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On some fresh-water Ciliates from Kashmir.

By

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(With 3 figures in the text.)

One of us has previously described fresh-water ciliates from India in a number of papers (BHATIA, 1916, 1920, 1922) and given a complete list of ciliates recorded by other authors as well, from different parts of India, up to 1921. In 1924, we had the opportunity of studying the fresh-water ciliates from the ponds of Srinagar, Kashmir. Srinagar is noted for its picturesque scenery, to which the river Jhelum, the Dal Lake, and the surrounding hills contribute a good deal. Besides the lakes, there are any number of large and small ponds and puddles which afford abundant material to the student of fresh-water forms.

The organisms met with were examined in the living condition as well as after making permanent preparations. Examination of the ciliates in the living condition is indispensable, for the proper determination of the systematic position of the ciliates. For fixing BOUIN's fluid, SCHAUDIN's fluid, or hot corrosive sublimate were employed, and BORAX-CARMIN, DELAFIELD's haematoxylin, and HEIDENHAIN's iron-haematoxylin were used for staining. It is regretted that we have not been able to send the notes and observations then made, for publication earlier. The preparations have now been examined afresh.

Of the 18 species recorded in this paper, 2 are new, and 4 are being recorded for the first time from any part of India. A list of these is given below: —

Loxodes bahaduri, sp. nov.

Loxodes striatus (ENGELMANN) PENARD.

Loxophyllum helus (STOKES).

Chilodon spiralidentis, sp. nov.

Colpoda steinii MAUP.

Spirostomum teres CL. & L.

For species of fresh-water Ciliates described from different parts of India after 1921, GULATI (1925) and MADHAVA RAO (1928) may be referred to. SANDON (1927) and Chaudhuri (1929) have recorded a large number of ciliates from soils from different parts of India.

We wish to thank Prof. BAHADUR SINGH of Sri Pratap College, Srinagar, for affording us laboratory accomodation and other facilities during our stay at Srinagar.

Order **Holotricha**.

Sub-order **Gymnostomata**.

Family **Colepidae** KENT.

Genus **Coleps** NITZSCH.

NOLAND (1925) has published a monograph on this interesting genus, in which he has given a key to the identification of seven species. LEPSI (1926) has followed him. Both these authors have overlooked the descriptions of *C. trichotus* SAVI (1913) and *C. Kenti* BHATIA (1922). In the species recognised by NOLAND, a number of posterior spines are always present, but in *C. Kenti*, there are no posterior spines, though the body is covered over by plates. According to NOLAND, *Coleps* is distinguished by the possession of a characteristic type of armour and by the presence of several spine-like processes at the posterior end. We think this definition should be emended so as to include forms which possess an armour, are rounded at the posterior end, and lack the spines, as these cannot be referred to the related genera *Plagiopogon* or *Tiarina*.

Coleps hirtus O. F. MÜLL.

Specimens of this cosmopolitan species were found abundantly in ponds in Srinagar. The specimens showed the usual structure, but were larger, measuring from 48 to 60 μ in length.

Family **Loxodidae** ROUX.Genus **Loxodes** CLAP. & LACHM.**Loxodes bahaduri** sp. nov.

(Fig. 1.)

Body elongated and laterally compressed, elastic, though preserving a definite oval shape, pointed towards the anterior end. The anterior end is curved towards the ventral border. The ventral border is marked by a groove, at the bottom of which the mouth is situated. The borders are uniformly ciliated. The cytoplasm is colourless and more or less vacuolated. Along the dorsal border are situated a few, small vacuoles, which are non-contractile. There is however, one contractile vacuule situated in the posterior region of the body which contracts after long intervals. There are two macronuclei, with a micronucleus lying close to each. Length of the animal varies from 130—170 μ . Found in pond water overgrown with aquatic vegetation, at Srinagar.



Fig. 1.
Loxodes bahaduri.

The form described above has a general resemblance with *L. rostrum* EHRBG., from which it differs however by its smaller size, number and structure of the macronuclei, and the possession of a definite contractile vacuule. The dimensions of *L. rostrum* are given as 250—580 μ , whereas our specimens do not exceed 170 μ . Again in that species there may be two or more nuclei.

WRZESNIEWSKI has demonstrated a racemose system of nuclei. SCHEWIAKOFF in his diagram of that species gives only one macronucleus. WARD and WHIPPLE in their figure, copied from CONN, show only two nuclei, and state in their description that the nuclei may be two or more. PENARD says that the nuclei are numerous, small and spherical. All these authors however agree as to the absence of a contractile vacuule in that species. So considering all the points, our specimens are sufficiently distinct to rank as a new species.

Loxodes striatus (ENGELMANN) PENARD.

Forms referable to this species were encountered in water from a pond overgrown with aquatic vegetation, at Srinagar. The body is elongated, lanceolate and colourless. The anterior end is curved

towards the ventral border. The mouth is situated in the groove running along the curved portion. The body is flexible, with its dorsal surface slightly convex and the ventral surface flattened. The surface is marked with longitudinal lines, along which very fine cilia are evenly distributed. There are two spherical macronuclei, each provided with a strong nuclear membrane and a large centrally placed nucleolus. The two micronuclei are placed close to the nuclear membrane, attached to the posterior pole of the anterior and the anterior pole of the posterior macronucleus. The statoblasts described by PENARD were not noticed, though a few non-contractile vacuoles were found along the dorsal border. There is no contractile vacuole. The length of our specimens varied from 142 to 190 μ .

Family **Amphileptidae** SCHOUTEDEN.

Genus ***Lionotus*** WRZESN.

Lionotus fasciola (EHRBG.) WRZESNIEWSKI.

The body is elongated, lanceolate, the anterior end is drawn out into a short neck, and the posterior end pointed. The border bearing the cytostomial groove is convex, and the groove is distinct. There is no pharynx. Trichocysts are arranged in a distinct row along the cytostomial groove. There are two macronuclei situated about the middle of the body, and these are connected together by a cord-like structure. There is only one micronucleus lying between the two macronuclei. The specimens are 50 to 60 μ in length.

Found in pond water, rather rare, as only a few specimens were encountered.

Genus ***Loxophyllum*** DUJ.

Loxophyllum helus (STOKES).

The body is elongated and flattened, the anterior end is prolonged into a short neck, which is slightly curved, and the posterior end is acuminate. The cytostomial groove and the mouth are present on the convex border of the neck. The surface of the animal shows longitudinal ciliary lines running close to one another. The dorsal border is raised into a number of papillae, underneath each of which there is a bundle of trichocysts. There are two ellipsoid macronuclei, with a rounded micronucleus lying between the two. The contractile vacuole is sub-terminal. Length of the animal is 124 μ .

The organism was found in pond water, and was scarce.

Family **Chlamydodontidae** CLAUS.Genus ***Chilodon*** EHRBG.***Chilodon cucullulus*** (MÜLL.).

Body asymmetrical, dorso-ventrally flattened, elongate, elliptical, deformable. The anterior extremity is produced into a lamellar beak like projection, curving towards the left. The posterior end of the body is rounded. The ventral surface is flattened, and the dorsal is convex in the posterior two-thirds of the body. The ventral surface bears longitudinally running ciliary lines, those on the right are curved and run on to the beak, whilst those in the left half run straight. The mouth is ventral situated in the anterior third of the body. The cytopharynx is straight, wider anteriorly and narrowing posteriorly, and contains a number of longitudinal rods. From the anterior end of the pharynx, a line of stronger bristle-like cilia extends towards the lip.

The cytoplasm is vacuolated. The macronucleus is large, oval and situated in the middle of the body. A narrow compact layer of nucleoplasm extends all along the margin of the nuclear membrane. The nucleus contains a large spherical nucleolus, which is surrounded by chromatin granules, which are specially aggregated on two sides of the nucleolus like two caps. There are three contractile vacuoles, two being in the neighbourhood of the macronucleus, and the third, which is largest, is postero-terminal. Length about 90 μ .

Found in water of a pond overgrown with green algae, in Amira Kadal, at Srinagar.

***Chilodon spiralidentis* sp. nov.**

(Fig. 2.)

Body is flattened, oval and nearly twice as long as broad. The dorsal surface is convex, while the ventral surface is flat. The cilia are uniform on the ventral surface. They are arranged along parallel lines, which run straight in the left half, and curve round to the anterior end in the right half of the body. The anterior extremity of the body is produced into a flattened beak slightly curving to the left. The mouth is situated some distance behind the anterior end and is followed by a pharynx, wider in front, and the narrow portion of which is curved. The cytoplasm is vacuolated. The macronucleus is somewhat oval and is surrounded by a clear space. The nuclear membrane has a wavy zone

of nucleoplasm adhering to it all round. There is a large, centrally placed nucleolus, with a dark central karyosome. The chromatin granules are compactly arranged in two masses on the anterior and posterior sides of the nucleolus and less densely laterally. There are three contractile vacuoles, the largest of which is near the posterior end.

The animal is usually gliding, but sometimes swims forward and rotates on its axis. The animal was very scarce. The length of the organism is $97\ \mu$ and the maximum width $53\ \mu$. Found in a pond in Hazuri Bagh at Srinagar.

This form is a new species showing certain resemblances both with *Ch. cucullulus* MÜLLER and *Ch. uncinatus* EHREBG. It resembles *Ch. cucullulus* in the arrangement of the ciliary lines, and the structure of the nucleus, but differs from it in the form of the cytopharynx, which is spiral. It resembles *Ch. uncinatus* in as much as the cytopharynx is spirally curved, but it differs from that species in the structure of the nucleus, the number and disposition of the contractile vacuoles, and its larger size.

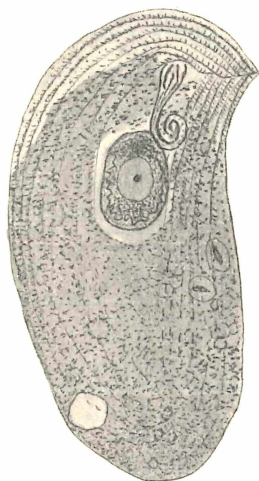


Fig. 2. *Chilodon spiracidensis*.

Sub-order **Trichostomata** BÜTSCH. emend. KAHL.

Family **Colpodidae** POCHÉ emend. KAHL.

Genus **Colpoda** O. F. MÜLL.

Colpoda steinii MAUP.

Body is oval and cylindrical, narrowed anteriorly, and with a deep bay-like depression on the ventral side. The mouth is situated at the bottom of the depression and is followed by a short, tubular cytopharynx. There is a tuft of longer cilia at the posterior end of the body, not mentioned in the previous descriptions of this species. There is a spherical macronucleus and a small micronucleus situated close to it. There is a single vacuole in the posterior region of the body. Length about $53\ \mu$.

Few specimens met with in pond-water at Srinagar.

Family **Paramaeciidae** GROBBEN.Genus **Paramaecium** STEIN.**Paramaecium caudatum** EHRBG.

The species is quite common and specimens show the usual characters. The specimens measure about 200 μ in length.

Paramaecium aurelia (O. F. MÜLLER).

Specimens referable to this species are also met with. They are smaller in size, less pointed at the posterior end and there is no tuft of longer cilia at the posterior end. There are two small vesicular micronuclei, situated one on each side of the macronucleus.

Paramaecium bursaria (EHRBG.).

This species is also commonly met with. As usual the form is dorso-ventrally flattened and the posterior end of the body is rounded. The cytoplasm is full of small green algae and shows rapid cyclosis. The peristomial groove is rather small in length as compared with the size of the animal. The macronucleus is large and kidney-shaped and lies in the middle of the body. The micronucleus is single, of massive type, and lies in the depression on the side of the macronucleus. Length about 306 μ .

Sub-order **Hymenostomata** HICKSON, emend. KAHL.Family **Frontonidae** KAHL.Genus **Frontonia** CLAP. & LACHM.**Frontonia leucas** (EHRBG.).

The body is elongated, cylindrical but somewhat flattened, rounded at both ends, the posterior end being somewhat narrower. The right border is straight or slightly concave, and the left border is convex. The cilia are fine, arranged along longitudinal lines, the lines of the right side meeting those of the left, in front of the mouth.

The living specimens are quite opaque and nothing can be seen except the contractile vacuole with its radiating canals, and the large number of green algal filaments, on which the organism has fed itself. In specimens properly fixed and stained with iron-haematoxylin, the detailed structure of the peristomial groove can be made out. The peristome (Fig. 3) is oval, being pointed at its anterior end and elongated in the direction of the length of the

animal. From the base of this oral fossa, is prolonged on the right side a longitudinal furrow, which extends almost to the posterior end of the body. The published diagrams of this species, by SCHEWIAKOFF and TONNIGES leave much to be derided, so far as the structures to be seen in the peristomial field are concerned. PENARD has given an excellent description of these structures, and we are able to verify and confirm all the details mentioned by him. The oral fossa is ornamented by cilia, which are enlarged at their points of attachment to the peristomial framework, and are free at their other extremity. Besides the fine cilia, there is a broad striated lamella attached to the left, and a long and narrow undulating membrane attached to the right border of the framework. On the right side of the peristomial aperture there are three parallel, striated bands, separated by lines covered with small and close-set basal granules from which the cilia arise. The innermost band also bears longer cilia along its left border and in addition gives attachment to the long, narrow undulating membrane referred to above, which extends along the whole length of the oral fossa and stops at the commencement of the pharyngeal groove, which latter runs along the ventral side of the animal, almost to the posterior end of its body.

Along the left margin of the oral fossa, are two striated bands. At the anterior end of the fossa, there seem to be three such bands, making an acute angle with those of the right side. Only two of the bands extend along the left border, and at the base of the oral fossa the outer one stops and the inner one is curved and continued to form the wall of the pharyngeal groove. The inner band bears along its right border, a number of thick lashes as shown in the diagram. To this border is also attached a broad, transversely striated membrane, which extends across, covering the oral fossa. This membrane is free at its right border and thus leaves a narrow groove uncovered, which is continued behind as the pharyngeal groove.

The trichocysts are abundantly distributed all over the body

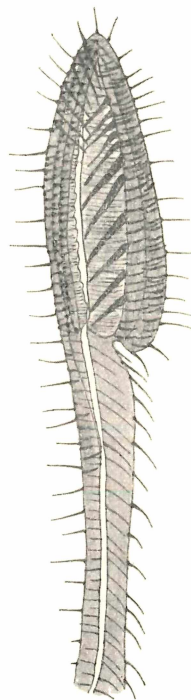


Fig. 3.
Peristomial field of
Frontonia leucas.

in the cortical region. PENARD has described a large variety of trichocysts in this species. We have been able to recognise in our specimens only three kinds, viz., (1) a spherical form of trichocysts lying close to the border of the peristome, (2) fusiform, and (3) some-what curved rod-like trichocysts, distributed all over the surface.

The large macronucleus is ellipsoidal and situated in the middle of the body. It is granular in structure. There are numerous micronuclei lying over the macronucleus. Each of these is an elongated oval body, with a strong nuclear membrane, and a single dense body inside.

There is a single contractile vacuole situated in the middle of the body, from which long canals are radiating in all directions.

The form was quite abundant in water from a pond in Amira Kadal, Srinagar. The length of the specimens varies from 200 to 324 μ .

Genus *Glaucoma* EHRBG.

Glaucoma pyriformis EHRBG.

This well-known species is fairly common in stagnant water. Body is oval and distinctly narrowed at the anterior end. Mouth is oval and situated at one fourth of the length of the body from the anterior end. It is provided with an undulating membrane, attached along the anterior part of the left margin of the peristome and extending along the anterior margin to its right border, the portion along the right margin being broader than that along the left. The body cilia are fine and arranged in longitudinal rows over the body. The macronucleus is rounded and central. The contractile is placed laterally near the hinder end. There is no bristle at the posterior end of the body. Our specimens are somewhat smaller than the size usually given for this species, measuring about 32 μ .

Family *Urocentrina* CLAP & L.

Genus *Urocentrum* NITZSCH.

Urocentrum turbo MÜLL.

The body is flexible and unevenly cylindrical, being rounded at the anterior and posterior ends. The body appears to be divided into two regions by a constriction in the middle. The posterior region is narrower and provided with a caudal appendage, which is a long, flattened, and flexible structure formed of a bundle of cilia. In some specimens this appendage is not present, or is seen

to be curved up over the body. The anterior part of the body is vacuolated. There are three ciliary girdles. The anterior one is very wide, the posterior one less so, and the one running round the middle is a narrow one consisting of very short cilia. The trichocysts are very abundant and distributed all over the body. The cytostome is obliquely placed just behind the middle ciliary girdle, and a narrow furrow extends backwards from the mouth towards the hinder end of the body. The contractile vacuole is single, lies posteriorly and is followed by a groove. The macronucleus is band-shaped, with two spherical extremities, placed horizontally across the posterior region of the body.

Length of the specimens varies from $33\ \mu$ to $60\ \mu$.

The organisms were found in pond water overgrown with *Lemna*. They became very abundant in a jar containing pond-water richly covered with *Lemna*, during the course of two or three days, but two or three days later, they became very scarce again.

Order **Spirotricha** BÜTSCHLI emend. KAHL.

Sub-order **Heterotricha**.

Family **Spirostomidae** KAHL.

Genus **Spirostomum** EHRENG.

Spirostomum teres CL. & L.

Specimens with characters of this species were found in pond water overgrown with *Lemna* and other aquatic plants. The body is elongated and cylindrical, rounded at the anterior and truncated at the posterior end. The peristomial groove extends only up to about one-third of the length of the body. The macronucleus is oval. The contractile vacuole is occupying almost the whole width of the posterior end of the body, and is continued anteriorly into a long canal running almost to the anterior end of the body. Length of the fully expanded specimens is about $400\ \mu$.

A few specimens were also encountered in which there are two oval macronuclei lying in the centre, closely approximated to each other. Each of these contains a large number of rounded microsomes.

Spirostomum ambiguum EHRENG. *var. minor*.

Specimens of this species are more commonly found than the preceding one. They occur in the same habitat, i. e., pond water overgrown with *Lemna*, and commonly occur in the company of such ciliates as *Urocentrum*, *Paramaecium* and *Coleps*.

The body is elongated and cylindrical, with the anterior end evenly rounded, and the posterior end truncated. The peristome is longer than in *S. teres* and extends to the middle of the body or even further than that, and is marked by longer and stronger cilia.

The macronucleus is usually found to be moniliform and runs through the greater part of the body. The beads are rounded, oval, or elongated-oval and tapering at either end, and are usually connected together by elongated and narrow commissures. Each lobe or bead of the nucleus, is seen in preparations stained with iron-haematoxylin, to contain a number of larger granules (macro-somes) which are vacuolated, and a number of smaller granules (microsomes) which are seen to be more deeply stained in borax-carmin preparations.

The micronuclei are numerous, but usually less in number than the lobes of the macronucleus. Each micronucleus consists of a deeply staining granular mass surrounded by a clear non-staining halo. The micronuclei are not in contact with the lobes of the macronucleus, but are situated at some distance from them.

The form and structure of the macronucleus varies a good deal in different specimens. In some specimens it is vermiform, resembling a band, which is twisted in its course. In some, the band is very much shortened and in still others there is an approach to the oval nucleus resembling that of *S. teres*. In the larger specimens, the macronucleus is always moniliform, and the shape and size of the beads varies a good deal. In some specimens, there are no commissures, and the lobes of the macronucleus are discrete. These variations in form of the macronucleus are to be regarded as stages in growth. There is no correspondence between the number of micronuclei and the lobes of the macronucleus. We have made an interesting observation regarding a correspondence between the form of the macronucleus and the length of the peristome. In specimens showing a band-shaped or vermiform nucleus, the peristome usually extends to about one-third of the length of the body, whereas in specimens with a moniliform nucleus, the peristome reaches the middle of the body or extends beyond it. Thus *S. teres*, and the minor and major varieties of *S. ambiguum* forma series, the structural peculiarities of which are closely paralleled by the stages of growth of the individual specimens of *S. ambiguum*.

The specimens are somewhat longer and thicker than those of *S. teres*, and can be readily recognised from the latter by the length of the peristome, and the form of the macronucleus.

Family **Stentoridae** CLAUS.Genus *Stentor* OKEN.*Stentor polymorphus* EHRLG.

Specimens encountered are solitary, and of the usual form and structure. Body is trumpet shaped and the peristome which occupies the whole of the anterior end of the body is equal to one-fourth of the length of the extended animal. The majority of the specimens are full of disc-shaped zoochlorellae and appear to be green, others are less full and appear as colourless. Body is metabolic, and when the organism is disturbed, it contracts itself to form a small globule, then gradually expands itself, swimming for some time in a half expanded condition.

The peristomial field in a fully expanded organism is circular in shape, and the disc is raised in the centre. The adoral cilia are very long and strong. The peristomial margin is spirally coiled at its left extremity and forms a depression, at the bottom of which lies the mouth. The general surface of the body is covered with very fine cilia distributed along close set parallel lines. No stronger bristles are present on the body.

The macronucleus is moniliform and consists of rounded or oval beads. The single contractile vacuole is situated in the anterior region of the body, followed by a long canal.

Specimens showed the phenomenon of regeneration, a piece containing four beads of the macronucleus regenerated into a complete specimen while under our observation.

The specimens were found in pond water at Srinagar, and were not common. The length of the specimens varies a good deal, but it is generally about 1 mm.

Order **Hypotricha.**Family **Oxytrichidae** KENT.Genus *Stylonichia* STEIN.*Stylonichia pustulata* (MÜLL.) EHRLG.

The body of the animal is oval, and rounded and equally broad at both ends. The dorsal surface is slightly convex and the ventral surface flat. The peristomial groove is wide and extends up to the middle of the body. Eight frontal cirri are arranged in the

manner characteristic of the family. Anal cirri are five in number, and project beyond the posterior end of the body. The marginal cilia arise a little inside the margin, and are interrupted at the posterior end by the caudal styles. The three caudal styles lie close to one another.

The macronuclei are two in number and lie at some distance from one another. Each has a micronucleus lying close to it. There is a single contractile vacuole lying close to the middle of the body.

Length of the specimens is 50 to 60 μ . Very common in stagnant water at Srinagar.

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