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TRANSACTIONS OF THE SOCIETY.

VII.—*The Genus Synchæta: A Monographic Study, with Descriptions of Five New Species.*

By CHARLES F. ROUSSELET, Curator and F.R.M.S.

(*Read June 18th*, 1902.)

PLATES III. TO VIII.

SOME of the members of this genus are amongst the commonest Rotifers inhabiting fresh-water lakes and ponds, as well as brackish tide pools and the open sea. Being also of fair size they will necessarily have been amongst the Rotifers observed by the early investigators with the Microscope. Pastor Eichhorn (1761) and F. O. Müller (1786) are probably the earliest authors who have left sketches that can be recognised as Rotifers belonging to this genus, but the species cannot be determined. Our real knowledge of these Rotifers dates from about 1831 to 1834, when Prof. Ehrenberg determined four species of Synchæta:—*S. pectinata*, *tremula*, *oblonga*, and *baltica*. Up to 1886, when Hudson and Gosse's monograph was published, these four remained the only known kinds, and in the Supplement published in 1889 only two more species, *S. longipes* and *gyrina*, were added to the list. At

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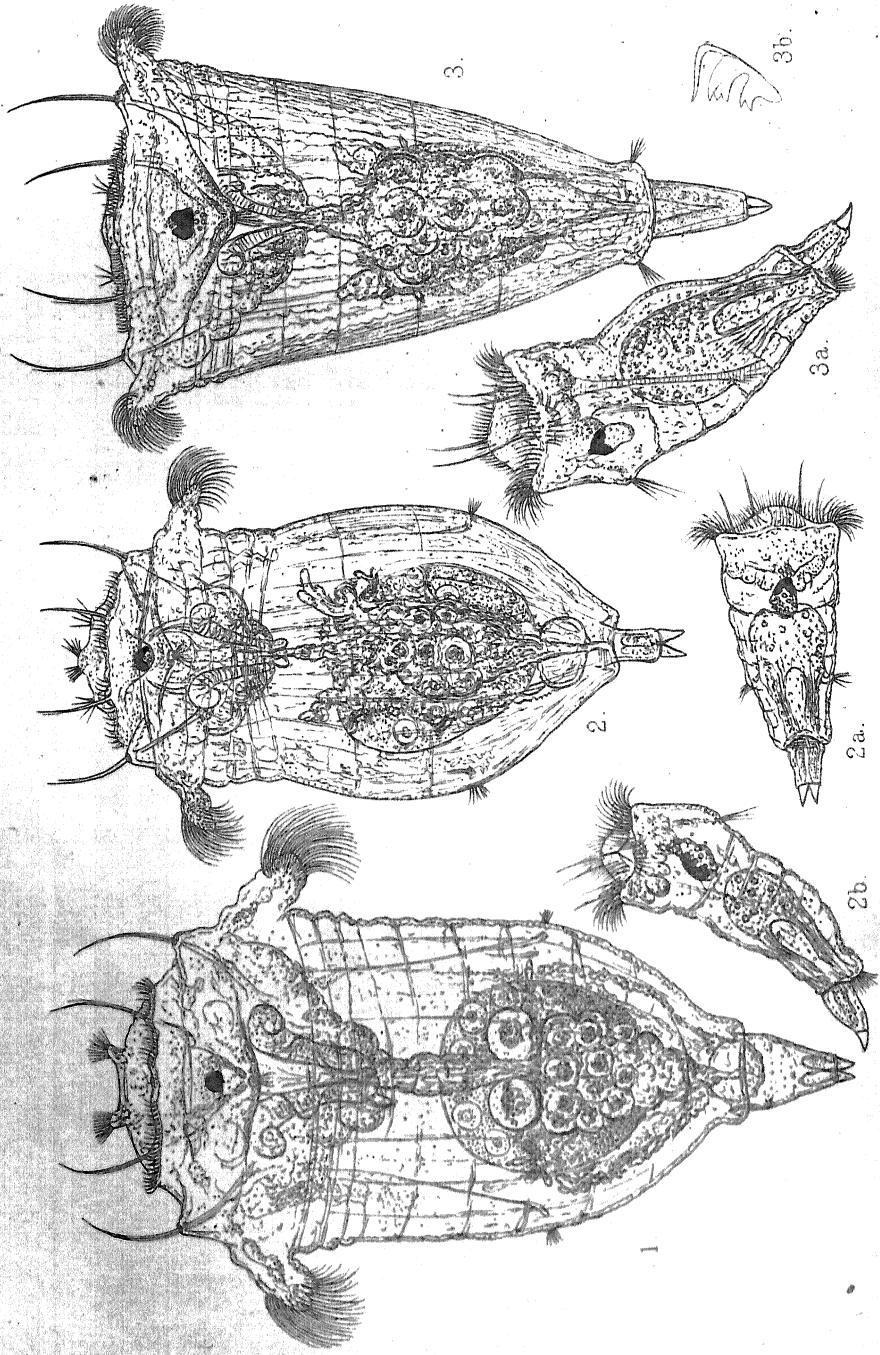
EXPLANATION OF PLATE III.

Fig. 1.—*Synchæta pectinata* Ehrbg. ♀ Dorsal view. × 250.
" 2 " *oblonga* Ehrbg. ♀ Dorsal view. × 375.
" 2*a* } " " " The male, dorsal and side views. × 400.
" 2*b* }
" 3 " *tremula* Ehrbg. ♀ Dorsal view. × 300.
" 3*a* " " " The male, side view. × 450.
" 3*b* " " " One uncus of the jaws.



F.R.Dixon-Nuttall del. ad nat.

West, Newman lith.

the present time I can record the following sixteen species of Synchæta, five of which are here described for the first time :—

IN FRESH WATER.

1.	*Synchæta pectinata* Ehrbg.	Greatest size	408 μ ($\frac{1}{62}$ in.).
2.	„ *tremula* Ehrbg.	„	292 μ ($\frac{1}{87}$ in.).
3.	„ *oblonga* Ehrbg.	„	225 μ ($\frac{1}{112}$ in.).
4.	„ *grandis* Zach.	„	505 μ ($\frac{1}{50}$ in.).
5.	„ *stylata* Wierz.	„	292 μ ($\frac{1}{87}$ in.).
6.	„ *longipes* Gosse.	„	204 μ ($\frac{1}{125}$ in.).
7.	„ *kitina* sp. n. Rouss.	„	136 μ ($\frac{1}{186}$ in.).

IN BRACKISH WATER.

8.	*Synchæta tavina* Hood.	Greatest size	254 μ ($\frac{1}{100}$ in.).
9.	„ *littoralis* sp. n. Rouss.	„	238 μ ($\frac{1}{107}$ in.).

MARINE.

10.	*Synchæta baltica* Ehr.	Greatest size	523 μ ($\frac{1}{48}$ in.).
11.	„ *gyrina* Hood.	„	326 μ ($\frac{1}{78}$ in.).
12.	„ *triophthalma* Laut.	„	265 μ ($\frac{1}{96}$ in.).
13.	„ *monopus* Plate.	„	254 μ ($\frac{1}{100}$ in.).
14.	„ *cecilia* sp. n. Rouss.	„	142 μ ($\frac{1}{180}$ in).
15.	„ *vorax* sp. n. Rouss.	„	340 μ ($\frac{1}{75}$ in.).
16.	„ *neapolitana* sp. n. Rouss.	„	163 μ ($\frac{1}{156}$ in.).

Both Prof. Ehrenberg and Mr. Gosse have associated some marine Synchætæ with the luminosity of the sea, for which, however, no evidence has been produced other than the fact that some Synchætæ were found in water which was luminous at the time. Their own experiments showed, moreover, that Synchæta was not the cause of the luminosity, and the sea-water contained other organisms such as Noctiluca and Peridinia which are known to be luminous.

The chief characteristic peculiarities of the Synchætæ are their prominent, rounded, ciliated auricles situated on each side of the head, and the more or less cone-shaped body, by means of which they can at once be distinguished from all other Rotifers. Their internal organization also presents peculiarities which are not found in other families. The structure of the large heart-shaped mastax, containing a V-shaped finely striated muscle, and forcipate jaws, is unique; then also the four large, stiff, styliform frontal setæ, which Ehrenberg thought were pincers connected with the jaws, are very characteristic and conspicuous.

The jaws are of large size, but the parts are so extremely thin and fine that they will hardly sink in the water when dissolved out with potash, and their exact shape is therefore exceptionally difficult to make out. After considerable trouble I have obtained a number of isolated clean jaws and have mounted them separately. There are two types of jaws in the Synchætæ which may be designated as the *pectinata* and *tremula* types, and which are represented in fig. 7, pl. IV. and fig. 10, pl. V. The main difference between these two types is that in the *pectinata* type the thin triangular unci have no teeth, whilst in the *tremula* type they have six to seven well developed teeth. In both types the fulcrum is very long, thin in front view and wide or broad from the side, and the narrow manubria, as well as the rami, have large rounded, but extremely thin, wing-like lateral prolongations which are quite invisible in the living animal, and can be seen only when the jaws have been completely dissolved out with potash, and then only satisfactorily by a good dark-ground illumination. When all the parts are in position the jaws form a nearly globular structure, and therefore no single view can give a good idea of the shape and form of the parts. By transmitted light only the outline of these thin plates is perceived. Fig. 7 shows a front view and fig. 7*a* a side view of the jaws of *S. pectinata*, and fig. 10 a front view of those of *S. oblonga*, whilst fig. 10*a* represents the unci and fig. 10*b* a separated manubrium of the same. The unci of *S. tremula*, *triophthalma*, and *vorax* are shown in figs. 3*b*, 14*a*, and 19*b* respectively. The jaws as a whole are nearly globular in shape, and therefore any drawing of them, showing the various parts in position, is bound to be semi-diagrammatic. The unci are situated immediately below the shield-shaped mouth, ready to seize anything that may enter, and a view of them with a high power can readily be obtained in the living animal by adding one drop of 2 p.c. cocaine, or of 1 p.c. eucaine, in a watch-glass full of water containing the Synchætæ and then transferring some to a compressor, when the animals will soon fix themselves with their heads to the cover-glass and remain there for a long time almost motionless, except the movement of cilia. With a high power (I use a fine Zeiss $\frac{1}{10}$ apochromatic water-immersion) this affords an excellent view of the whole front of the head, which it is otherwise almost impossible to obtain.

The great majority of Synchætæ have jaws of the *tremula* type. I do not think any Synchæta can project its jaws through the mouth, for the unci are quite twice as large as the shield-shaped mouth-opening. The heart-shaped mastax contains in its interior a roughly dumb-bell shaped cavity. The muscles of the mastax can expand this cavity suddenly, and it is my belief that by this sucking action the food-particles, consisting of diatoms, algæ, infusoria, and small rotifers, are forced into the mouth when they are at once seized by the unci.

Figs. 11*a* and 12*a*, pl. VI., represent the front view of the head of *S. baltica* and *S. monopus* respectively, which have been drawn

and communicated to me by Dr. K. M. Levander. This arrangement of the mouth, auricles, vibratile cilia, and frontal styles is common to all Synchætæ. Another peculiarity of all species of this genus, which has not been described before, is the single row of very fine short setæ which surround the shield-shaped mouth, all curving over the opening and forming a dome-shaped screen through which all food-particles must pass before reaching the mouth. In some species some of these stiff fine hairs can just be perceived at the extreme front from a dorsal view, but the real shape and structure of this screen can only be seen well from a good front view with a high power.

There are other bundles of sense-hairs on the front of the head which vary in different species and are described in their respective places.

Unlike what obtains in most other Rotifers, it appears that in no Synchæta do the lateral canals and flame-cells (vibratile tags) extend much beyond the anterior end of the gastric glands. The lateral canals lie close to the walls of the stomach on each side, if they are not actually fixed to them by connective tissue threads; near the gastric glands they make a convolution to which two flame-cells are usually attached, and send on each side a single short branch forward which is attached to the body-wall by a fine thread, and terminates in one or two flame-cells. Two more flame-cells are situated on the branch lying near the middle of the stomach on each side. In no case have I observed a lateral canal or flame-cell in the head of a Synchæta. Posteriorly the lateral canals usually make a loop in the wall of the contractile vesicle before opening into it.

In all Synchætæ the muscular bands, retractors of the head and foot, are very narrow and finely striated.

The brain-sac is large and usually lobed, very transparent and not readily seen; it carries the cervical eye, which is a spherical vesicle filled with granules which may be all red or partly red and partly white. In the first case the eye appears spherical as in *S. pectinata* and *stylata*; in the other cases, as in *S. tremula*, *oblonga*, *tavina*, &c., it appears more or less completely divided into closely apposed halves, which may be unequal in size. In two species, i.e. *S. triophthalma* and *littoralis*, there is a very fine double canal connecting the cervical eye with two red eye-spots in the front part of the head; the canals are filled with numerous very fine red granules. I have observed similar canals containing a few scattered red granules occasionally in *S. tremula* and *oblonga*. The colour of the eyes of Synchæta is usually red, sometimes with a tinge towards violet. The red may occasionally be so deep as to appear black by transmitted light. These eyes enable the Synchætæ to perceive light, and they quickly collect to the light side of a small aquarium, but there is no evidence that they can see

objects, as I have shown to be the case with some other rotifers, such as *Pedalion mirum*.* They never collide with others, however, in their incessant and quick movements through the water.

The eggs of Synchætæ are clear and transparent, nearly spherical, or slightly oval in shape, and contain usually a small cluster of golden yellow granules. As a rule the eggs are laid in the water, where they fall to the bottom, but having a sticky surface they adhere to any plant or object which they may touch. In a few pelagic marine species, i.e. *S. baltica*, *cecilia*, *triophthalma*, and *neapolitana*, the eggs are habitually carried about, attached to the toes till hatched. In *S. oblonga* I have seen the extrusion of an egg: it remained attached to the toes for a few seconds and then fell off. *S. stylata* has developed an egg of very unusual character, being surrounded by very fine, long, stiff spines, about three times as long as the diameter of the egg, which prevents it from sinking, and the egg consequently floats in the water, fig. 4*a*, pl. IV. All these are summer eggs; thick-shelled or spiny resting eggs have not been observed in any species. Dr. Zacharias has stated that in the lakes of the north of Germany *S. pectinata* and *tremula* habitually carry their eggs attached to their toes, which they certainly never do in this country, nor am I aware of anyone else having observed this in any other part of the world.

The **males** of Synchætæ are rather rare; I have seen those of the following species:—*S. tremula*, *oblonga*, *tavina*, *cecilia*, *vorax*, *neapolitana*, and *littoralis*, which are described in their places in the following pages. Mr. John Hood has seen that of *S. gyrina*, and has also reported to me doubtfully the male of *S. pectinata*. In every case the males are very small, conical in shape, with cervical eye, four frontal styles, prominent dorsal and lateral antennæ, and devoid of mastax and intestine. It is strange, however, that no fertilised resting egg has ever been observed in any Synchæta, though the males were occasionally present in great numbers.

The Synchætæ, particularly *pectinata* and *tremula*, are not infrequently subject to both external and internal parasites. The external parasites I have observed consist of Infusoria: a species of minute vorticella with a very short stalk, which attaches itself singly anywhere on the integument, and also *Trichodina pediculus* the parasite of Hydra, which I have once seen running all over a *S. pectinata*; the connection, however, may have been quite accidental and temporary. The internal parasites are more serious and consist of numerous spherical bodies, 22 μ ($\frac{1}{1150}$ in.) in diameter, filled with clear protoplasm and some fine refractive granules, and of elongated sausage-shaped bladders 68 μ ($\frac{1}{374}$ in.) long by 13·6 μ ($\frac{1}{1870}$ in.) wide. At first these latter are similar in structure to the spherical bodies, but afterwards the whole bladder becomes

* On the Sense of Vision in Rotifers. Journ. Quekett Micr. Club, vol. iv. pp. 371–3 and 376–7 (1892).

filled with small spherical cells of uniform size, pl. VI. figs. 13 and 13*a*. The spherical bodies are probably a stage in the development of the elongated bodies. The real nature of these parasites, which probably belong to the class known as Sporozoa, their development and mode of entry, remain obscure; they have no motion of their own, but float in the fluid of the body-cavity on which they live and are continuously shifted about by the contraction of the rotifer's muscles. The Synchætæ do not seem to be much inconvenienced by the parasites, but no doubt they succumb eventually. These parasitic protozoa are evidently the same which Dr. Bertram has described as "Parasitische Schläuche in der Leibeshöhle von Rotatorien,"* and which he found in some *Brachionus pala*. They have also been mentioned by Dr. Zacharias as occurring in Synchæta and named by him *Ascosporidium blochmanni*;† and Prof. A. Fritsch has described similar parasites under the name of *Glugea asperospora*.‡ The parasites lately described by Mr. A. M. Przesmycki§ as occurring in Brachionus are of a different nature; the latter are very much smaller unicellular cells which render Brachionus and other rotifers quite white and milky.

The Synchætæ occur both in fresh and brackish water and in the open sea, but it seems to me that they keep to their respective elements and that the fresh-water species are never found in salt water, and the salt-water species never in fresh water. If a *S. pectinata* be placed in brackish or sea water it dies in a few minutes, and if the marine *S. triophthalma* be placed in fresh water the same thing occurs. It cannot be supposed that salt water or fresh pond water can exert a poisonous influence on these species respectively. The inability of these rotifers to live in an element to which they are not accustomed is due to the mechanical action of fluids having different densities on the cell-contents of their tissues and organs. The specific gravity of fresh water being 1, that of sea water is 1·027, and this is quite sufficient to produce strong diffusion currents by osmosis between the outside fluid and that contained in the body-cavity, and eventually in the cells of the various organs. The lighter fluid will get through the cell-walls quicker than the denser fluid can get out and *vice versa*, with the result that the cells and the whole animal will either swell or shrivel up, and this will injure or burst the delicate cells and completely stop the functions of the various organs, causing the death of the animal.

As regards their appearance, some forms such as *S. pectinata*, *tremula*, and *oblonga* can be found all the year round, but often appear in greatest numbers in the winter months or very early

* Zool. Jahrbücher, Bd. v. 1892, pp. 596-600.

† Plöner Forschungsberichte, Teil 6, 1898, p. 48.

‡ Ueber Parasiten bei Crustaceen und Räderthieren der süssen Gewässer. Bull. Intern. de l'Académie des Sciences de l'Empereur François Joseph I., Prague, 1895.

§ Ueber Parasitische Protozoen aus dem Innern der Rotatorien. Bull. de l'Académie des Sciences de Cracovie, 1891.

spring; other kinds like *S. littoralis*, *tavina*, *gyrina*, *vorax*, *cecilia*, and *kitina* like a little warmer weather, but are most erratic in their sudden appearance and disappearance. *S. grandis*, *stylata*, and *longipes* I have found only in the summer months, July to September, whilst the pelagic marine species *S. baltica*, *monopus*, *triophthalma*, and *neapolitana* seem to come to the surface in the summer when the sea has been calm for a considerable time.

All Synchætæ can be prepared easily and preserved fully extended by the method I have described, of which the following are the main stages:—Isolation in a watch-glass full of clean water; narcotisation with one or two drops of 2 p.c. cocaine or 1 p.c. eucaine for about half an hour; killing and fixing with ¼ p.c. osmic acid or Hermann's platino-osmic mixture, washing in water (the marine species in sea water), preserving in 2½ p.c. formaldehyde. Marine species die fully extended when placed in distilled water. I possess preserved specimens of all the sixteen species, and they are here under Microscopes for your inspection.

I am very greatly indebted to my friend Mr. F. R. Dixon-Nuttall, J.P., of St. Helens, for the excellent drawings of the various species which accompany this paper, and which he has spared no pains to make, with his accustomed skill, from the living animal whenever possible, or from preserved specimens; it would indeed have been impossible for me to have made such life-like representations, which so very greatly increase the value of this memoir, and will assist in the identification of the various species. My thanks are also due to Mr. John Hood, of Dundee, and Mr. H. E. Hurrell, of Great Yarmouth, for sending me living specimens of the various marine species, and to Dr. K. M. Levander, of Helsingfors, for preserved specimens of the species living in the Baltic Sea, and for the figures of *S. monopus* which he has been good enough to send me.

It has been found impracticable to draw all the animals on a uniform scale, as was at first intended, because if that had been done, either the smaller Synchætæ would have been drawn too small for recognition, or else the larger species would have gone beyond the limit of the plates. The figures therefore have been drawn of convenient dimension, irrespective of their size, which must be ascertained from the descriptions. All species vary considerably in size, as the newly hatched individuals are only about half the bulk of the adult. In most cases the largest observed proportions have been given. It must not be forgotten also, in comparing the figures with the living animals, that the shapes also vary considerably, some species being more conical when young, and stouter and rounder occasionally when the food-material is exceptionally abundant.

It has not been the object of this paper to give an exhaustive description of the minute anatomy of the various organs of

Synchætæ, which on the whole are much the same as in other Rotifers, and moreover, would require a separate volume. My intention rather has been to give a sufficiently detailed description and good figure of each species, so as to clear up the existing uncertainty and allow any one of the species to be readily identified. I trust this has been accomplished in this memoir on which I have been at work for some years.*

Synchæta pectinata Ehrenberg.

Pl. III. fig. 1, and Pl. IV. fig. 7.

SYNONYMY.

Synchæta mordax Gosse.
Synchæta oblonga Gosse.

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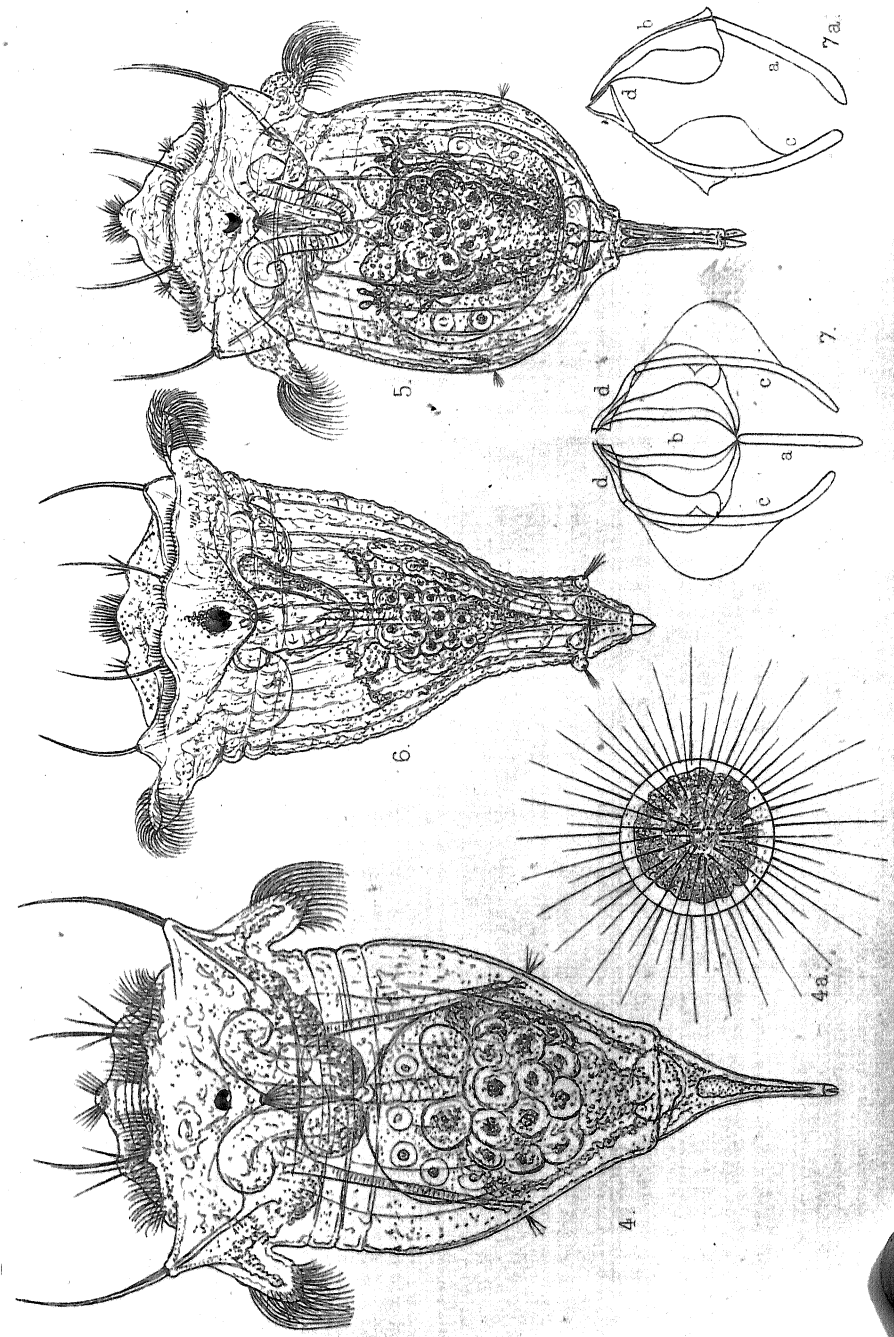
Spec. Char.—Body sub-conical, very broad and convex anteriorly; auricles large, more or less pendent; two small cylindrical fleshy prominences bearing a broad brush of setæ on front of head; four frontal styles, the outer pair the largest; eye round, dark red or bluish-purple in colour; toes two, small, acute. Size

EXPLANATION OF PLATE IV.

Fig. 4.—*Synchæta stylata* Wierz. ♀ Dorsal view. × 350.
" 4a " " " The egg. × 275.
" 5 " *longipes* Gosse ♀ Dorsal view. × 400.
" 6 " *kitina* sp. n. Rouss. ♀ Dorsal view. × 500.
" 7 } " *pectinata* Ehrbg. The jaws. × 275.
" 7a }

* Dr. Wesenberg-Lund of Copenhagen, in a paper published in 1900 (Biologisches Centralblatt, Bd. xx. Nos. 18 and 19, 1900), wished to recognise only two fresh-water species of Synchæta, namely *S. pectinata* and *tremula*, considering all the other described species as merely seasonal varieties of these main forms. I am not inclined to make or maintain new species out of mere variations of size or form, but when these are accompanied by constant internal and external anatomical characters, males and eggs of different shape and structure, I think it is going too far to fuse them all into one or two species. The animal Dr. Wesenberg-Lund calls *S. pectinata minor* is most probably *S. oblonga*, which may occasionally be seen carrying an egg for a short time.



F.R.Dixon-Nuttall and C.F.Rousselet del.ad nat. West,Newman lith.

up to 408 μ ($\frac{1}{62}$ in.) long by 231 μ ($\frac{1}{110}$ in.) wide at the auricles. Egg spherical, 98·5 μ ($\frac{1}{258}$ in.) in diameter. Lacustrine.

This handsome rotifer, one of the most common and widely distributed species in England, as well as on the Continents of Europe and America, appears to have first been recorded by Ehrenberg in 1831, in a communication to the Berlin Academy of Science, and afterwards in 1838 in his great work on the Infusoria.

In 1870, Dr. C. T. Hudson subjected this species, under the name of *S. mordax*, to a careful study, which was published in the *Monthly Microscopical Journal*, vol. iv. pp. 26–32, with a plate of good figures, showing its various aspects. The animal Mr. Gosse has figured as *S. oblonga* in *The Rotifera* is certainly a *S. pectinata*, swollen and half dead; the two frontal processes are sufficient to identify it as such.

Synchæta pectinata is a well characterised species, which cannot be mistaken when once seen. Its large sized, white, very transparent, more or less conical body, and large prominent auricles, make it a conspicuous object even with the naked eye. But its special character, which serves best to distinguish it at once from its congeners, are two fleshy setose protuberances, or little horns, on the front of the head; no other species of Synchæta has these organs.

The shape of the body is that of a more or less swollen cone, very broad and convex anteriorly, ending in a short stout foot and two minute conical toes. The exact shape of the body varies a good deal. Young animals have straighter sides than represented in fig. 1, whilst occasionally extra well fed specimens are met with which are more swollen round about the stomach.

The head is very broad, and, with the auricles, forms a wide semicircle; dorso-ventrally it is a little compressed, rising only to a prominence on the dorsal side where the dorsal antenna protrudes. The ciliary wreath consists of two parts: the dorsal part is formed by a nearly straight double cushion of vibratile cilia, interrupted in the centre; the ventral part forms a smaller rounded double cushion of cilia below and at the sides of the mouth, and these cilia are mainly concerned in driving food-particles to the mouth. The prominent auricles are large, semicircular, slightly pendent, and furnished with long, powerful vibratile cilia, all arising on the upper surface of the auricles, from a cushion of dense grey protoplasmic material. The auricles are supplied with a number of muscular bands, arising from the integument of the head and body-cavity, which can retract and also alter the position of these organs, and thereby vary the incidence of the beat of the cilia. This explains the vigorous turning movement and gyrations which the animal performs with such rapidity.

Of sense-organs there are on the head, first of all, two pairs of styles, which are really clusters of long, fine, stiff setæ. The outer pair are the largest and most prominent, arising from a small triangular fleshy flap, and can be followed for some distance within a muscular sheath in the head, to which a nerve-thread is attached. The inner pair is smaller, more dorsal in position, and situated immediately below the ciliary wreath. On the ventral side of the head, on each side of the mouth, there are two setigerous pimples, each bearing two short styles. These are not seen from a dorsal view. Then, right in the middle of the front of the head, are the two characteristic fleshy prominences already mentioned, surmounted by a fan of short, stiff sense-hairs. A nerve-thread with ganglionic enlargement can be seen within the prominences. The dorsal antenna, seated on an eminence just above the eye, is quite large and prominent when seen from the front or side, but is not readily observed when looked at from a dorsal view; it seems to be a double organ fused into one, as two rocket-shaped nerve-threads are seen to converge to it. The lateral antennæ were thought to be absent altogether by all previous observers. For a long time I searched for them in vain up and down the sides of the body, and could not understand why so large a rotifer should be without these sense-organs, so characteristic of the entire class. About two years ago I had received some dried pond mud from Australia, and placing this in water, in a few days a solitary *Synchæta pectinata* made its appearance from some dormant egg, which shows at the same time how rotifers can be transported from one distant continent to another. On examining this pale, very transparent individual with quite a low power under dark-ground illumination, it slowly turned round on its longer axis, when suddenly I noticed a fine brush of long setæ protruding from the side of the body on a level with the stomach. On further investigation of this strange appearance, which I had searched for many times with low and high powers and with the very best optical means, I found that the lateral antennæ are quite obvious, but situated on the *ventral* side of the body, and therefore are quite invisible from a dorsal view, the position in which I, and no doubt everybody else, had always searched for them. In the figure their position at the sides is indicated, but it must be remembered that they are situated just round the corner on the ventral side.

The mouth is not oval, as has been stated, but shield-shaped, and quite straight on the upper side. On the upper, and on each lateral side there is a cushion of grey protoplasm, from which arise a single row of very fine, short, stiff setæ, which curve over the mouth, meeting in the centre, and thus form a screen through which all food-particles must pass. This very fine dome-shaped screen is seen well only in a front view of the head under a high

power. I can see it best with my fine Zeiss apochromatic $\frac{1}{10}$ in. water-immersion.

Dr. Hudson enlarges upon the great difficulty in obtaining a frontal view of Synchæta's head. It is to be regretted that he did not know the effect of a drop of 1 p.c. cocaine solution added to a trough full of water. After a few minutes Synchæta, which Dr. Hudson rightly calls "perpetual motion itself," becomes as quiet as a dove, the body fully extended, the cilia moving, but with gradually decreasing vigour until they stop altogether, remaining thus narcotised and nearly motionless for more than an hour before the animal dies. Moreover, some of them frequently fix their heads to the cover-glass of the compressor and remain there for ten or twenty minutes at a time, the cilia beating feebly all the time. In this way I found no difficulty in obtaining ideal views of this and other Synchætæ, usually in perpetual motion.

The large mastax of *Synchæta pectinata* has a peculiar pear-shaped form, characteristic of the genus, containing in particular two finely striated V-shaped muscles embracing the base of the long fulcrum. I have taken great pains to dissolve out the jaws of *S. pectinata*, which has proved a difficult task owing to the extreme thinness and lightness of the parts. By mounting a number of these separated jaws without pressure in a shallow cell, I think I have succeeded in obtaining a correct interpretation of their structure, which is shown in figs. 7 and 7*a*, front and side view. The fulcrum *a* is a long narrow rod; the rami *b b* are thin elongated blades, ending in a single sharp tooth, with very thin, curved, wing-like plates fixed to the sides; the malleus consists of a narrow curved manubrium *c*, from which also a very thin plate of chitine projects, and a small triangular plate forming the uncus *d*. The edges of the unci are quite smooth, and there are no teeth as is the case in those of *S. tremula*, *oblonga*, *gyrina*, and others. When looking at the unci from the dorsal or ventral side, a side view is obtained, which of course gives the appearance of a single sharp tooth. The shape and position of the parts will best be seen from the figures. The snapping motion often seen in Synchæta bears, I think, a different interpretation from that usually given to it. Various authors have thought that the jaws protrude through the mouth and seize their prey; this, I think, is not the case, and the snapping motion seen is due to a sudden opening of the buccal funnel and cavity of the mastax, thus producing a strong sucking action, just as in Asplanchna, which draws in the small algæ, infusoria, &c., forming the food of Synchæta. I have seen a pair of tubular muscular bands attached to the dorsal side of the mastax, just by the side of the spot where the œsophagus arises, which may produce this action. The thin plates of the unci lie exactly below the mouth, so that everything entering the mouth can be seized by, and must pass between them.

A small rounded opening below the middle of the dorsal side of the mastax leads to a long, thin-walled œsophagus, which is not ciliated internally, and empties in the rounded thick-walled stomach. The cells of the stomach are large, often containing numerous yellow oil-globules, and ciliated internally, keeping the food in continual motion. The food-particles are usually green or brown, and occasionally pink in colour. The intestine is quite inconspicuous; the cloaca is situated dorsally at the root of the foot. The gastric glands attached to the stomach are spherical in shape, and contain a granular centre and some nuclei.

The ovary is rounded and more or less compressed; usually it is of the same size as the stomach, but in some animals I found it twice as large, filling the greater part of the ventral half of the body-cavity, and containing eight to sixteen nucleated germ-cells. Maturing eggs containing a cluster of small, spherical, yellow granules are often seen by the side of the ovary. The eggs, when laid, fall off immediately, and are not carried about; they are spherical in shape, white, transparent, except the small cluster of deep yellow granules mentioned above; their size is 98·5 μ ($\frac{1}{258}$ in.) in diameter. The surface of the egg is covered with minute sparsely scattered dots. It is worthy of mention that Dr. O. Zacharias has stated that in the north of Germany *S. pectinata* habitually carries its eggs about, attached to the toes. This is very strange, considering that here in England I have never once, during the many hundreds of times that I have had this species under observation, seen a single *S. pectinata* do anything of the kind.

The eye, seated on the granular brain-sac, is fairly large, spherical in shape and bluish-purple in colour; its structure is that of a hyaline vesicle closely packed with very minute purple granules. There is no sign in this species of a stream of red granules forward or of frontal eyes.

The lateral canals and flame-cells are of normal structure, but reach only to the height of the stomach and gastric glands. The contractile vesicle is small, situated at the base of the foot, and a tubule of the lateral canals can clearly be seen to enter it on each side, after making a loop in its wall.

The muscular system is well developed, particularly in the head, where there is a complicated system of narrow, finely striated muscular bands for regulating the position of the auricles and for the retraction of the head. The long retractors of the head and foot are very narrow and finely striated. The transverse muscular bands are more numerous and more closely set around the head and neck region.

The foot is stout and short, contains two foot-glands and carries two small, acute toes.

Synchæta pectinata is a most vigorous swimmer, and its course

is usually that of cork-screw curves, revolving at the same time on its longer axis, but occasionally turning somersaults in rapid succession for a change. More rarely it is seen to hover over one spot with all its cilia in rapid motion, producing a strong current in the water. It does not, however, anchor itself to a thread secreted from the toes as *S. tremula* does habitually. Small as is the body-cavity of this rotifer it is not free from internal parasites of considerable size. I have often observed numerous elongated sausage-shaped bodies, 95 μ ($\frac{1}{267}$ in.) in length by 14 μ ($\frac{1}{1800}$ in.) thick, and also spherical bodies, apparently living on the nutritive fluid it contains, pl. VI. fig. 13. These bodies are not ciliated, have no motion of their own, and consist of a transparent membrane thickly filled with spherical smaller vesicles; they appear to do little harm to the organs of Synchæta, and the individuals containing them seem as vigorous as the others.

I am greatly indebted to my friend Mr. F. R. Dixon-Nuttall for the very fine figure of this species, pl. III. fig. 1, which he has drawn for me from life.

The **male** I have not yet seen, nor have I ever seen any indication of fertilised resting eggs which would indicate the presence of the male; but I should mention that Mr. John Hood has doubtfully reported it to me.

The size of *S. pectinata* varies between 340 μ ($\frac{1}{75}$ in.) and 408 μ ($\frac{1}{62}$ in.), but very young animals may be smaller.

Synchæta tremula Ehrenberg.

Pl. III. fig. 3.

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Gosse, P. H.—On the Structure, &c., of the Manducatory Organs in the Rotifera. Phil. Trans. of the Royal Soc. of London, 1856, p. 434, figs. 41, 42.

—— On the Dicœcious Character of the Rotifera. Phil. Trans. of the Royal Soc. of London, 1858, p. 321, figs. 30, 31.

Hudson & Gosse.—The Rotifera. London, 1886, vol. i. p. 128, pl. 13, fig. 2.

Weber, E. F.—Faune Rotatorienne du bassin du Léman. Revue Suisse de Zool., Genève, 1898, p. 394, pl. 16, fig. 17.

Spec. Char.—Body top-shaped, truncate and straight in front; often yellowish in colour; auricles small, in line with front of the head; four frontal styles; lateral antennæ situated at extreme base of body; eye red, cervical; foot short, narrow; toes two, small, acute. Size from 212 μ ($\frac{1}{120}$ in.) to 292 μ ($\frac{1}{87}$ in.) in length by 115 μ ($\frac{1}{220}$ in.) to 149 μ ($\frac{1}{170}$ in.) wide at the auricles. Male conical, 110 μ ($\frac{1}{230}$ in.) in length; lacustrine.

This bright, common, and widely distributed species has been figured best by Dr. Hudson in his monograph, fig. 2, pl. XIII. It was probably seen by most observers in the early days of Microscopy, but Ehrenberg was the first to figure and describe it with sufficient accuracy for future identification.

In the early spring, it is, as a rule, the most abundant Rotifer in nearly all lakes and pools; it is also frequently met with throughout the summer and autumn, and even in winter under the ice many inches thick. Its ubiquitous habitat is made evident by its presence in nearly every list of Rotifers that has been published in England as well as on the Continent of Europe, in America, Australia, and South Africa. I cannot, however, help expressing a suspicion that one or two other species, particularly *S. oblonga*, have sometimes been mistaken for *tremula*.

In size it is decidedly smaller than *S. pectinata* with which it is frequently associated. In colour it often has a slight yellowish tinge which contrasts with the white transparency of *S. pectinata* when seen together. The integument is thin, white, and transparent, and has some slight longitudinal folds along the dorsal side.

In shape the body of *S. tremula* is that of a slender cone, quite straight and flat in front, the small rounded auricles forming a lateral prolongation of the flat frontal surface. In young animals the sides of the body are quite straight also, but in well-fed specimens the sides bulge out more or less. The foot is short, less wide in girth than the apex of the body, and tapers to the two small acute toes.

The front of the head bears two pairs of styles, the larger outer pair arise from very small triangular fleshy flaps. Two pairs of setose pimples are, as usual, situated ventrally on each side of the mouth, each bearing two or three stiff divergent hairs. The ciliary wreath consists of a nearly straight band along the dorsal border of the head, which, however, is interrupted by a dorsal gap in the middle, and ventrally by two strongly ciliated cushions, one on each side of the mouth.

The auricles are thin, small, semicircular, of usual structure, and in line with the front of the head.

The mouth is situated on the ventral half of the head; it is shield-shaped, and surrounded by the usual single row of very small stiff hairs curving over it all round.

The dorsal antenna protrudes from an eminence in the usual position above the eye and is connected by two rocket-shaped enlargements and nerve-threads with the brain. The lateral antennæ are found very low down at the sides of the body, close above the foot.

The eye, seated on a granular brain-sac, is deep red, rounded and of usual structure; the red granules do not always fill up the whole eye-vesicle, and sometimes, congregating on either side of it, give rise to an appearance of a double eye. From the eye two narrow divergent tubules, as described in the introduction, advance to the front of the head, and these tubules sometimes contain very minute scattered red granules. I have counted ten and twelve of these on each side on a recent occasion.

The characteristic mastax is somewhat smaller in proportion than in *S. pectinata*, whilst in structure it is very much like that which is figured for *S. oblonga*, pl. V. fig. 10. The unci are thin triangular plates with five or six teeth, very irregular in shape and divided in two sets by a deep incision (fig. 3*b*); the first tooth is long and pointed and well separated from the rest, which is characteristic of this type; a very small knob of chitin at the back of this first tooth indicates the spot where the manubrium is fixed. The unci lie immediately below the mouth, and can readily be seen from a frontal view in the living animal. I do not think the jaws can be projected through the mouth as has been stated, and the action of the mastax is the same as I have described in the case of *S. pectinata*. The œsophagus is of moderate length and opens into a saccate thick-walled stomach, the cells of which usually contain yellow oil-globules. A small and densely ciliated intestine opens on the dorsal side of the base of the body. The usual rounded, or more or less pointed, gastric glands are readily seen. The ovary is a fairly large and thick rounded plate on the ventral side, filled with nucleated germ-cells. The lateral canals seem to be attached to the wall of the stomach on each side, where they form some convolutions, from which one branch runs forward and is attached to the body-wall at a height corresponding to the middle of the œsophagus, and there ending in two flame-cells on each side. Two more flame-cells are seen lower down on the canal running by the side of the stomach. No canal or flame-cell has ever been seen in or near the head. The contractile vesicle is fairly large, in its usual position above the foot.

The longitudinal muscles, retractors of the head and foot, are narrow and finely striated; six to eight fine transverse muscular threads run close together round the integument on the anterior part of the body; lower down there are fewer threads and they seem to be confined to the dorsal side.

The **male**, fig. 3*a*, was first discovered by Mr. Gosse; it is a small conical creature with a bent towards the ventral side close behind the head. The front is truncate, with four styles. The red eye, dorsal antenna, large sperm-sac, and two acute toes are prominent. The mastax and stomach are quite absent, and replaced by the sperm-sac. The size is 110 μ ($\frac{1}{230}$ in.) in length. I found the male in some abundance in a gathering in October 1900, and it is not very rare.

Synchæta tremula is a vigorous swimmer, and takes, as a rule,

a more or less straight course. It loves also to spin a fine thread from its toes, and attaching it to any convenient object, remains anchored, spinning round and round on its longer axis for a long time on the same spot, while the vigorous action of the frontal cilia, instead of propelling the animal forward, produces a strong current of water towards the head which brings food to the mouth. *S. pectinata* and *oblonga* never spin round in this way. Contrary to what other observers have reported, I have never seen *S. tremula* carry its eggs about. Dr. Zacharias has stated that in the North of Germany this species, as well as *S. pectinata*, habitually carry their eggs, which seems very strange if there be no error as to species.

I have never seen *S. tremula* in salt water, and have little doubt that when it has been reported as occurring in the sea or in brackish tide pools, one of the marine species must have been mistaken for it.

Its largest size when full-grown I have found to be 292 μ ($\frac{1}{87}$ in.) long by 149 μ ($\frac{1}{170}$ in.) wide at the auricles. Young animals are, of course, much smaller, and an average size would be about 235 μ ($\frac{1}{108}$ in.) long by 124 μ ($\frac{1}{205}$ in.) wide.

Synchæta oblonga Ehrenberg.

Pl. III. fig. 2 and Pl. V. fig. 10.

Synonymy.

Synchæta neglecta Zacharias.

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Ehrenberg, C. G.—Abhandlung der Akad. d. Wiss. Berlin, 1831, p. 135; 1833, p. 221.

—— Die Infusionsthierchen. Leipzig, 1838, p. 438, pl. 53, fig. 4.

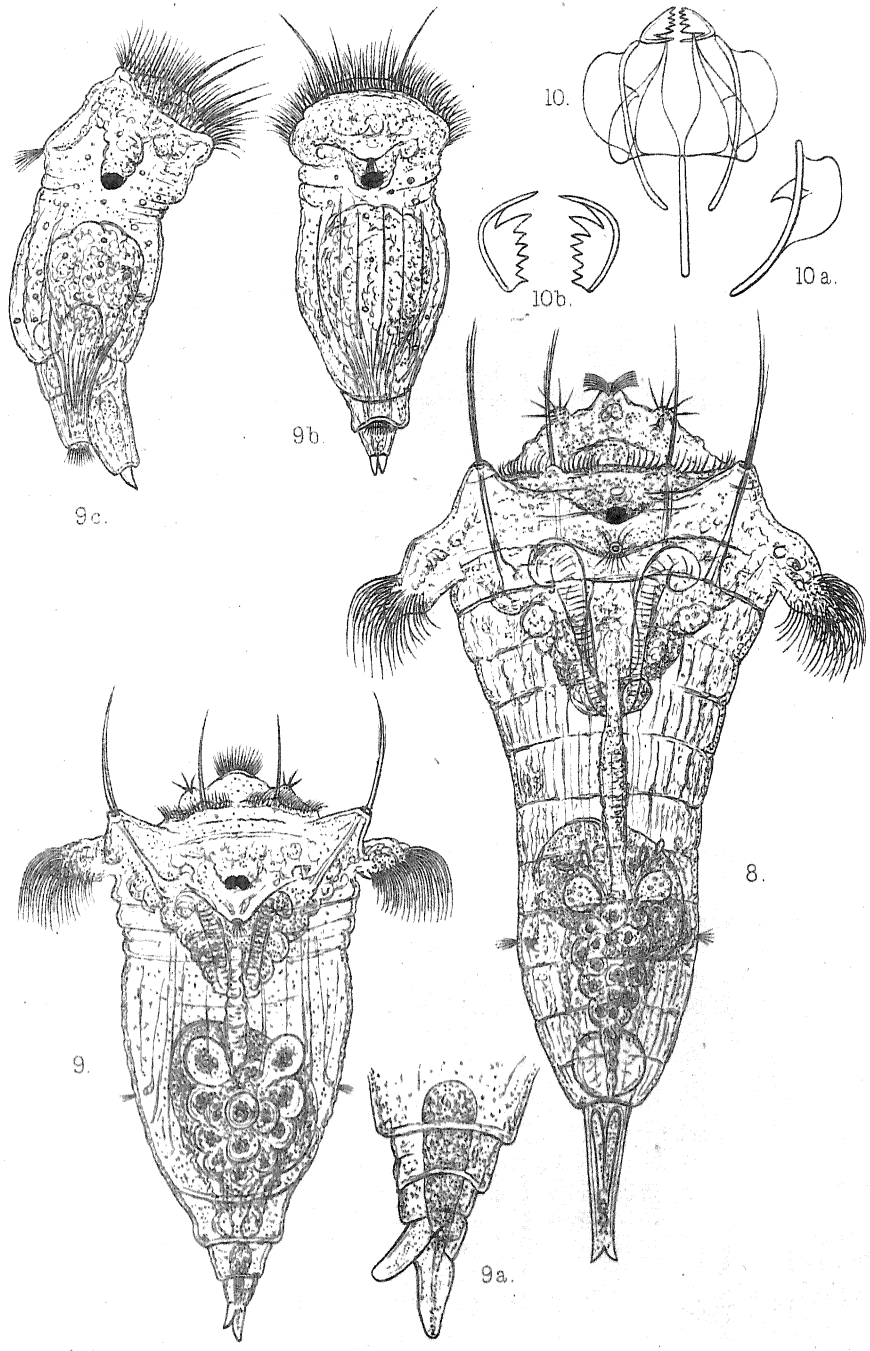
Hudson & Gosse.—The Rotifera. London, 1889, vol. i. p. 127.

Zacharias, O.—Ueber die im Süsswasserplankton vorkommenden Synchæten. Biol. Centralblatt, Bd. ii. 1901, pp. 381–3.

Spec. Char.—Body small, cone-shaped, somewhat oblong and more or less swollen at sides, rounded in front; auricles small; four frontal styles; lateral antennæ very small, situated two-thirds down the sides of the body; eye red, cervical; foot short, narrow;

EXPLANATION OF PLATE V.

Fig. 8.—*Synchæta grandis* Zach. ♀ Dorsal view. × 225.
„ 9 „ *neapolitana* sp. n. Rouss. ♀ Dorsal view. × 470.
„ 9*a* „ „ „ The toe and spur. × 1175.
„ 9*b*, 9*c* „ „ „ The male, dorsal and side views. × 680.
„ 10 „ *oblonga* Ehrbg. The jaws. × 550.
„ 10*a* „ „ A separated manubrium. × 550.
„ 10*b* „ „ The unci. × 875.



F.R.Dixon-Nuttall and C.F.Rousselet del.ad nat. West, Newman lith.

Synchaetae.

toes two, small, acute, well separated. Size up to 225 μ ($\frac{1}{113}$ in.) in length by 115 μ ($\frac{1}{220}$ in.) wide at the auricles. Male 102 μ ($\frac{1}{250}$ in.) in length. Lacustrine.

Although a very common species everywhere in fresh-water ponds and lakes, I fear this animal has not been clearly recognised until quite lately. One reason possibly is that Ehrenberg gives it a size equal to that of *S. pectinata*, which is obviously not correct; another reason is that Mr. Gosse has figured under this name of *oblonga* an animal which certainly was a sick *pectinata*, the two frontal fleshy little horns being quite sufficient to recognise it as such.

Most workers will have taken this common Synchæta for a small *S. tremula*, whilst I have for a considerable time past separated it from *tremula*, but have confounded it with *S. gyrina* of Hood, which I now know is a larger and exclusively marine and brackish water species. In the lists of Rotifers, therefore, found at the Quekett Club's excursions published in the *Quekett Journal*, wherever *S. gyrina* is mentioned, this name should be altered into *oblonga*. Quite recently Dr. Zacharias, recognising its distinctive characters, has given it the new name of *S. neglecta*, while it is represented in his earlier lists under the name of *S. tremula*.

Prof. Ehrenberg in his great work describes *S. oblonga* as the commonest Synchæta occurring in his time near Berlin, and usually associated with *pectinata* and *tremula*. This is exactly what I find to be the case here near London at the present time.

At first sight, and when observed with a low power, it has much resemblance in shape and size with a small *S. tremula*. A closer acquaintance, however, shows a number of differences in shape, structure, and habits, which can always be readily recognised. Perhaps it will be convenient if I first clearly state the differences which separate these two species. *S. tremula* has a top-shaped body with the front of the head quite straight and flat, and the auricles in a line with the front. *S. oblonga*, whilst also more or less cone-shaped, is, as a rule, more swollen at the sides and has the front of the head convex, and the auricles are lower down at the end of the convex frontal curve. The lateral antennæ in *S. tremula* are situated low down near the base of the foot; in *oblonga* these organs are much higher up at the sides of the body and slightly ventral in position. On the extreme front of the head, when seen from the dorsal side, *S. oblonga* has two divergent tufts of very fine stiff sense-hairs which are absent in *tremula*. Finally, *S. tremula* is a little, but distinctly, larger in size and more yellowish in colour; it also likes to anchor itself on a thread from the toes and spin round and round on its longer axis on the spot; this habit *S. oblonga* does not possess. The two figs. 2 and 3 on pl. III., drawn from life by Mr. Dixon-Nuttall, will give a clear idea of these differences.

Synchæta oblonga is small in size, and the shape of the body is that of an oblong cone, more or less swollen at the sides; it is white, transparent, and the head is distinctly convex in front. The exact shape of the body varies somewhat according to the locality, the age of the individuals, the abundance or scarcity of food, &c. The integument is very thin, white, transparent, and shows numerous very fine longitudinal folds on the dorsal side. The foot is short and narrow and carries two small, conical, well separated toes; the foot is usually slightly enlarged at the base of the toes, and contains two foot-glands.

The front of the head bears the usual two pairs of styles, the longer outer pair arising from triangular fleshy flaps. At the extreme front are seen two divergent bundles of very fine stiff setæ, which arise from a pimple situated immediately above the mouth, and which are not present in *S. tremula* or *gyrina*. The auricles are small, slightly pendent, and situated at the ends of the frontal curve of the head. The mouth is in the usual position on the ventral side of the front of the head, shield-shaped, closely surrounded by a single row of very fine, stiff, curved hairs, and with four larger setigerous pimples a little further off at the four corners.

The dorsal antenna protrudes in the usual position above the eye on a slight eminence, whilst the very small lateral antennæ are situated at the sides of the body, on a level with the stomach, and slightly on the ventral side; frequently they are very difficult to find.

The cervical eye is deep red in colour, often appearing divided in two halves, and sometimes in this species two more or less prominent aggregations of red granules occur on the front of the head, and two streams of very minute red granules connect these with the cervical eye, much like the frontal eyes of *S. triophthalma* and *littoralis*, but much less pronounced.

I have taken considerable trouble to dissolve out the very delicate jaws of this species, and believe fig. 10, pl. V. gives a correct representation of their structure, which is a type different from that of *S. pectinata*, but common to a number of other species. The malleus consists of a long, thin, curved manubrium, having a broad, very thin, wing-like flange on one side, and a triangular projection on the other; the unci are thin triangular plates armed with one large, deeply-cut tooth, well separated from the rest, and five shorter sharp teeth, rather irregular and varying in shape. The incus consists of a long, narrow but deep fulcrum, and very thin, broadly triangular rami. The figs. 10, 10*a*, and 10*b* will give a better idea of the shape and position of these organs than any amount of description.

The œsophagus, arising from the dorsal side of the mastax, is of moderate length, and opens in a thick-walled stomach of usual

structure. The intestine is inconspicuous, and opens dorsally above the base of the foot. The gastric glands in this species are more or less divided into lobes. The ovary is large, rounded and flattened, filling nearly the whole of the ventral side of the body-cavity, and contains usually eight nucleated germ-cells, and often a maturing egg lies by the side of it. The egg when extruded may sometimes be seen attached to the toes for a very short time, but soon becomes detached and falls to the bottom; it can hardly be said that *S. oblonga* carries its eggs, though occasionally an individual may be seen with an egg attached.

The lateral canals are distinct on each side of the stomach, and end in a branch with two flame-cells near the top of this organ; posteriorly, they open into the small contractile vesicle.

The muscles of the body are very narrow, striated, and arranged as in *S. tremula*.

The male has often been observed by me, and is represented in figs. 2*a* and 2*b*. It is small, elongated, curved ventrally, with two toes and four short frontal styles, has a large red eye and large sperm-sac; its greatest length is 102 μ ($\frac{1}{250}$ in.).

Synchæta oblonga is a moderate swimmer when compared with its more vigorous cousins; it swims fairly straight forward or in graceful curves, and has not the habit of anchoring itself to a thread and revolving on its longer axis, which is such a conspicuous habit of *S. tremula*.

In size *S. oblonga* is distinctly smaller than *tremula*, but of course young specimens of *tremula* may be smaller than adult *oblonga*. The usual size is: female up to 225 μ ($\frac{1}{113}$ in.) by 115 μ ($\frac{1}{220}$ in.) wide at the auricles.

Synchæta grandis Zacharias.

Pl. V. fig. 8.

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Zacharias, Dr. Otto.—Forschungsberichte aus der Biolog. Station zu Plön, Theil 1, 1893, p. 23, fig. 2.

Spec. Char.—Body very long and slender, broadest at the auricles, compressed in the middle, tapering to an elongated single-jointed foot, bifurcate at the tip; auricles large, pendent; frontal styles four; eye spherical, red, cervical. Size, total length 505 μ ($\frac{1}{50}$ in.) by 258 μ ($\frac{1}{98}$ in.) wide at the auricles. Lacustrine.

This is probably the largest member of this genus, and was first found by Dr. O. Zacharias in 1893 in the great inland lake of Plön, in Holstein. Five years ago I obtained it from one of the large reservoirs of the East London Waterworks Company at

Tottenham, where I have found it several times since, always in the month of July.

The very clear, white, transparent body is very narrow and elongate, with a distinct waist in the middle, then tapering, and terminating in a fairly long foot, bifurcate at the tip, which, however, does not seem to carry proper toes. The broadest part is the head, which is rounded anteriorly, with a projecting, rounded point at the extreme front, carrying two broad bundles of very fine stiff setæ. This frontal tuft of sense-hairs seems to have been overlooked by Dr. Zacharias, as he makes a point of their absence. The four frontal styles are present as usual, the outer pair emerging from broad triangular fleshy flaps. The sheath of the large styles can be followed for some distance inside the head to a nervous base or ganglion cell, from which two nerve-threads are seen running towards the brain, and a third thread backwards. On either side of the extreme front of the head, and slightly towards the ventral side, are two hemispherical projections, one on each side, which bear bundles of radiating, fairly long, and stiff sense-hairs.

The ciliary wreath has the form usual in other Synchætæ, the two ventral cushions on each side of the mouth having exceptionally long and powerful vibratile cilia. The auricles are very prominent, broad, rounded, and more or less pendent.

The dorsal antenna is not very prominent, situated in its usual position over the eye; the lateral antennæ are low down in the lumbar region and quite on the ventral side.

The brain is large, consisting of a broad sac containing greyish granular cells, and carries the spherical deep red eye.

The mastax is very large, of the usual Synchæta pattern, but the presence or absence of teeth in the unci has not been ascertained, unfortunately. The œsophagus is a very long, contractile, thin-walled tube, not ciliated internally, leading to a small thick-walled stomach, the large cells of which often contain yellow oil-globules. The gastric glands are rounded and small. The lateral canals are distinct, ending at the height of the stomach in a convolution, to which two or three flame-cells are attached. The contractile vesicle, of fairly large size, is situated at the extreme base of the body-cavity. The ovary is rather small for so large an animal, rounded, and containing eight to sixteen nucleated germ-cells. By the side of the ovary a large egg is often seen, with large nucleus and a number of small, deep yellow oil-globules. The eggs are not carried.

The foot is long and stiff, and has but a single joint containing two narrow elongated foot-glands; at the end it bifurcates more or less, but does not carry proper toes.

The integument of the body is very thin, white, transparent, very finely folded longitudinally on the dorsal side.

The muscles, retractors of the head and foot, are normal, very narrow and finely striated; the transverse muscular bands, encircling the body under the integument, more particularly on the dorsal side, are numerous, and more prominent than usual.

In swimming this fine species is more vigorous and rapid than *S. pectinata*, bending and turning constantly; it is more pliable also and flexible at the waist than any other species. When once seen there is no difficulty in distinguishing it from *S. pectinata* even with a pocket lens. Its food seems to consist mainly of the smaller rotifers, such as Polyarthra.

The accompanying fine drawing (fig. 8) has been made by Mr. Dixon-Nuttall from a living specimen I was able to send him.

In size it reaches a total length of 505 μ ($\frac{1}{50}$ in.) by 258 μ ($\frac{1}{98}$ in.) wide at the auricles; the body a little below the auricles is only 170 μ ($\frac{1}{150}$ in.) wide. Dr. Zacharias gives the greatest length as 600 μ. The **male** is as yet unknown.

Synchæta stylata Wierzejski.

Pl. IV. fig. 4.

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Wierzejski, Prof. Dr. A.—Rotatoria Galicyi, Krakau, 1892, p. 62, pl. iv. fig. 5.

Spec. Char.—Body large, elongated, conical, tapering both anteriorly and posteriorly; foot long and styliform, carrying two very small toes. Eye single, cervical, dark red. Egg spherical, covered with very long and thin spines, floating in the water. Habitat fresh-water lakes. Size, 242 μ ($\frac{1}{105}$ in.) to 292 μ ($\frac{1}{87}$ in.). Lacustrine.

This well marked and fine species was first discovered by Prof. A. Wierzejski in Galicia in 1892, and figured and described by him in his *Rotatoria Galicyi*. I have met with it repeatedly, in the summer months, in canals and lakes round London: Putney, Hanwell, Willesden. The shape of the body is that of an elongated cone, tapering gradually posteriorly to the foot, which is long, and perfectly round and styliform, ending in two very minute, but distinct toes. The head is elongated, and also tapers anteriorly to a rounded point, which bears at its extreme front two bundles of very fine, divergent, stiff setæ. The auricles are of fair size. The head carries the usual two pairs of styles; the outer and larger pair arise from well developed triangular fleshy flaps, and are continued inward as far as the mastax. The mouth is situated on the ventral side of the head, and on each side of it there is a bunch of three or four long stiff setæ, arising from a fleshy knob. The ciliary wreath is situated on a ridge running round the head between the two pairs

of styles, as shown in the figure. The eye is cervical, deep red, small, single, though often showing a line, as if it consisted of two apposed halves. The mastax is large, of the usual Synchæta type, followed by a long œsophagus, not ciliated internally, which leads into a stomach of the usual structure. The body-cavity, being large in proportion to the organs contained in it, looks rather empty. The integument is thin, and often shows many longitudinal folds dorsally.

The dorsal antenna protrudes on an eminence in the usual position; the lateral antennæ are in the lumbar region, slightly on the ventral side.

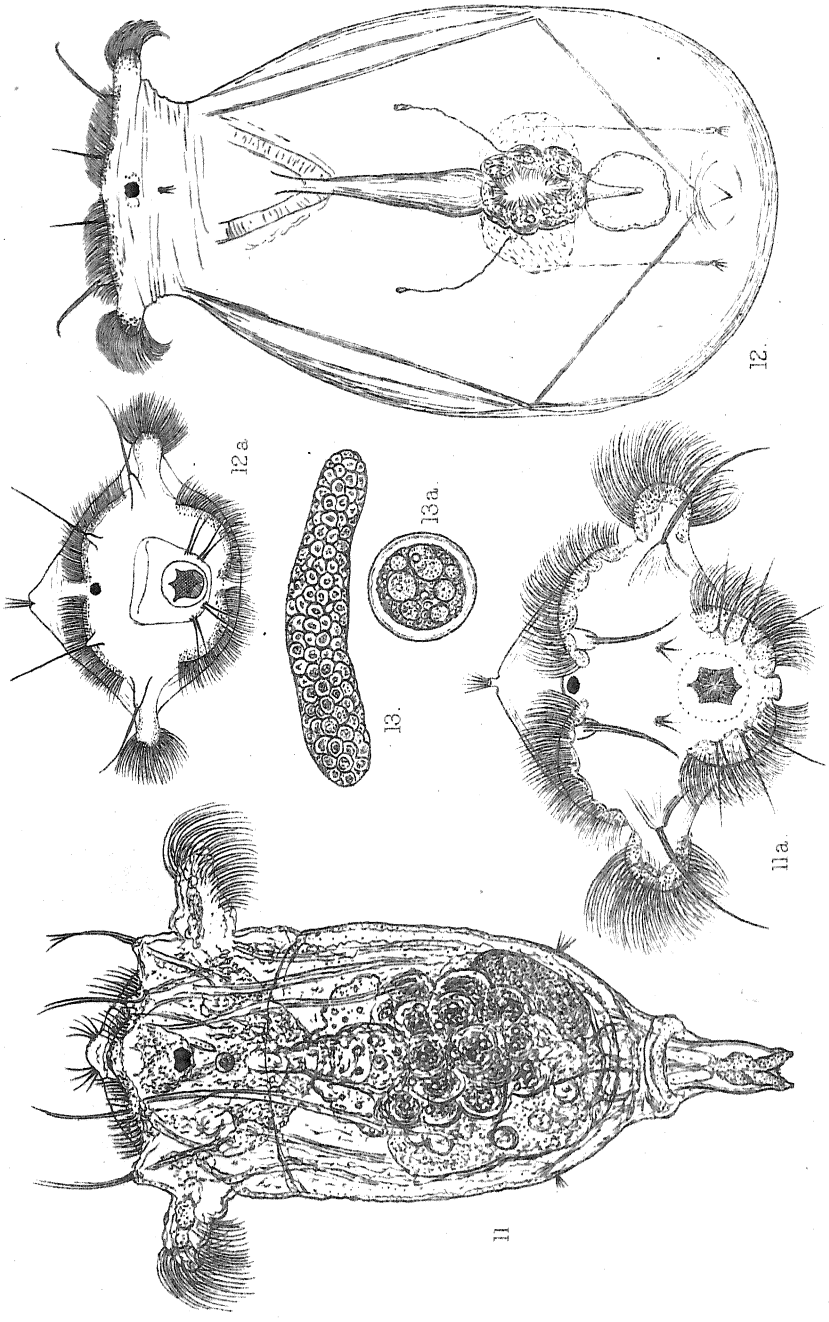
The egg of this species has a very unusual structure (fig. 4*a*). It is spherical or slightly oval in shape, and covered all over with very long and very thin spines, by means of which it floats in the water instead of sinking to the bottom. I found these floating eggs in my tank containing this species, and in order to make quite sure that they were the eggs of *S. stylata*, I isolated a number of animals in perfectly clean water and left them over night, when next day these spiny eggs were again there. The size of the egg-shell is 75 μ ($\frac{1}{340}$ in.), and the total size to the extremity of the spines 136 μ ($\frac{1}{186}$ in.). I am not aware of any other Synchæta, or any other rotifer, having eggs of this structure. These spiny eggs have been seen also by Dr. O. Zacharias and Dr. R. Lauterborn, who have attributed them to *S. pectinata*, which is evidently a mistake, as has already been pointed out recently by Herr Max Voigt.*

The only Synchæta with which this well characterised species could be confounded is *S. pectinata*, from which, however, it is readily distinguished by the absence of the two fleshy horns and the structure of the head and foot, which are quite unlike those of *pectinata*. The drawing (fig. 4) has been made by Mr. F. R. Dixon-Nuttall from my preserved specimens, and it shows the characteristic form and structure very well.

The **male** has not yet been seen.

* Max Voigt, Beiträge zur Kenntnis des Planktons pommerscher Seen. Forschungsberichte a. d. Biol. Sta. zu Plön, 1902, p. 25.

(*Continued on page* 393.)



Dixon-Nuttall and K.M.Lavender del.ad nat. West,Newman lith.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST 1902.

TRANSACTIONS OF THE SOCIETY.

VII. (continued).—*The Genus Synchæta: A Monographic Study, with Descriptions of Five New Species.*

By CHARLES F. ROUSSELET, Curator and F.R.M.S.

(*Read June 18th*, 1902.)

Synchæta longipes Gosse.

Pl. IV. fig. 5.

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GOSSE, P. H.—Twenty-four new Species of Rotifera. Journ. Roy. Micr. Soc., 1887, p. 5, pl. II. fig. 15.
HOOD, JOHN—Chats about Rotifers. Science Gossip, 1887, p. 220.
HUDSON & GOSSE.—The Rotifera. Supplement. London, 1889, p. 17, pl. 31, fig. 4.

Spec. Char.—Body wide and triangular in front; rounded, almost globular posteriorly, possessing a long foot carrying two acute toes; four frontal styles; broad pendent auricles; eye red, cervical. Largest size 204 μ ($\frac{1}{125}$ in.) long by 95 μ ($\frac{1}{267}$ in.) wide at the auricles. Lacustrine.

First found by Mr. John Hood near Dundee, this well marked species was described by Mr. P. H. Gosse in one of the last papers he wrote. The figure accompanying the description must unfortunately have been made from a very abnormal specimen, and it

EXPLANATION OF PLATE VI.

Fig. 11.—*Synchæta baltica* Ehrbg. ♀ Dorsal view. × 180.
„ 11*a* „ „ „ Front view of head. × 180.
„ 12 „ *monopus* Plate ♀ Dorsal view. × 350.
„ 12*a* „ „ „ Front of head. × 350.
„ 13 and 13*a*.—Parasites from body-cavity of *S. pectinata*. × 650.

August 20th, 1902

2 D

does not give a good idea of the creature. I have met with it three or four times in the middle of the summer round London, at Hanwell, Woking, and near St. Helens in Lancashire, and from these Mr. Dixon-Nuttall has made the accompanying excellent drawing, but it is rather a rare species not often seen.

The body is very rounded and globular behind, not unlike a wine-glass in shape, the stem of which is represented by the long foot. The head is abnormally large, slightly compressed dorso-ventrally and broad at the auricles, advancing to a regular point in front, and thus giving it almost the shape of an equilateral triangle. The front of the head bears the usual four styles, the outer pair being much the larger and protruding from large triangular fleshy flaps. Two more pairs of setose pimples are situated in front and around the mouth as usual, and the extreme pointed front is furnished with a fine and broad brush of sense-hairs.

The ciliary wreath is of the usual Synchæta type, the wide auricles being more or less pendent and further back in position than in *tremula* and *oblonga*. Immediately behind the auricles the body is considerably constricted and then swells out again to a width equal to that of the head.

The foot is very narrow, elongated, about one-quarter the size of the body, terminating in two small acute toes. It may be swollen a little occasionally, but it can hardly be called "rhomboidal" in outline. The foot is moved about and lashed in all directions like a tail.

The dorsal antenna is in the usual position on an eminence above the eye, and the lateral antennæ issue two-thirds down the sides of the body, slightly on the ventral side. The mastax is large, of usual *Synchæta* type, but, I regret to say, I have omitted to look at the teeth of the unci, and having been unable to find this creature recently, do not know their presence or their number. The œsophagus is short, leading to a stomach of the usual structure with rounded gastric glands. The lateral canals, contractile vesicle as well as the foot-glands, ovary, and muscular system, are all quite normal. The red eye is rounded, not particularly large, and of normal structure.

In the projecting triangular head and narrow foot this species has some superficial resemblance with *S. stylata*, from which it is however quite different in shape, structure, and size.

Synchæta longipes does not carry its eggs. It is a powerful swimmer, very voracious, and catches its prey, consisting of *Polyarthra* and other similar rotifers, and devours them whilst swimming at full speed. The **male** has not yet been discovered.

Its greatest total size is 204 μ ($\frac{1}{125}$ in.), one-fifth of which is represented by the foot and toes. Smaller young animals are always present also.

Synchæta kitina sp. n.

Pl. IV. fig. 6.

Spec. Char.—Body very small, cup-shaped, truncate anteriorly, much contracted posteriorly, head flat or slightly rounded in front, foot short and tapering, carrying two small conical toes. Eye cervical, red, appearing double, imbedded in semi-opaque granules. Size, up to 136 μ ($\frac{1}{185}$ in.) in length by 102 μ ($\frac{1}{250}$ in.) wide. Lacustrine.

In a tube of some water from the reservoirs supplying Dundee with water, containing *Notholca longispina* and other rotifers, which Mr. John Hood sent me in July 1898, I found a very small Synchæta which proved to be new and to which I have given this name in honour of an enthusiastic friend greatly interested in these minute sparks of life. After having had his attention called to it, Mr. Hood was able to send it me again several times, but it has so far not been obtained in any other locality than the neighbourhood of Dundee, where it makes its appearance at the end of May and usually remains until the beginning of September, associated with *Notholca longispina*, *Anuræa cochlearis*, and *Gastropus stylifer*. Its unusual shape, very small size, and mode of swimming at once arrest the attention of anyone familiar with the commoner species of Synchæta, but being so small it requires a fairly high power for observation and identification.

The general shape of the body is that of a cup or wine-glass with somewhat stout stem. The posterior cylindrical and constricted part of the body widens again slightly and then terminates; the foot is short, broad at the base and tapering, carrying two small toes at the end. The foot can be retracted within the body so that only the toes protrude. The auricles are comparatively large, broad and semicircular in shape, and are carried on a level with the front of the head; when contracting the auricles fold over the head. The head is very broad and almost flat in front. Two pairs of tactile styles arise from the front, the larger outer pair from fleshy triangular flaps and the inner pair from the dorsal edge as usual. Four more groups of two or three shorter tactile hairs are placed around the mouth. The vibratile cilia are confined to four regions or patches on the frontal part of the head as usual, in addition to the long cilia on the auricles. The mouth is situated in front near the centre of the head, but slightly ventral, surrounded by the projecting circlet of very fine stiff hairs, part of which are visible from a dorsal view. The eye is cervical, situated in the usual position, and consists apparently of two dark red corpuscles, closely apposed and imbedded in a small mass of semi-opaque granules. The mastax is large, filling the anterior part of the body-

cavity; the jaws are of usual Synchæta type, but extremely delicate; the unci have five or six teeth.

The stomach is small, carrying two pointed gastric glands, and the rounded ovary, lateral canals, and contractile vesicle are present as usual.

The dorsal antenna projects from a dorsal eminence a little below the eye, while the lateral antennæ protrude at the extreme posterior and narrow part of the body, as in *S. tremula*.

The integument is very soft, showing more or less distinct fine longitudinal folds. When held fast in the compressor the animal is very restless, contracts and contorts its body in all manner of shapes, so that it can hardly be recognised under these conditions.

In swimming the motion is slow and steady, the animal revolving on its longer axis as it proceeds, and now and again suddenly changing its direction at right angles to its former course. *S. kitina* does not anchor itself to a thread and revolve on the same spot as does *S. tremula*.

The pretty sketch, fig. 6, has been drawn by Mr. F. R. Dixon-Nuttall from life, and gives a good idea of its usual shape.

In size, this is one of the smallest Synchætæ known, being only 136 μ ($\frac{1}{185}$ in.) in total length by 102 μ ($\frac{1}{250}$ in.) wide at the auricles, whilst smaller individuals are always present also.

Synchæta tavina (Hood).

Pl. VIII. fig. 18.

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HOOD, JOHN.—*Synchæta tavina*. Inter. Journ. of Microscopy and Nat. Science, 1893, pp. 382–3 (1 pl.).

Spec. Char.—Body markedly cylindrical in shape, truncate in front; auricles small; foot short, carrying two small, separated toes; eye cervical, usually appearing double; the lateral antennæ situated in the lumbar regions. Size 254 μ ($\frac{1}{100}$ in.) by 95 μ ($\frac{1}{267}$ in.) wide at the auricles. In brackish water.

Mr. John Hood also discovered this species in the tide pools of the Tay in the early spring of 1893, and published an account of it in the *International Journal of Microscopy and Natural Science* for October of that year.

The shape of the body is conspicuously cylindric, being scarcely wider in front than at the side and somewhat compressed laterally, then tapering gradually to the short foot and toes. The foot is in a line with the ventral side of the body, and the toes are generally carried turned upwards. At first sight it is hardly recognised as belonging to the genus *Synchæta*, so unlike is it to the characteristic cone-shape of nearly all the other species of this genus.

Mr. Dixon-Nuttall's sketch very well represents its usual shape, which of course varies slightly according as it is filled with food or empty. The integument is thin, white, transparent, and shows a number of fine longitudinal folds on the dorsal side. The auricles are small, and in retraction are folded over the head by a muscular band running from the auricle to near the centre of the head. The front of the head is truncate and slightly rounded, carrying the usual two pairs of styles, the outer pair arising from well-marked triangular fleshy flaps. On the extreme raised front of the head are two bundles of very fine diverging stiff setæ, similar to those found in *S. oblonga*. The mouth is nearly central in position, screened as usual by a row of fine, overhanging setæ, which can be seen from a dorsal view in this species. At some little distance from and around the mouth are the usual four bundles of three or four larger setæ which are rather conspicuous. The vibratile cilia are arranged on four ridges or cushions on the front of the head, as is the case with all other species. The cervical eye consists of a clear vesicle partly filled with white opaque and red granules, the latter often separated into two groups, and thus giving the appearance of a double eye.

The mastax is large and of the usual Synchæta type; the jaws are very delicate and difficult to make out; they are of the same type as those of *S. tremula*, the unci are curved, and have four or five teeth.

The œsophagus arises on the dorsal side of the mastax and leads into an ample stomach which is thick-walled anteriorly and thin-walled posteriorly, and to which two elongated gastric glands are attached. The ovary is large, flat, oval or nearly circular in shape and contains large germ-cells.

The lateral canals and contractile vesicles are of normal structure.

The dorsal antenna is situated on a raised prominence in the usual position, and the lateral antennæ are readily seen in the lumbar region. The foot is stout and the two broad and pointed toes are usually carried turned upwards.

I have found the **male** of this species in March 1895 and several times since. It is a small, soft, conical animal with two minute toes, large sperm-sac, long brain with opaque granules at the tip of which red granules forming a double eye are imbedded. It is usually detected by its more rapid movements among the females.

Synchæta tavina swims vigorously and steadily in spiral curves and is rarely anchored to a thread, nor does it carry its eggs. Its habitat is brackish water, and I have obtained it many times from Mr. John Hood from the mouth of the Tay near Dundee, and also from Great Yarmouth in water sent by Mr. H. E. Hurrell, generally in the early spring, March and April. In size it reaches up to 254 μ ($\frac{1}{100}$ in.).

Synchæta littoralis sp. n.

Pl. VII. fig. 15.

Spec. Char.—Body cone-shaped, convex anteriorly, usually cylindrical in the middle, tapering to a stout foot and well separated acute toes; auricles small; four frontal styles. Eyes three, one cervical, large, red, connected by two streams of red granules with two frontal eye-spots; lateral antennæ prominent in lumbar region. Size up to 238 μ ($\frac{1}{107}$ in.) long by 109 μ ($\frac{1}{232}$ in.) wide at the auricles. In brackish water.

For some years past I have received this distinctive species from Dundee, Margate, Great Yarmouth, and various places near the sea coast, always in water that was slightly brackish In general appearance and structure it comes nearest to *S. oblonga*, from which it can, however, be readily distinguished by a much stouter foot, by its three eyes, and a prominent stream of red granules running forward from the cervical eye, which is unusually large, to the two frontal eye-spots, very much resembling *S. triophthalma* in this respect.

The front of the head is convex, and the shape of the body more or less cylindrical, merging posteriorly into a conspicuously stout foot with two fairly thick acute toes, which are always carried well apart. The outer styles emerge from fairly large triangular fleshy flaps, and at the extreme front of the head are two bundles of very fine diverging sense-hairs. The dorsal antenna is situated in its usual position, and the lateral antennæ, which are readily visible, protrude from the sides in the lumbar region and a little on the ventral side.

The integument is white, transparent, folded longitudinally on the dorsal side. The mastax is large, of usual shape and structure, and the unci have five or six teeth. The thick-walled stomach is surmounted by two rounded gastric glands.

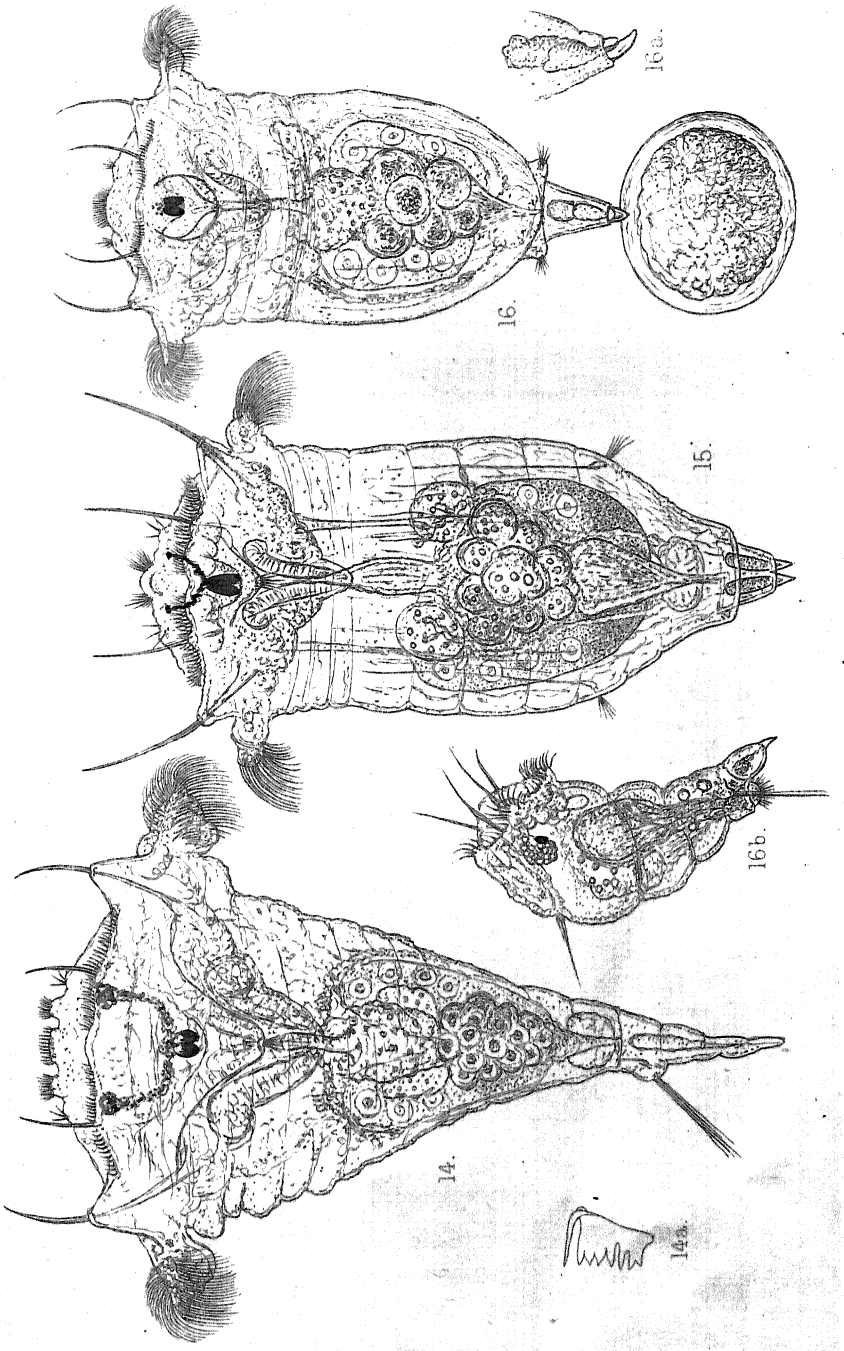
The remainder of the anatomy follows that of other Synchætæ; the eggs are not carried.

The **male** has been seen several times, and has much analogy with that of *S. oblonga*.

The accompanying fig. 15 has been drawn by Mr. Dixon-Nuttall, and gives a good idea of the animal.

EXPLANATION OF PLATE VII.

Fig. 14.—*Synchæta triophthalma* Laut. ♀ Dorsal view. × 400.
„ 14*a* „ „ „ One uncus of the jaws.
„ 15 „ *littoralis* sp. n. Rouss. ♀ Dorsal view. × 375.
„ 16 „ *cecilia* sp. n. Rouss. ♀ Dorsal view. × 500.
„ 16*a* „ „ „ Side view of toe. × 750.
„ 16*b* „ „ „ The male. × 500.



F.R.Dixon-Nuttall del.ad nat

West,Newman lith.

Synchæta baltica Ehrenberg.

Pl. VI. fig. 11.

Synonymy.

Synchæta apus Plate.

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—— Die Infusionsthierchen. Leipzig, 1838, p. 437, pl. 53, fig. 5.

Hudson & Gosse.—The Rotifera. London, 1889, vol. i. p. 126, pl. 13, fig. 1.

Plate, L. H.—Ueber die Rotatorienfauna des bottnischen Meerbusens, etc. Zeitschr. f. wiss. Zool., Bd. 49, 1890, pp. 1–4.

Levander, K. M.—Zur Kenntniss der Wasserfauna in der Umgebung von Helsingfors. Acta Societatis pro Fauna et Flora Fennica, Helsingfors, vol. xii. No. 3, 1894, p. 18, pl. 1, fig. 4.

Spec. Char.—Body very large, bell-shaped, rounded in front, constricted below the auricles, tapering to a stout foot and thick obtuse toes; four frontal styles; wide front, and large, broad auricles; eye red, cervical, with a tendency to be cleft in two halves. Size 455 μ ($\frac{1}{56}$ in.) to 523 μ ($\frac{1}{48}$ in.) long by 245 μ ($\frac{1}{104}$ in.) to 270 μ ($\frac{1}{235}$ in.) wide at the auricles. Marine, pelagic in the Baltic.

The species to which Ehrenberg gave this name appears to have been first found by a Dr. Michaelis in Kiel harbour in 1830. It was early associated with the luminosity of the sea, because it was found in sea water that was luminous, but according to Ehrenberg's own account, his experiments to prove its luminosity were entirely negative, as Synchæta did not shine when isolated, whilst the water contained other marine organisms, such as Peridinia, which undoubtedly were luminous. There is, therefore, no valid reason for the statement that this Synchæta, or any other rotifer, is connected with the luminosity of the sea.

Ehrenberg obtained his specimen from Dr. Michaelis, and communicated his first account and drawings of this species to the Berlin Academy of Sciences in 1834, the description and figures being afterwards reproduced in his great work on the Infusoria in 1838.

Until quite recently the real *S. baltica* does not seem to have been again met with, or to have been searched for in its particular haunts, the Baltic Sea. Mr. Gosse, in his early writings, mentions a marine Synchæta which he often found and supposed was Ehrenberg's *S. baltica*, and figured it in his *Tenby*. This, however, is the animal now known as *Synchæta gyrina* of Hood. Later Gosse received another, smaller and different marine species from Mr. John Hood of Dundee, which he figured in *The Rotifera*, pl. xiii. fig. 1, under the name of *S. baltica*. It is, however, quite clear now that none of these are identical with Ehrenberg's species, and

I have it from Mr. John Hood that the small marine species he sent to Mr. Gosse in 1888 is the one which is now described in this paper under the name of *S. cecilia*.

Ehrenberg's figure shows a large Synchæta, with very large and broad auricles, and it was not until 1894 that it was again certainly identified by Dr. Levander, who found it in abundance in the open sea and at various places round the coast of Finland, and has given a better drawing of it in his memoir. A few years previously Dr. L. Plate received some spirit material collected by Dr. Nordqvist in the Gulf of Bothnia and in the northern parts of the Baltic. In this material he found a large Synchæta fully contracted into a ball, showing no foot at all. This Dr. Plate named *Synchæta apus*, and described as a new species. Dr. Levander, however, has proved quite satisfactorily that it is no other than *S. baltica*.

I have considered it necessary to give this short historical sketch of *S. baltica* in order to clear up its identity and separate it from the various species to which this name has been wrongly applied.

Dr. Levander has been good enough to send me some fairly well preserved specimens of *Synchæta baltica*, yet they are not so perfect and fully extended as one could wish. Fig. 11, pl. VI. has been drawn by Mr. Dixon-Nuttall from one of these, and is sufficiently characteristic, but should be compared with Dr. Levander's sketch of the living animal. Fig. 11*a* represents a front view of the head, which has been kindly sent me by Dr. Levander.

The shape of the living *S. baltica*, according to Dr. Levander's description, is bell-shaped, rounded in front, constricted below the auricles, then widening again considerably in the middle of the body, whence it tapers gradually to the thick foot. In the preserved specimens the posterior end of the body shows a ring-like thickening of the integument from which the foot emerges; it may be, however, that this is due to the partly retracted foot, and that in the living animal the body merges gradually into the foot, as shown in Dr. Levander's drawing. The foot is stout, of considerable size, and carries two thick obtuse toes, well separated, in which the fine canals of the foot-glands can be readily seen. The toes are not pointed, but distinctly cut off, or truncate and flat at the tip.

The ciliary wreath is of the usual type, but the auricles are particularly large and very broad and clothed with long vibratile cilia as is well represented in Mr. Dixon-Nuttall's figure. Four frontal styles are present as usual, the outer pair emerging from triangular fleshy flaps of skin. On each side of the extreme front is a tuft of fine radiating sense-hairs; around the mouth on the ventral side are the usual four setose pimples carrying each two or three stiff hairs.

The dorsal antenna is situated on an eminence in its usual position above the eye, and the lateral antennæ emerge low down in the lumbar regions and a little on the ventral side.

The eye is large, red, usually cleft in two halves, and seated on the rounded brain mass.

The mouth is shield-shaped and guarded all round by a single row of very small stiff converging hairs. The mastax is large, of the usual Synchæta shape and type; the fulcrum seems to be particularly long; the unci have each five pointed teeth. The thin-walled œsophagus arises in the middle of the dorsal side of the mastax, is fairly long and not ciliated in its interior. The stomach is thick-walled, consisting of large rounded granular cells, and carrying the usual gastric glands; the intestine is not very well marked off. The lateral canals appear to be attached to the walls of the stomach and reach forward as far as the gastric glands only. According to Dr. Levander each canal forms here a convoluted knot from which two branches are sent off. One branch goes forward a short distance in the body-cavity, is held in position by a fine thread fixed to the body-wall, and ends in a single flame-cell. The contractile vesicle is large, situated at the base of the foot on the ventral side; the lateral canals make several turns in its walls before opening into it.

The ovary is oval, of usual structure, and lies across the body-cavity on the ventral side. Two foot-glands are very prominent in the stout foot.

The eggs are slightly oval in shape and generally carried about. I found several eggs still attached to the toes by a fine thread in the preserved specimens; their size is 109 μ ($\frac{1}{233}$ in.) long by 88 μ ($\frac{1}{289}$ in.) broad.

As far as is at present known *S. baltica* is found only in the Baltic, where it is truly pelagic, occurring in great abundance in the open sea as well as in all the large and small bays. It is well known that the salinity of the water of the Baltic is much less than that of the North Sea, due to its enclosed position, to the absence of tides, and to the great volume of fresh water that is constantly poured into it by numerous rivers.

According to Dr. Levander the greatest total length of *S. baltica* is 523 μ ($\frac{1}{48}$ in.) The largest preserved specimen I have received measured 455 μ ($\frac{1}{56}$ in.) long by 245 μ ($\frac{1}{104}$ in.) wide at the auricles.

The **male** has not yet been observed.

Synchæta gyrina Hood,

Pl. VIII. fig. 17.

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Hood, John.—Chats about Rotifers: *Synchæta gyrina*. Science Gossip, 1887, p. 149, 2 figs.

Hudson & Gosse.—The Rotifera. Supplement. London, 1889, p. 18.

Spec. Char.—Body large, barrel-shaped, not much wider in front, and tapering gradually posteriorly to the short foot and toes; eye cervical, appearing double; auricles comparatively

small but powerful; four anterior styles. Largest size of female 326 μ ($\frac{1}{78}$ in.) long by 145 μ ($\frac{1}{175}$ in.) wide across the auricles. Marine and in brackish water.

Mr. John Hood, of Dundee, first discovered this marine and brackish water species in the spring of 1886, in tide pools of the estuary of the Tay, and gave a description and rough sketch of it in the July number of *Science Gossip* of 1887.

In the autumn of last year I obtained specimens from Great Yarmouth, and subsequently also from brackish water pools near Exmouth and Worthing, which have enabled me to make this description and Mr. Dixon-Nuttall the accompanying excellent drawing, fig. 17. Both the drawing and the well preserved and mounted animals were identified by Mr. Hood, which was necessary, as his rough sketch is deficient in accuracy.

The body is stout, cylindrical or barrel-shaped, widest in the middle, tapering gradually posteriorly; the foot is distinct, short, tapering, and carrying two distinct broad and acute toes, slightly shouldered on the outer side; two distinct foot-glands are contained in the foot. The head also is cylindrical, hardly wider than the widest part of the body. The auricles are comparatively small but powerful; the head is truncate in front without any conspicuous prominences. Two pairs of styles arise in front, the outer pair from very small fleshy eminences. The vibratile cilia in front have the usual arrangement in four regions. The mouth is ventral in position, surrounded by the usual tactile tufts of setæ and circlet of short stiff hairs. The eye is large, cervical, and consists of two dark red closely apposed bodies or clusters of red granules. The mastax is large, of usual Synchæta shape and structure, and of *S. oblonga* type with six broad, lancet-shaped teeth in each uncus. The dorsal antenna protrudes on a dorsal eminence above the eye, and the lateral antennæ are situated at the sides, slightly below the middle of the body.

The stomach is large, of usual shape, as well as the gastric glands, ovary, lateral canals and contractile vesicle, all of which are clearly indicated in Mr. Dixon-Nuttall's excellent figure. The integument is fairly firm, showing more or less prominent transverse and longitudinal folds, particularly on the dorsal side.

In swimming, this Synchæta moves rapidly, almost rolling in the water like a barrel, without apparent aim; it also spins a thread from the toes to which it attaches itself occasionally.

The eggs are nearly spherical, coloured slightly brown, and 78 μ ($\frac{1}{326}$ in.) in diameter; when laid they fall off at once, and are not carried about.

The **male** has been seen by Mr. Hood, who describes it as a conical slender creature, 85 μ ($\frac{1}{300}$ in.) in length.

Habitat: in sea-water and brackish tide pools, near Dundee, Great Yarmouth, Exmouth, Worthing, and probably all round the coast.

Synchæta triophthalma Lauterborn.

Pl. VII. fig. 14.

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LAUTERBORN, ROBERT.—Wissensch. Meeresuntersuchungen aus der Biol. Anstalt auf Helgoland, 1894, i. pp. 207-13, 1 fig.

Spec. Char.—Body cone-shaped, very wide and rounded in front; foot indistinct; toe thin, style-shaped, apparently single; eyes three, one large cervical, and two frontal eyes. Lateral antenna asymmetrical, large, single, situated on left side of body. Size 181 μ to 265 μ ($\frac{1}{140}$ to $\frac{1}{96}$ in.). Marine, pelagic.

In June 1898 Mr. John Hood found this peculiar Synchæta in the sea near Dundee, and sent me some living specimens for identification. I recognised it at once as the animal Dr. Robert Lauterborn had discovered off the coast of Helgoland in August 1893, and of which he had given a rough figure and short description in his *Beiträge zur Meeresfauna von Helgoland.* Since his first capture, Mr. Hood has found it repeatedly and has sent it to his correspondents, and I have no doubt it could be obtained at other points along the coast during the summer months. Mr. Dixon-Nuttall has made a fine and accurate portrait of it (fig. 14) which gives a better idea of its appearance than any amount of description. The general outline of this species is cone- or top-shaped, very broad anteriorly and very slender posteriorly, ending in a thin, pointed, style-like toe, which appears to be single. The auricles are very large, and the front of the head is rounded, and so wide as to be, with the auricles, very nearly as broad as the animal is long. The usual pair of large outer frontal styles project from large triangular fleshy flaps, and the two smaller styles are situated on the dorsal edge just above the frontal eyes. A peculiarity of this species is that it has three deep red eyes: a cervical eye which is double, in the usual position, and two frontal eyes situated in front, a short distance below the dorso-frontal edge of the head. Two streams of minute red granules usually connect the dorsal eye with the frontal eyes, as if the latter were connected with the cervical eye by means of very fine tubules. I have noticed a similar tendency in several other species such as *S. oblonga*, and more rarely in *S. tremula*, but only in *S. littoralis* are the frontal eyes so constant and so prominent as in *S. triophthalma.* The dorsal antenna is present in its usual position, but the main and unique feature of this Synchæta is that it has a single, very large and asymmetric lateral antenna, protruding from a fleshy prominence low down on the left side of the body near the toe. There is no trace of a lateral antenna on the right side. The

foot is not well marked off, and body, foot, and toe follow each other without much distinctness. The foot-gland is elongated and club-shaped and apparently single.

The mouth is situated in the usual position on the ventral half of the front of the head; around the mouth are four groups of five or six fairly long stiff sense-hairs, and outside these there are the usual four patches of vibratile cilia. The mouth is oval in shape, and guarded by a wreath of short, closely-set, overhanging, stiff hairs. The mastax, œsophagus, stomach, ovary, lateral canals, and rest of the anatomy are quite normal of Synchæta type. One uncus of the jaws is represented in fig. 14*a*. The egg, when extruded, is carried about for a time, attached by a thread, but often becomes detached. I have observed an individual carrying two eggs. It is oval in shape, 75 μ ($\frac{1}{340}$ in.) long by 58 μ ($\frac{1}{440}$ in.) broad.

In swimming this Synchæta sails in long graceful curves, without undue haste, and reminds one of the flight of the swallow through the air. When once seen this species can be recognised by this mode of swimming, which is very different from that of the other species.

The **male** has not yet been observed.

I have been very successful in preserving and mounting this animal fully extended, and showing all its characteristic peculiarities.

The size varies a good deal according as the animal is young or full grown, from 181 μ to 265 μ ($\frac{1}{140}$ in. to $\frac{1}{96}$ in.). The width across the auricles is very nearly the same.

Its habitat, as far as known, is the open sea round Helgoland, near Dundee, and the Bay of Naples, appearing in the summer months from May.

Synchæta monopus Plate.

Pl. VI. fig. 12.

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Spec. Char.—Body a greatly swollen bag, very thin-walled and extremely transparent, terminating in a very small foot with single toe. Head small, with four frontal styles and small auricles. Eye red, cervical. Size 254 μ ($\frac{1}{100}$ in.) long by 164 μ ($\frac{1}{155}$ in.) broad. Marine, pelagic in the Baltic.

This remarkable pelagic marine species was named by Dr.

L. H. Plate from material collected by Dr. O. Nordqvist in the Bay of Bothnia. The specimens having been killed and preserved in spirit, were all fully contracted, so that only a very imperfect description could be given. Dr. Levander has, however, found this form again in great abundance in the open sea near Helsingfors, and has given a better account of it with a drawing. He has also been good enough to send me some fairly well preserved specimens and two sketches of the dorsal side and front view of the head, which are here reproduced (figs. 12 and 12*a*), so that I owe my acquaintance with this peculiar Synchæta to these. Not having seen it in the living state, however, my account of it must be largely taken from Dr. Levander's description.

The shape of the body is quite unlike that of any other Synchæta, and instead of the usual cone it presents an extremely thin-walled, very transparent, bag-like, rounded vesicle, constricted anteriorly, with a very small head, which, however, has the usual characteristic Synchæta structure. The body terminates in a very small swollen foot carrying a single toe.

The whole structure of all the organs is so fine and delicate that it appears evident the whole organism, in acquiring these characters, has been evolved with a view to render itself as transparent, and therefore as invisible as possible, which is characteristic of many pelagic animals.

The small head, as will be seen from fig. 12*a*, which represents a front view, carries a normal ciliary wreath in two interrupted regions, four frontal styles, and two small but distinct auricles.

The cervical eye is red, seated on the oval brain mass. The dorsal antenna is slightly raised above the eye, while the ventral antennæ emerge very low down close to the foot, somewhat on the ventral side. The mouth is shield-shaped and guarded by the usual screen of fine hairs. The mastax is also small, of Synchæta structure, and the unci have five strong teeth, which I was able to see in some swollen specimens where the unci had been forced through the mouth.

The œsophagus is a very thin, long tube, not ciliated internally, leading to a small thick-walled stomach, to which very small and rounded gastric glands are attached.

The ovary is very small, oval, containing about eight germ-cells.

The muscular system is of normal character; a dorsal and ventral pair of extremely thin and narrow muscular threads originate both in the head and in the foot, and are inserted a little below the middle to the body-walls.

The excretory system is represented by lateral canals, which are attached, on either side, to the wall of the stomach, whence they continue forward for a short distance, being suspended quite freely in the body-cavity by a very fine thread attached to the side

of the body; each canal ends in a single flame-cell. The contractile vesicle is fairly large, and situated below the stomach.

The whole of the internal organs, digestive system, ovary, &c., take up only a very small proportion of the comparatively large body-cavity, so that this *Synchæta* at first sight looks much more like a small *Asplanchna priodonta* than anything else. The dorsal half of the body-cavity is smaller than the ventral half, and sometimes the ventral wall is swollen out to such a degree as to extend much beyond the foot.

Synchæta monopus has not the appearance of being so vigorous a swimmer as its near relatives. Dr. Levander states that it occurs in great abundance, associated with *S. baltica*, from the middle of June to October, in the bays and open sea near Helsingfors, and it is evidently also found in other parts of the Baltic. It has not yet been found on the English coast, or in any other seas. It does not carry its eggs.

Its size is 254 μ ($\frac{1}{100}$ in.) long by 164 μ ($\frac{1}{155}$ in.) wide. The **male** is not known.

Synchæta cecilia sp. n.

Pl. VII. fig. 16.

Spec. Char.—Body small, pear-shaped in form, rounded in front; four frontal styles; foot distinct, conical, carrying apparently a single toe. Lateral antennæ situated at extreme base of body. Eye cervical, red, with a tendency to separate in two halves; carries one or more eggs about attached by a thread to the toe. Greatest size 142 μ ($\frac{1}{180}$ in.); width at auricles 82 μ ($\frac{1}{310}$ in.); male 78 μ ($\frac{1}{326}$ in.) long. Marine.

In November 1895 I first obtained this small and attractive marine species from Mr. F. Daunou, who had found it in a tide pool close to the sea at Margate. Since then I have received it repeatedly, sometimes in large numbers, from Mr. John Hood, of Dundee, and from Mr. Hurrell, of Great Yarmouth. A great peculiarity, which at once attracts attention, is that it habitually carries about its eggs, one, two, or sometimes three in a string, in its restless gyrations.

In size it is one of the smallest Synchætæ, and in shape it is cylindric, somewhat pear-shaped, convexly rounded in front, rounded behind, with a distinctly marked-off foot of fair size, bearing a small conical, apparently single, toe. The foot and toe are often bent dorsal-wards. The auricular lobes are small. In front the head bears the usual prominent four styliform bundles of stiff sense-hairs, the outer pair emerging from triangular fleshy flaps. On each side of the shield-shaped mouth there are the

usual four tufts of sense-hairs, but only two of these tufts can be seen from a dorsal view. The crimson eye is in the usual position, and consists of two apposed red bodies. The dorsal antenna protrudes from a conical elevation in the usual situation. The lateral antennæ are situated at the extreme base of the body, where the foot begins. The mastax is fairly large, of normal structure, and of *S. tremula* type, with six teeth in the thin, flat, and broad unci, the first tooth being longer than the others. A short, thin-walled œsophagus leads to a thick-walled, rounded, yellow stomach, the anterior part of which is thin-walled, and having large cells in its wall, and densely ciliated inside. The stomach carries ample gastric glands of irregular shape. The lateral canals, contractile vesicle, and muscular system are distinct and normal. The integument is fine and soft, and with a high power numerous very fine longitudinal folds can be observed in it. The ovary is flat and rounded, and contains a number of large nucleated germ-cells. The egg is large, being estimated at about one-fifth of the total bulk of the animal, and oval in shape; it is attached to the toe by means of a fine mucous thread, which is sometimes lengthened, and the egg then follows the animal at some distance behind. I have seen two and three eggs attached side by side or one behind the other in a string—a peculiar sight. This habit of carrying its eggs is quite uncommon in Synchætæ, but with this species it appears to be habitual, and dozens of individuals can be seen with eggs in a fresh gathering, while of course there are also always some without them. Mr. F. R. Dixon-Nuttall has made the attractive drawing, fig. 16, and also fig. 16*a*, which shows a side view of the single toe with a small knob, looking like a rudiment of a second toe.

On comparing this new species with the described forms it seemed to me that it had some resemblance with the marine Synchæta Mr. Gosse has figured and described in the Monograph, p. 126, as Ehrenberg's *S. baltica*, though there are some discrepancies in the description, and he does not mention that it carries its eggs. I therefore applied to Mr. John Hood and inquired what animal it was he sent to Mr. Gosse, from which he made the drawing on pl. xiii. fig. 1, as mentioned in the text, and Mr. Hood informs me that it was this Synchæta to which I have now given the name of *S. cecilia*. Mr. Gosse has never seen the real *S. baltica* of Ehrenberg, which, as far as is known, is confined to the Baltic, and hence his mistake.

The male.—At the end of October last Mr. Hurrell sent me some sea water in which this species was very abundant, and amongst them I noticed some carrying bundles of two to four small male eggs. By isolating these I soon obtained the male, which is represented in fig. 16*b*. It is a small cylindrical creature 78 μ ($\frac{1}{326}$ in.) in length, with a foot and toe turned ventral-wards. The front of the head is conical and carries four styles; the base of the cone

bears a nearly circular wreath of vibratile cilia. The brain-sac carries a red eye imbedded in grey granules, and just above it the large dorsal antenna is seen to emerge, slanting backwards. The lateral antennæ are also conspicuous by their size, protruding low down at the sides of the body. A mouth, jaws, and digestive tract are absent; a large sperm-sac fills the greater part of the body-cavity. The male was seen to attach itself invariably to the side of the female. Although the males became abundant in the water I never observed an egg with thicker walls that could be recognised as a fertilised resting egg, and such eggs are so far quite unknown in any Synchæta.

Size of female: 142 μ ($\frac{1}{180}$ in.) in length by 82 μ ($\frac{1}{310}$ in.) wide at the auricles; young and smaller animals are always present also. The male: 78 μ ($\frac{1}{326}$ in.) in length; the eggs are slightly oval in shape. Female eggs, 61 μ ($\frac{1}{415}$ in.) by 47·5 μ ($\frac{1}{535}$ in.); male eggs, 42·5 μ ($\frac{1}{600}$ in.) by 35·7 μ ($\frac{1}{710}$ in.).

Synchæta vorax sp. n.

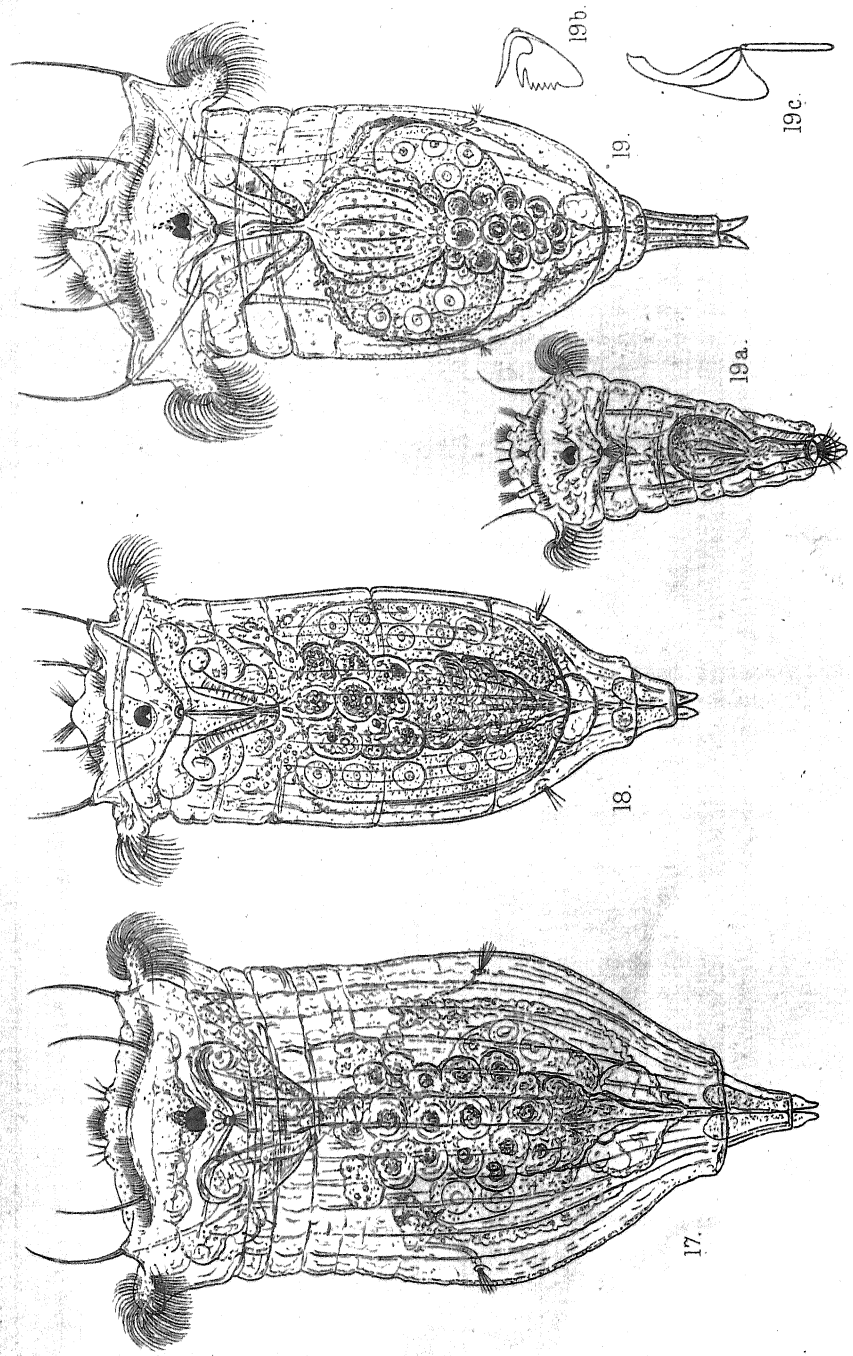
Pl. VIII. fig. 19.

Spec. Char.—Body stout, more cylindrical in shape rather than conical, pointed anteriorly, with a well-marked, narrow, fairly long, and flexible foot, carrying two distinct toes. Frontal styles four; in addition to usual dorsal and lateral antennæ it has a unique tubular frontal antenna. Cervical eye large, red, appearing double. Size of female, average 272 μ ($\frac{1}{93}$ in.) long by 136 μ ($\frac{1}{185}$ in.) broad across the auricles. One large specimen measured 340 μ ($\frac{1}{75}$ in.) long by 149 μ ($\frac{1}{170}$ in.) broad. **Male** with three tubular frontal antennæ and two movable, setose, fleshy processes in front of head; 149 μ ($\frac{1}{170}$ in.) long. Marine.

In June 1898, in sea water from the harbour of Dundee sent by Mr. John Hood, I first discovered a few specimens of this new and savage species in company with *S. triophthalma*, and then again in June 1899 Mr. Hood obtained it in the same spot in larger numbers, which I was able to preserve and mount most perfectly. It has not been met with at any other season or place, and seems to be a summer form.

EXPLANATION OF PLATE VIII.

Fig. 17.—*Synchæta gyrina* Hood ♀ Dorsal view. × 300.
„ 18 „ *tavina* Hood ♀ Dorsal view. × 325.
„ 19 „ *vorax* sp. n. Rouss. ♀ Dorsal view. × 275.
„ 19*a* „ „ „ The male, dorsal view. × 300.
„ 19*b* „ „ „ One uncus of the jaws.
„ 19*c* „ „ „ One ramus and fulcrum of the jaws.



F.R.Dixon-Nuttall del ad nat.

West, Newman lith.

The body is more cylindrical in shape than the other species of the genus, rounding off towards the foot, which is very flexible and distinctly marked off, narrow, fairly long, and terminated by two small pointed toes always carried well apart. The auricles are powerful, but less broad than in some other species; the head is prominently pointed in front, and carries the usual pair of style-like antennæ issuing out of a triangular flap of the integument, and two small styles on the dorsal frontal edge of the head. Below the frontal eye, exactly in the middle of the front and above the mouth, this species has a large tubular antenna of peculiar structure, not known, so far, in any other species of Synchæta. It consists of a bundle of fine setæ protruding out of a fairly long, fleshy tubule pointing straight forward. The usual median dorsal antenna above the eye is also present. The mouth is situated immediately below the pointed front, is surrounded by the usual four tufts of stiff setæ and four patches of vibratile cilia. The mouth-opening itself is V-shaped and, as in all other species, is guarded by a single row all round of closely set, short, stiff hairs, all converging over its centre. The lateral antennæ are very small, and situated in the lumbar region, about two-thirds down the side of the body, and slightly on the ventral side. The median eye is large, deep red in colour, looking like two eyes closely apposed. The mastax is large and of usual *Synchæta tremula* type with some variation in the shape of the rami (fig. 19*c*); the unci have one large tooth and four or five very small teeth, mere serrations (fig. 19*b*). The large stomach, intestine, lateral canals, and contractile vesicle are of usual structure and call for no particular remark. The ovary is large and roughly oval in shape. The eggs are not carried about, and I have seen an egg lying beside the ovary with a rather stout, smooth shell, measuring 11·5 μ by 9·5 μ.

This species swims with such impetuosity through the water that its rush cannot be described otherwise than furious; its course is straight forward, then it dashes suddenly round in another direction, lashing its foot up and down and right and left, attacking any other Synchæta that may come in its way, and not at all particular as to species. I have seen it seize an unfortunate *S. triophthalma* with its jaws, carry it in its mouth and devour it without a moment's stop in its furious career.

No other Synchæta of my acquaintance is so fast in motion and so fierce of temper. In this respect it can only be compared with *Ploesoma hudsoni*, which is equally wild and fierce.

In retraction the auricles are turned in over the head, and a fold of the skin closes over them, while the foot is completely retracted within the body.

The male. The Synchæta males are rare, but I observed the male of this species attached to the posterior part of a large female, while at the same time the latter was rushing through

the water at express speed with a *S. triophthalma* in its jaws, which it was devouring. Seizing the opportunity, I secured and mounted all three in a slide. The male is small, conical in shape, has no mouth, mastax, stomach, or intestine; a small rounded sperm-sac takes the place of the stomach. The front of the head carries the usual four styles. The median frontal tubular antenna, which is so prominent and characteristic in the female, is also present, but of small size; in addition to this, the male has on the front two small tubular antennæ, one on each side, which is very strange. Further, it has at the extreme front of the head, but slightly ventral in position, two stout, fleshy, freely movable processes, surmounted by a broad brush of long stiff hairs. In no other male have I seen such organs.

A deep red eye, usually imbedded in a mass of semi-opaque granules, is present. Size of male 149 μ ($\frac{1}{170}$ in.).

Mr. Dixon-Nuttall has made excellent drawings of the male and female from living specimens (figs. 19 and 19*a*), by means of which this species will be readily identified.

Synchæta neapolitana sp. n

Pl. V. fig. 9.

Spec. Char.—Body small, top-shaped, sometimes swollen at sides; head broad, and rounded in front; four frontal styles; auricles fairly large; lateral antennæ very small, situated two-thirds down the sides of the body; eye red, cervical; foot with two distinct joints, the last joint bearing a blunt spur, and carrying a single pointed toe. Size: female up to 163 μ ($\frac{1}{155}$ in.) long by 108 μ ($\frac{1}{235}$ in.) wide at the auricles; male 75 μ ($\frac{1}{340}$ in.) long. Marine.

In June 1897, Mr. H. S. Jennings of U. S. America sent me, from the Zoological Station at Naples, a rough sketch of a Synchæta which had just been collected in very large numbers in the open sea in the Bay of Naples, showing a spur-like projection on the foot as its most distinctive feature. At that time I was unable to recognise or diagnose this animal, but having since made a careful study of, and become personally acquainted with, all the known species of Synchætæ, and having also received some preserved specimens from Mr. Jennings, I can now say that it is undoubtedly a new species, which I have named *S. neapolitana*.

A very few specimens of the somewhat larger *S. triophthalma* I discovered in the same material.

From the Director of the Naples Zoological Station I learn that this new *Synchæta neapolitana* appears in the bay occasionally

in June in immense swarms, when the sea has been very calm for a long time, but not every year. Mr. Jennings' preserved material, prepared for the purpose of studying the segmentation and development in the egg, is not very good as regards the adult Synchæta, the great majority of the animals being badly contracted, but by searching some fairly extended specimens have been secured, of which the following is a description:—

The body is top or cone-shaped, either straight or slightly swollen at the sides. The front part of the head is broad and rounded, and bears four styles, the outer pair arising from triangular fleshy flaps, and auricles of fairly large size. The foot has two distinct joints, and carries a spur-like process at its dorsal end. It is somewhat difficult to decide whether this process is a true spur, an organ otherwise unknown in this genus, or a second toe turned upwards, and to some extent gone out of use. The process is situated on the dorsal side of the second joint of the foot, but to the left of the median line, and originates a little higher than the base of the true toe, which seems to be the only exit for the secretion of the large and apparently single foot-gland. Whatever its true meaning, this structure forms the most prominent distinctive character of this species, and fig. 9*a* gives an enlarged view of the foot and spur-like structure.

The mastax is of usual Synchæta shape and structure, the unci have teeth similar to those of *S. oblonga*, but their exact number could not be ascertained in the preserved specimen. The stomach is not large, of usual structure, and carries two rounded gastric glands. A rounded ovary, contractile vesicle, and lateral canals are present. The cervical eye is single, with occasionally a slight appearance of splitting in two halves, but I could see no trace of frontal eyes such as *S. triophthalma* possesses. The dorsal antenna is situated on a fleshy projection above the eye, and the lateral antennæ are very small and protrude at a point about two-thirds down the side of the body and slightly on the ventral side.

In life the eggs are carried about attached to the toes. I found a large number of both male and female eggs in the preserved material, and also the **male**, which is of usual structure and represented in figs. 9*b* and 9*c*, dorsal and lateral view.

Mr. F. R. Dixon-Nuttall has made a good drawing of both male and female, figs. 9*a*, *b*, and *c*, after looking at and comparing a number of specimens which were not too well preserved.

The size of the female varies considerably, as usual, from 109 μ ($\frac{1}{237}$ in.) to 163 μ ($\frac{1}{155}$ in.) long by 75 μ ($\frac{1}{340}$ in.) to 108 μ ($\frac{1}{235}$ in.) wide at the auricles. The **Male** is 75 μ ($\frac{1}{340}$ in.) long. The eggs are oval in shape and measure:—female eggs, 61 μ ($\frac{1}{415}$ in.) long by 51 μ ($\frac{1}{500}$ in.) broad; male eggs, 44 μ ($\frac{1}{575}$ in.) long by 34 μ ($\frac{1}{750}$ in.) broad.