and Charlton Water Company proves that these waters may be supplied to the consumer in a state of almost absolute purity, and entirely free from even the smaller and simpler living forms of organic matter. For further particulars, see page 267. For general conclusions, see page 269.