Contributions to our knowledge of Indian algae—3. Euglenineae Part 3. The genera Trachelomonas Ehrenberg and Strombomonas Deflandre

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Abstract. Though about 120 taxa of Trachelomonas and 13 taxa of Strombomonas are recorded from the Indian region, only about 60 taxa have been described fully. These descriptions are scattered in different journals. The present account brings together 70 taxa of Trachelomonas and 36 of Strombomonas collected from north-east, central and south India during 1937–1976, with keys and figures for their identification.

Of these, 3 species of Trachelomonas, viz. Trachelomonas costatus, Trachelomonas assamensis and Trachelomonas jayasagarensis and 5 species of Strombomonas, viz. Strombomonas hexagonalis, Strombomonas madraspatensis, Strombomonas vaseiformis, Strombomonas indica and Strombomonas tortuosa are considered new. Sixteen varieties and forms of Trachelomonas and 7 varieties and forms of Strombomonas are also considered new. Nine species and 12 varieties of Trachelomonas and 11 species and 7 varieties of Strombomonas are new records for the Indian region.

A list of 87 taxa of Trachelomonas and 7 of Strombomonas, the major part of which are only just listed by various authors for the Indian region, are given at the end of each genus.

Some ecological observations on Trachelomonas and Strombomonas are given. The majority of Trachelomonas species occurred in ponds with a fairly high degree of organic matter and fairly high nitrates and phosphates and low alkalinity during the rainless months of December to May. Strombomonas spp. were usually more common in ponds with higher alkalinity. Strombomonas verrucosa var. conspersa and Trachelomonas volvocina tolerated a wide range of total alkalinity. Excessive heat and sunlight or continuous rains seemed to have an adverse effect on the latter organism.

1. Introduction

This is the third and final part in the series ‘contributions to our knowledge of Indian algae—3. Euglenineae’, the first two parts having been on Euglena, Lepocinclis and Phacus (see Philipose 1982, 1984).

Bhatia (1930) appears to be the first to record two species of Trachelomonas from Kashmir. Skvortzov (1937) described 36 taxa from Rangoon. Of these, 18 taxa were considered as new. Subsequent workers have referred some of Skvortzov’s taxa to other species and varieties while a few have been considered doubtful. Philipose (1940) described 12 taxa consisting of Trachelomonas and Strombomonas from Madras. Gonzalves and Joshi (1946) recorded 4 taxa from Bombay. Skuja (1949) recorded 21 taxa from Burma. Suxena (1955) described 6 taxa of Trachelomonas from Hyderabad. Zafar (1959) listed 4 species from the same place.

Kamat (1962, 1963) recorded 6 taxa of Trachelomonas from Ahmedabad, and 13 taxa of Trachelomonas and one of Strombomonas from Kolhapur, Maharashtra, respectively. Kamat (1964, 1967, 1968a,b, 1975) also reported 12 taxa of Trachelomonas from Bombay, two from Mount Abu (Rajasthan), 8 from Alibag (Maharashtra), 5 from Simla (Himachal Pradesh) and 45 from Vidarbha (Maharashtra) respectively. Kamat and Freitas (1976) listed 6 taxa from Nagpur.


Considering the overlapping in the record of many species and the fact that some taxa have been referred to other species, altogether about 55 species of *Trachelomonas* and about 64 varieties and forms have so far been recorded in the Indian region. Seven species and 6 varieties of *Strombomonas* are also known from the Indian region. With the present description of 12 additional species and 27 varieties and forms of *Trachelomonas* and 18 species and 14 varieties and forms of *Strombomonas*, there appears to be altogether 67 species and 91 varieties and forms of *Trachelomonas* and 25 species and 20 varieties and forms of *Strombomonas* for the whole of the Indian region. Out of these only about 54 taxa of *Trachelomonas* and 7 taxa of *Strombomonas* have been described fully, the rest being only listed, and these are scattered in different journals. In this paper 70 taxa of *Trachelomonas* and 36 taxa of *Strombomonas* are described with figures. A list of 87 taxa of *Trachelomonas* and 7 of *Strombomonas* described or recorded by other authors are given at the end of each genus.

2. Additional locations of collection

In addition to the locations of collection given in Philipose (1982, 1984) samples from the following places were also studied.

**Assam:** (1a) Sibsagar Jamuna (15–6–1955); (1b) Bighauri tank, Sibsagar (15–6–1955); (5b) NP 1, Joysagar Fish Farm (27–5–1955 and 1–6–1955); (5c) NP 4, Joysagar Fish Farm (4–6–1955); (5d) NP 16, Joysagar Fish Farm (6–4–1955 and 9–6–1955); (6a) NP 24, Joysagar Fish Farm (19–5–1955 and 30–5–1955); (19a) Namli Sarathi Pond, Nazira (15–6–1955).

**Madhya Pradesh:** (44a) Manzoor tank, Jabalpur (27–4–1956).

**Orissa:** (46a) G Mohanty’s Pond, Balasore (25–11–1954); (52a) Sunda Bibi Tank, Bhadrak (28–11–1954); (56a) Shyamasunder Das Pond, Nilgiris (26–11–1954); (78a) Tank 6, Chaudwar Fish Farm (2–1–1953); (80a) NP 2, Dhenkanal Fish Farm (26–2–1957); (88a) Ramsagar Tank, Sambalpur (12–12–1954); (88b) Municipal Tank, Sambalpur (12–12–1954); (88c) Adharakonta, Sambalpur (12–12–1954); (88d) NP 7–
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Sambalpur Fish Farm (12–12–1954); (88e) NP 6–NP 6 and NP 20, Sambalpur Fish Farm (30–12–1954); (93a) NP 5–Kausalyagang Fish Farm (27–11–1952); (97a) Government Tank, Nawapara, Boudh (12–12–1954); (99a) Agra Bund, Berhampur (20–12–1954).


Kerala: (136b) Thattapallikulam, Azhicode (10–2–1950); (136c) Palakudikulam, Azhicode (26–2–1949); (137b) Ayyappankutty Kulam, Edavankad, Azhicode (6–10–1951); (137c) Padathakulam, Azhicode (8–10–1951); (137d) Thondandikulam, Azhicode (9–2–1950); (142b) Rahinakaparamp, 2 (1–3–1949).

Tamil Nadu: (160a) Railia Reservoir, Coonoor (12–5–1952).

3. Ecological notes

Though a wide variety of Trachelomonas and Strombomonas became very common or abundant in a number of ponds of north-east and south India, the meteorological and physico-chemical conditions under which they became dominant are available only for a few ponds. Nor were these studied in detail since the present account is more of a taxonomic nature.

Table 1 shows the conditions under which a number of Trachelomonas and Strombomonas species became dominant in 6 ponds. Trachelomonas volvocina which became very abundant in the Museum pond, Madras, and Chaudwar pond 6, Orissa, appeared to be favoured by moderate temperatures, high sunshine values and absence of rains, and higher nitrates than phosphates. High temperatures in summer, especially when the water level was low, was found to have an adverse effect on this organism since it migrated to the bottom layers during the bright hot hours of the day and back to the surface at night. With continuous rains obtaining in the winter monsoon months it became much less or disappeared altogether (also see Philipose 1940). Strombomonas verrucosa var. zmiewika and S. verrucosa var. borysheniensis on the other hand, seemed to be favoured by a certain amount of rainfall accompanied by lowering of temperature and slight increase in nitrates.

Most extension at Cuttack and the swamp at Kausalyagang where organic matter was high due to the decomposition of weeds, nitrates and phosphates were high, with the latter higher, and the water level was low, several species of Trachelomonas and a few of Strombomonas occurred. Dhar’s pond, Barrackpore, and Dwarapudi pond, Srikakulam, also showed a wide variety of Trachelomonas and Strombomonas. These 4 water areas had bright hours of sunshine, moderately high temperatures, no rainfall and phosphates higher than nitrates.

Six other ponds (not included in the table) worth mentioning are Stocking tank-4, Joyasagar, in which 8 species of Trachelomonas (including T. volvocina which was abundant) and Strombomonas verrucosa var. conspersa occurred on 4–6–1955; Gaurisagar tank, Joyasagar, with 14 species of Trachelomonas on 10–12–1965; Sagore Dutt pond-2, Kamarhati, in which 6 species of Strombomonas and
Table 1. Showing the meteorological and water conditions in 6 ponds in which *Trachelomonas* and *Strombomonas* dominated and the species concerned.

<table>
<thead>
<tr>
<th>Water bodies and date of collection</th>
<th>Museum</th>
<th>Pond</th>
<th>Pond</th>
<th>Pond</th>
<th>Pond</th>
<th>Pond</th>
<th>Pond</th>
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<td>Nil</td>
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<td>Nil</td>
<td>Nil</td>
<td>Nil</td>
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<td>Nil</td>
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<td>Nil</td>
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<th>Bright Sunshine</th>
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<td>9.7</td>
<td>7.9</td>
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<tr>
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<td>Nil</td>
</tr>
<tr>
<td>Kushtabad 30</td>
<td>4.4</td>
<td>Nil</td>
</tr>
<tr>
<td>Srikakulam 31.2</td>
<td>37.4</td>
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<td>Madras 30</td>
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<td>Madras 30</td>
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<td>Kushtabad</td>
<td>31.2</td>
<td>31.2</td>
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<td>37.4</td>
<td>37.4</td>
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<td>Chaudwari Farm</td>
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<td>60</td>
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<td>Kushtabad</td>
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<td>60</td>
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<tr>
<td>Srikakulam</td>
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<td>Madras</td>
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<td>31.2</td>
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<td>Kushtabad</td>
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<td>37.4</td>
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<td>Madras</td>
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<td>Kushtabad</td>
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<td>Madras</td>
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<th>Dissolved oxygen (ppm)</th>
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<td>Cuttack</td>
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<tr>
<td>Kushtabad</td>
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<tr>
<td>Srikakulam</td>
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<td>Madras</td>
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<th>Oxidisable organic matter (ppm)</th>
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<tr>
<td>Cuttack</td>
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<td>30</td>
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<tr>
<td>Chaudwari Farm</td>
<td>70</td>
<td>70</td>
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<tr>
<td>Kushtabad</td>
<td>70</td>
<td>70</td>
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<tr>
<td>Srikakulam</td>
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<td>Madras</td>
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<td>Chaudwari Farm</td>
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<td>32</td>
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<td>Kushtabad</td>
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<td>32</td>
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<tr>
<td>Srikakulam</td>
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<td>Madras</td>
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<thead>
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<th>Nitrates (ppm)</th>
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<tr>
<td>Cuttack</td>
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<td>0.99</td>
<td>0.99</td>
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<td>0.09</td>
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<td>Madras</td>
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<td>Cuttack</td>
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<td>Chaudwari Farm</td>
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<td>Cuttack</td>
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<td>Nil</td>
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<tr>
<td>Chaudwari Farm</td>
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<td>Nil</td>
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<tr>
<td>Kushtabad</td>
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2. Abundant: e, common; r, rare; i, isolated; va, very abundant; vc, very common; re, rather common; vr, very rare.
Trachelomonas scabra became dominant on 30–5–1950; pond No. 17, Jobra, Cuttack, in which Strombomonas verrucosa var. conspersa became abundant on 19–5–1955; pond 2, Birbati, Cuttack, with 9 species of Trachelomonas on 25–2–1957; and Thandankulam, Azhicode, which showed 7 species of Trachelomonas on 26–2–1949. Of these, except Sagore Dutt pond-2, all had total low alkalinity (50–70 ppm). Also, in cultures of silt from pond 16, Jobra, Cuttack, collected on 23–9–1951 and kept in the laboratory, 11 taxa of Trachelomonas appeared on 26–9–1951.

Thus, Trachelomonas and Strombomonas dominated in most ponds usually during December–May or early June when there was bright sunshine and no rainfall. Though total alkalinity seemed to be on the higher side (80–200 ppm or more) for T. scabra and most species of Strombomonas (e.g. Strombomonas verrucosa var. zmiewika, S. gibberosa, S. napiformis var. brevicollis, S. praelaris, S. tambowiika, S. triquestra var. torta and S. reisii), it was on the lower side (30–70 ppm) for most species of Trachelomonas (e.g. T. lismorensis, T. costatus, T. mucosa, T. hispida var. crenulatocollis, T. armata, T. volvii var. cylindracea, T. pseudocaudata var. elongata, T. helvetica and T. nadsonii var. indica). T. volvocina and Strombomonas var. conspersa seemed to tolerate a wider range of total alkalinity. Some ponds like Moat Extension, Cuttack, Birbati pond, Swamp, Kausalyagang and Thandankulam had also high organic matter due to the decomposition of weeds.

Incidentally, it may be mentioned that in British ponds, both Lund (1942) and Philipose (1948) observed the predominance of Trachelomonas spp. after the autumn leaf fall (usually October–November) when organic matter was maximum. Philipose also observed that high nitrates and phosphates coincided with the maximum of Trachelomonas in November.

4. Systematic account

Genus Trachelomonas Ehrenberg 1833

Single-celled and free swimming with delicate membrane, highly metabolic, and enclosed within a stiff and brittle envelope (lorica) of different shapes, the protoplast partially or completely filling the lorica; lorica spherical, subspherical, ovoid, cylindrical or spindle-shaped, with or without a collar at its opening (pore) and with or without a tail; pore with or without an annular thickening; lorica smooth or rugged, dentate or with spines; colourless (mostly when juvenile) or coloured yellow, brown or sometimes red; lorica rarely enclosed within a mucilaginous envelope; with a flagellum which is usually more than body length; vacuolar system as in Euglena; Chromatophores two to numerous and discoid, trough-shaped or parietal, rarely absent, and with or without pyrenoids which are often double-sheathed (diplo-pyrenoids) and sometimes projecting and button-like; paramylum bodies roundish or elongated, rarely ring-shaped or sometimes absent; eye-spot usually present, semi-spherical or streak-like and lying by the side of the reservoir. Mostly in standing freshwater, rarely in brackish water.

Key to the Indian species described

I. Lorica generally without a tail . . . . Section I. Rotundatae
   (A) Lorica spherical to subspherical or compressed . . . . Subsection 1. Sphaericae
Contributions to our knowledge of Indian algae—Euglenineae 323

(1) Lorica spherical to subspherical and smooth . . . . . . . Group Volvocinae
   (a) Lorica spherical, collar usually absent, very rarely present
      (i) Chromatophores 2 and with pyrenoids; 5–32 μm in diameter . . . 1. T. volvocina
         With a cylindrical partially depressed collar; 14–15 μm in diameter . . . . . . var. planctonica
      (ii) Chromatophores usually up to 10, rarely up to about 30, and
         without pyrenoids; 14–16 μm in diameter . . . . . . 2. T. volvocinopsis
   (b) Lorica spherical to broadly ellipsoid with depressed collar; chromatophores numerous and without pyrenoids; 22–27 μm in diameter . . . 3. T. varians

(2) Lorica with small spines all over the surface or at one or both poles only . . . Group Spiniferae
   Lorica spherical and with small spines scattered at fair distances; 17–18 μm in diameter . . . . . . 4. T. sparsesetulosa

(3) Lorica spherical to subspherical and with diverse ornamentation . . . . . . Group Diversisculptae
   (a) Surface covered with close granulations or verrucae or granular
      pustules; lorica 18–34 μm . . . . . . . 5. T. verrucosa
      Ornamentation in the form of circular to semi-circular tubercles; lorica
      14–15.8 μm . . . . . . var. macrotuberculata
   (b) With prominent longitudinal ribs; 13–27 μm in diameter . . . . . . . 6. T. costatus
   (c) Lorica with reticulate sculpturing; 14–15 μm in diameter . . . . . . 7. T. assamensis
   (d) Lorica spherical to slightly rectangular with sharp spiral striae to the
      left; 22–27 × 19–23 μm . . . . . . . 8. T. heduma

(4) Lorica compressed along the longitudinal axis with one or both poles
    flattened . . . . . . . . . . . . . . Group Compressae
   Without any collar round the pore . . . Subgroup Mespiliformes
   (a) Both poles flattened
      (i) Lorica smooth, pore with annular thickening; 17–29 × 20–31 μm . . . . . . 9. T. curta
      (ii) Lorica with radially arranged spines; pore small and surrounded
         by a row of small spines; Lorica 20 μm; spines up to 4 μm . . . . . . 10. T. lismorensis
         One row of spines below the equator and above it longer, the rest
         shorter; spines up to 6 μm . . . . . . var. biseriata
   (b) Front end only flattened, membrane with prominent tubercles
      including 5 conical ones around the pore; lorica 19–24 × 20–22 μm . . . . . . 11. T. tuberculata
      Tubercles irregular in shape and arrangement; lorica 16.3 × 14.1 μm . . .
      var. irregularis var. nov.

(B) Lorica elongate-ellipsoid to cylindrical or ovoid; with or without a short
    collar; diversely ornate, rarely smooth . . . . . . Subsection 2. Ellipticae
   (1) Lorica smooth or diversely ornate but not wrinkled or scrobiculate . . .
      Group Intermediae
(a) Lorica ellipsoid with front end sometimes slightly broadened . . . .
Subgroup Oblongae
(i) Lorica smooth
(++) Lorica with or without a short collar and not enclosed within mucilage; 12–19 × 9–13 μm . . . . . . . 12. T. oblonga
Lorica subspherical to 4-cornered and with rounded edges; with wide depressed collar; 11–22 × 10–20 μm . . . . . . . var. australica
(++) Lorica with short cylindrical collar and enclosed within mucilage; 44 × 33 μm . . . . . . . 13. T. mucosa
Lorica spherical and smaller; 12 μm in diameter . . . . . . . var. sphaerica var. nov.
Lorica subglobose and smaller; collar absent or reduced; 17–21 × 15–19.4 μm . . . . . . . var. subglobosa var. nov.
(ii) Lorica ornamented
(* ) Lorica subspherical to broadly ellipsoid and finely punctate or rarely with small tubercles; chromatophores 3–11 and with diplopyrenoids; 16–23 × 14–19 μm. 14. T. intermedia
Lorica larger (31.7 × 28.2 μm); chromatophores 10–11 . . . . . . . var. major forma nov.
(++) Lorica small, broadly ellipsoid and with minute warts; pore without collar but with a crown of spines; 16.5–17 × 15–16 μm . . . . . . . 15. T. neotropica
(++) Lorica large and ellipsoid, densely covered with small warts; chromatophores many, without pyrenoids; 60–64 (−65) × 34–42 μm . . . . . . . 16. T. ovata
(b) Lorica very much elongated and ellipsoid to cylindrical . . . . . . . Subgroup Cylindricae
Lorica cylindrical with parallel sides, depressed collar and smooth; 16–20 × 8–10 μm . . . . . . . 17. T. cylindrica
Without collar; 16–20 × 8–10 μm, var. decollata
(2) Lorica variable in shape and usually with spines all over, rarely at poles only . . . . . . . Group Spiniferae
(a) Spines short, conical and numerous
(i) Lorica ellipsoid with spines all over, rarely at poles only or absent altogether; with or without collar; with 8–10 chromatophores having diplopyrenoids; 20–42 × 15–26 μm . . . . . . . 18. T. hispida
(*) Lorica with collar
(∗ ) Collar widening at pore; 10–13 discoid chromatophores without pyrenoids; 31.7 × 18.5 μm . . . . . . . var. crenulatocollis
(∗ ∗ ) Collar cylindrical; 24.6–26.4 × 17.6–19.4 μm . . . . . . . fa recta
(∗ ∗ ∗ ) Lorica smooth and narrower; chromatophores many and without pyrenoids; 37 × 14.5 μm. fa glabra fa nov.
(∗ ∗ ∗ ) Lorica without collar
With uniform short spines but no punctae; pore with a crown of spines joined at the base or separate. (30–) 37–40 × 19–21 μm . . . . . . . var. coronata
(ii) Lorica more or less cylindrical with nearly parallel sides; chromatophores numerous and without pyrenoids; 30-35 x 19-22.5 \( \mu \)m  
[19. T. allia](ii) Lorica ellipsoid with very fine spines uniformly distributed; without collar; pore with annular ring and very small teeth; 26.2 x 20.2 \( \mu \)m  
[20. T. joysagarensis sp. nov.]
(iv) Lorica subspherical to ellipsoid with irregular rows of tubercles or short spines at both poles; pore without collar; 34-39 x 31-35 \( \mu \)m  
[21. T. kelloggii]
(b) Spines short, obtuse and rod-like  . . . . . . . . . Subgroup Bacilliferae
Lorica elongate-ellipsoid or cylindrical; without collar; 35-40 x 33-38 \( \mu \)m  . . . . . . . . . 22. T. bacillifera
(i) Lorica smaller than in the typical species; 22-28 x 18-26 \( \mu \)m  
[23. T. bacillifera var. minima]
(ii) Spines smaller in number and irregularly disposed; (21-) 27 x 22-30 \( \mu \)m  . . . . . . . . . var. sparsispina
(c) Spines conical, stout, scattered and of different lengths  . . . . . Subgroup Crassispinae
(i) Lorica ellipsoid, spines short; pore without collar but often with several spines; 20-30 x 17-23 \( \mu \)m  . . . . . . . . . 23. T. robusta
Lorica obovoid, spines thicker with blunt ends, and closer; 45.4 x 24.2 \( \mu \)m  . . . . . . var. major var. nov.
(ii) Lorica ellipsoid, with spines of varying lengths; pore with or without annular ring and collar; 38-55 x 30-39 \( \mu \)m  . . . . . 24. T. superba
With a crown of spines of equal length around pore and only a few spines in posterior half; 30.8 x 26.4 \( \mu \)m  . . . var. coronata var. nov.
(iii) Lorica ellipsoid, scrobiculate and densely covered with very stout prismatic spines; with or without collar; 40 \( \mu \)m  . . . . . . . . . 25. T. horrida
With a prominent cylindrical collar, stout membrane and reduced scattered spines; 37-39 (-42) x 20-22 \( \mu \)m; collar 5.7-7.5 \( \mu \)m long . . . . . . var. moenacanthum
(d) Hind end of lorica with a varying number of stout spines  . . . . . Subgroup Armatae
(i) Lorica ellipsoid to ovoid; posterior spines usually recurved and convergent; pore with or without an annular ring and collar; 29-37 x 22-29 \( \mu \)m  . . . . . . 26. T. armata
(*) Lorica larger (37-40-42 x 30-33 \( \mu \)m) and with one or more crowns of spines of variable number and size around the pore; hind end with long spines; 37-40 x 30-33 \( \mu \)m  . . . var. steinii
(***) Lorica ovoid with scattered short conical spines; anterior end with a number of medium-sized spines; hind end with stout spines of varying length; 37 x 33 \( \mu \)m  . . . var. malabarica var. nov.
(+++) Lorica ovoid with loose granulations and a crown of long spines at both poles; with very short collar with 4 dents;
M T Philipose

46 × 35 μm . . . . . . var. *duplex*
Granulations closer; anterior and posterior spines longer and fewer, with the latter often lateral; 46–50 × 35.5–36.5 μm . . . .

*L. jorhatensis* forma nov.

(+++) Lorica often with flattened poles; anterior pole with short and posterior pole with long, stout spines; membrane thick and finely punctate; (39–) 41–43 × 29–30.5 μm . . . . var. *longa*

(+++) Lorica more ovoid and with posterior end broader, and with long spines; entire surface also covered with widely placed short spines; 41–45 × 32–34 μm . . . . var. *longispina*
Entire surface with widely placed short spines and punctae;

42 × 31.7 μm . . . . . . f. *punctata* forma nov.

(ii) Lorica ellipsoid, rarely ovoid, with arched sides; posterior pole with a crown of thick straight or divergent long spines; entire surface with short rod-like obtuse spines or papillae; 36–40 × 27–28 μm . . . . 27. *T. dangeardiana*

(*) Hind end as in type; membrane otherwise smooth;

34–46 × 28–34 μm . . . . var. *giabra*

(* *) Lorica more cylindrical to oblong with posterior spines slightly recurved; 43 × 28 μm . . . . var. *cylindrica* var. nov.

(3) Lorica ovoid, usually with spiral striae, sometimes with spines . . . . .

Group Helicoideae

Striae punctate; pore with depressed collar with free end wavy; 26 × 19 μm . . . . . . . 28. *T. eurystoma*

Lorica cordate with broad pore; membrane smooth; 15–35 μm . . . . . . var. *nuda*

(4) Lorica elongate-ellipsoid with hind end sometimes conical; usually without collar; membrane with fine dents or scrobiculae . . . . . . . Group Scrobiculatae

(a) Lorica ellipsoid with arched sides, finely and densely scrobiculate; two chromatophores with diplo-pyrenoids; (15–7–) 19–22 × 14–16–19.8 μm . . . . . . . 29. *T. zorensis*

(b) Lorica ellipsoid-cylindrical with arched or parallel sides; with fine scrobiculae; 10 chromatophores without pyrenoids; 22–30 × 12–19 μm . . . . . . . 30. *T. abrupta*

(i) Lorica smaller (15.5–22 × 9–12 μm) and densely punctate . . . . . . var. *minor*

(ii) Lorica elongate-ellipsoid with arched sides; 20–30 × 14–18 (– 21) μm . . . . . . var. *arcuata*

(c) Lorica ellipsoid with curved sides; surface with small granules or fine pearls; 17–26 × 13–22 μm . . . . . 31. *T. granulosa*
Lorica ellipsoid with coarse punctae or lens-like elevations; collar short and widened towards outside and tooth-like tubercles; 24.7 × 16–20 μm . . . . . . var. *crenulatocollis*

Lorica more or less obovate with scrobiculae less crowded; 28.2 × 17.6 μm . . . . . . f. *obovata* forma nov.
(5) Lorica variable in form with hind end sometimes pointed; membrane always rugged or wrinkled. Group Scabrae
   (a) Lorica ellipsoid with hind end sometimes pointed; with a wide depressed collar; membrane rugged but never with regular granulations; 20–33 × 15–20 μm. T. scabra
   (i) With long, straight or bent collar; 22–33 × 16–19 μm; collar 6–7 × 3.5 μm. var. longicollis
   (ii) Lorica subspherical with front end sometimes narrower; collar cylindrical; 18–20 × 17–19 μm; collar 3–4 × 3–4 μm. var. coberensis
   (iii) Lorica ovoid or ellipsoid with posterior half often slightly twisted; pore with two lip-like ridges; 20–22 × 17–18 μm. var. longicollis

(b) Lorica ellipsoid with numerous broad-based lumps from its surface; 21 × 19.2 μm. T. szabadosiana
    Smaller form with fewer lumps; 15.8–16.7 × 13.2 μm. var. minor forma nov.

(C) Lorica very variable in form and always with a fairly high collar; surface smooth or sometimes punctate. Subsection 3. Ampulliformes
   (1) Collar straight. Group Erectae
      (a) Lorica spherical, subspherical, ovoid or ellipsoid. Subgroup Subglobosae
         Lorica subspherical and strongly punctate; pore with stumpy, conical, irregularly toothed collar, 19–30 × 17–20 μm. T. planctonica
         Smaller form; 12.3 × 8.8 μm. T. minor forma nov.
      (b) Lorica pear-shaped. Subgroup Pyriformes
         With cylindrical collar surrounded by a characteristic membrane cone at base; 32 × 15 μm; collar 4 μm high. T. volzii
         Collar stout and without basal membrane; 34–38 × 16 μm; collar 4–5 μm. var. cylindracea
      (c) Lorica elongate to cylindrical. Subgroup Elongatae
         (i) Lorica smooth
             (*) Lorica ellipsoid-cylindrical with parallel sides and a cylindrical collar; 22–26 × 11–14 μm. T. dubia
             Lorica broader; 24–27 × 16 μm. var. lata
             (**) Lorica nearly 6-sided in front view with median region parallel; collar cylindrical, sometimes with a membrane cone; 24–34 × 10–16 μm. T. hexangulata
         (ii) Lorica ornamented
             Lorica elongate-ellipsoid, hind end sometimes attenuated; irregularly ornamented; collar broad and conical; 30–39 (–42) × 20–24 μm; collar 7–11 μm at base and 4–6.5 μm at the opening. T. bulla

(2) Collar bent or curved. Group Incurvae
      (a) Lorica ellipsoid to quadrangular; collar cut regularly; membrane smooth; 19–23 : 16–18.5 μm; collar 3–3.5 μm high. T. playfairii
         Membrane hyaline and smooth; lorica 18.7–33 × 15–15.5 μm. var. hyalina
(b) Lorica ellipsoid to ovoid; margin of collar irregularly dentate; membrane punctate; 22–40 × 14–23 μm; collar 3–3.5 × 4.5–5.5 μm ...... 41. T. similis

(c) Lorica ellipsoid with a few rows of hemispherical granulations in posterior half; 26–33 × 16–24 μm; collar 4–5.7 × 4.5–7 μm ...... 42. T. atrata

Front half of lorica often smooth or with scattered granules; granules in hind half grouped in 2–4; 13–16 × 10.5–13 μm; collar 2–4 × 2 μm ...... var. pustulosa

(d) Lorica ellipsoid with irregular ridgelike elevations of different shapes, size and thickness; 16.5–20 × 14–16.5 μm; collar 2.5–3 μm ...... 43. T. gregussii

II. Lorica always with a tail ...... Section II. Caudatae

(A) Lorica ellipsoid or ovoid to elongate with a collar and tail distinct from body; ornamented ...... Subsection 1. Colliferae

(a) Membrane with spines ...... Group Spiniferae

Lorica elongate-ellipsoid and covered with dense short obtuse spines; tail stout and bifurcate at tip; chromatophores 8–10 (–12) and without pyrenoids; 41–43.5 × 22–23 μm ...... 44. T. pseudocaudata

Lorica longer and narrower; 54–55.5 × 18–18.4 μm ...... var. elongata var. nov.

(b) Membrane without spines but diversely ornamented ...... Group Diversiornatae

Lorica elongate-ellipsoid, usually with curved sides; membrane densely scrobiculate; collar variable, rarely with annular ring; tail variable; 34–43 × 18–22 μm ...... 45. T. bernardinensis

(B) Lorica attenuated towards hind end, with tail not distinct from body ...... Subsection 2. Obattenuatae

Lorica usually ellipsoid to ovoid with conical tail; pore without collar; membrane covered with spines; 38–42 × 17.5–20 μm ...... 46. T. helvetica

(a) More elongated and narrower than type; 40–55 × 15–15.6 μm ...... var. elongata

(b) Smaller than type and with rounded hind end; 30–35 × 14.5–15.7 μm ...... var. cucurbita

(C) Lorica spindle-shaped, small to very broad, thick, coloured and with spines ...... Subsection 3. Speciosae

Lorica with arched sides and with sparsely arranged spines; tail usually pointed at tip; chromatophores numerous and without pyrenoids; 66.5 × 22.5 μm ...... 47. T. nadsonii

Lorica with irregular little broad spines or punctae; neck enlarged and serrated at pore; 50–55 × 17 μm, neck 8–8.5 × 5–5.2 μm ...... var. indica

Lorica punctate to granulate; tail stouter with bifurcate ends; 59–61.6 × 17.6 μm ...... f. kausalyayangensis forma nov.

1. Trachelomonas volvocina Ehr. 1833 (Figures 1a, b)

Deflandre 1926, p 55, figures 1–6; Huber-Pestalozzi 1955, pp 251–52, figure 349.
Lorica spherical; pore with or without an annular ring, sometimes with a very much depressed collar; membrane smooth, deep yellow, yellowish brown or deep reddish brown; with two chromatophores, each with a projecting double-sheathed pyrenoid; flagellum (1.5)–2–3 times body length; lorica 10–15.8 µm in diameter; pore 2.1–2.6 µm; eye-spot usually disc-like (rarely triangular).

**Habitat:** One of the most common species occurring in fresh-water ponds, with maximum frequency usually during the cool dry months of the year; Observed in abundance in locations 5b, 5c, 6, 6a, 28 (April), 61 (NP 1 and 4, May), 63 (NP 24, January), 78a and 151 (very common to very abundant, January–December); Rather common to common in locations 4, 5d, 19, 22, 46, 46a, 51, 88b, 88c and 109; stray to rare in locations 1a, 1b, 4a, 18, 19a, 28 (April–June, August), 29 (January to December), 32, 33 (April–June, September–November), 35, 36a, 37, 38, 40a, 44, 44a, 51a, 63 (NP 25–28, January–March, July–November), 72, 74–76, 79, 85, 88, 88a, 88b, 88e, 89, 90, 90a, 93, 97a, 99, 102, 126, 130–132, 135, 135a, 136, 137, 137b, 138, 143, 154, 157 and 159.

The usual range of dimensions of the species is 5–32 µm (see Deflandre 1926; Huber-Pestalozzi 1955).

**Distribution in the Indian region:** Burma (Skvortzov 1937, 13.6–14.2 µm in diameter, flagellum 1.7 µm; Skuja 1949, 9–30 µm); Madras (Philipose 1940, 10–10.7 µm); Bombay (Gonzalves and Joshi 1946; Kamat 1964, 12–18 µm); Hyderabad (Suxena 1955, 17–17.5 µm; Zafar 1959); Gujarat (Kamat 1962, 8–28 µm); Kolhapur (Kamat 1963, 18–21 µm); Rajasthan (Kamat 1967); Alibag (Kamat 1968a); Simla (Kamat 1968b); Cranganore, Kerala (Suxena et al 1973); Vidarbh (Kamat 1975); Nagpur (Kamat and Freitas 1976); Karnataka (Bongale and Bharati 1980; Hosmani and Bharati 1983; Hegde and Bharati 1986); Aurangabad (Ashtekar 1982); Kandesh, Maharashtra (Barhate and Tarar 1985); Assam, West Bengal, Bihar, Madhya Pradesh, Karnataka, Kerala and Tamilnadu (!).

**var. planctonica** Playfair 1921 (figure 1c)

Playfair 1921, p 129, plate 6, figure 12; Huber-Pestalozzi 1955, p 252, figure 353.

Lorica spherical and smooth, with a straight cylindrical collar two-thirds of which projects outside the surface and one-third inside the lorica; collar thick-walled with both ends thinner; diameter of lorica 14–15 µm, collar 2.2 × 3.2 µm.

**Habitat:** Stray in locations 5c, 63 (NP 24, November), 76 and 159.

It agreed well with Playfair's species measuring 15 µm with collar 2 × 3 µm.

**Distribution in Indian region:** Assam, Orissa and Tamilnadu (!).

2. *Trachelomonas volvocinopsis* Swirenko (figures 2a, b)

Deflandre 1926, p 58, figure 20; Huber-Pestalozzi 1955, p 253, figure 358. = *T. indica*

Skvortzov 1937, p 77, plate 10, figure 13.
Lorica spherical, smooth and brown, 15–16 μm in diameter; chromatophores usually about 10, rarely up to 30 or more, discoid and without pyrenoids; eye-spot (reported as red and elongated) and flagellum (reported as about 3 times body length and up to about 40 μm) not observed.

**Habitat:** Stray in locations 5c, 22 and 92.

Huber-Pestalozzi treats Skvortzov’s (1937) *T. indica* (18.7–23 μm with pore 1.7–1.9 μm) as synonymous to *T. rolvocinopsis* since it differs only in the larger number (38) of chromatophores. Further, he states that Bourrelly (1952) has expressed the same opinion. In the author’s material from Dum Dum (location 22) there were about 30 chromatophores while in the Joysagar (location 5c) and Kausalyagang (location 92) materials there were only about 9–10. Diameter of the species as given by Swirenko is 14–16 μm, 26 μm as given by Deflandre and 15 μm as given by Prowse (1962).

**Distribution in Indian region:** Burma (Skvortzov 1937, as *T. indica*) Aurangabad (Ashtekar 1982); Kashmir Valley (Compère 1983); Assam, West Bengal and Orissa (!).

### 3. *Trachelomonas varians* Deflandre 1924 (figures 3a, b)


Lorica subspherical to broadly ellipsoid (slightly longer than broad) but never perfectly spherical, smooth and dark reddish brown; pore with an interior cylindrical tube 4.4–5.3 μm long; chromatophores numerous, discoid or polyhedral and without pyrenoids; eye-spot rod-like or discoid; flagellum about 1.8 times body length; lorica 23–24 × 20.3–22 μm with pore 3.5–5.3 μm in diameter.

**Habitat:** Stray to very rare in locations 14, 29 (April–May), 33 (April–May, October), 44a, 63 (January, March, August and November), 76, 88d, 100a and 135a; rare in cultures of silt from location 61 (NP 16, September) and abundant in location 65 (April).

Usual dimensions as given by Deflandre (1926) are 22–27 × 19–23 μm, with cylindrical tube 4.8–9.5 μm.

**Distribution in Indian region:** Vidarbh, Maharashtra (Kamat 1975); Aurangabad (Ashtekar 1982); Karnataka (Hosmani and Bharati 1983); Kandesh, Maharashtra (Barhate and Tarar 1985); Assam, West Bengal, Madhya Pradesh, Orissa and Karnataka (!).

### 4. *Trachelomonas sparsesetulosa* Huber-Pest. 1955 (figure 4)

Huber-Pestalozzi 1955, p 257, figure 370

Lorica regularly spherical with a narrow pore having an annular thickening but
without a collar; surface of lorica with fine spines (about 1.5-2 μm long) scattered at fair distances from each other; lorica light brown in colour and 16.7–17.6 μm in diameter. Internal contents not observed.

**Habitat:** Stray in location 76 (February).

The organism agreed well with Huber-Pestalozzi's species measuring 17–18 μm in diameter. The flagellum is described by Huber-Pestalozzi as 2½ times body length.

**Distribution in Indian region:** Orissa (!).

5. *Trachelomonas verrucosa* Stokes 1887

Deflandre 1926, p 61, figures 78–79; Huber-Pestalozzi 1955, p 261, figure 392.

Lorica spherical and thick, and ornamented with small semicircular granulations or warts; pore without annular thickening; dimensions 18–24 × 20–34 μm.

The typical species not observed by the author but is known from Hyderabad (Suxena 1955, 23–24 μm, pore 1.7–2.3 μm).

**var. macrotuberculata** Grandori (figure 5)

Huber-Pestalozzi 1955, p 261, figure 396.

Lorica spherical or nearly spherical, deep reddish brown with fairly large and conspicuous roundish to papilla-like tubercles which are dark brown in colour; pore with a slightly depressed collar; lorica 14–16.7 μm in diameter.

**Habitat:** Rather common in location 125 (February).

The organism agreed fairly well with Grandori's variety. However, Grandori has not given the dimensions.

**Distribution in Indian region:** Andhra Pradesh (!).

6. *Trachelomonas costatus* Philipose sp. nov. (figures 6a, b)

Lorica de more est sphaericalis vel aliquando ellipsoidea, plene fulva necnon aliquot plus minusve regulares, rara paululum internexas, longitudinales costas habens a vertice superiore ad verticem inferiorem procedentes, et in casibus individuis ab una vertice ad alteram radiare videntes; fistula circulo annulari; lorica 14.1–17.6 × 12.8–15.8 μm.

**Habitatio:** In planktone locationis 14 (mensibus Februario et Decembri) et in culturibus limi ex locatione 61 (NP 16, mense Septembri).

**Typus:** Figurae 6a, b.

Lorica usually spherical or sometimes ellipsoid, deep brown, and with a number of
more or less regular, rarely slightly anastomosing, longitudinal ribs running from pole to pole, the ribs appearing to radiate from pole to pole in spherical individuals; pore with an annular ring; lorica 14-1-17.6 × 12.8-15.8 μm.

*Habitat:* In plankton from location 14 (February and December) and in cultures of silt from location 61 (NP 16, September).

For caption, see p. 393.
Contributions to our knowledge of Indian algae—Euglenineae

For caption, see p. 393.
For caption, see p. 393.
Contributions to our knowledge of Indian algae—Euglenineae

For caption, see p. 393.
For caption, see p. 393.
Type: Figures 6a, b.

Distribution in Indian region: Assam and Orissa (!).

7. *Trachelomonas assamensis* Philipose et Radhakrishnan sp. nov. (figure 7)

Lorica est a forma subglobosa ad late ellipsodeam coloreque flavido-fulvo; superficies membrani ornamenta dense reticulateque; fistula parva sine annulari condensatione; lorica $14 \times 12.2 \, \mu m$, fistula $2.5 \, \mu m$ diametri.

Typus: Figura 7.

Habitatio: Abberrans in locatione 14 (Mense Februario).

Lorica subglobe to broadly ellipsoid and yellowish brown; surface of membrane with close reticulate ornamentation; pore small and without annular thickening; lorica $14 \times 12.2 \, \mu m$, pore $2.5 \, \mu m$ in diameter.
Type: Figure 7.

Habitat: Stray in location 14 (February).

The organism resembles *T. radiosa* var. *reticulata* Bourrelly (see Huber-Pestalozzi 1955, p 272, figure 439) in the reticulate nature of the wall but differs in the shape of the cell, the nature of the pore and the absence of longitudinal ribs. The name *T. reticulatus* would have been appropriate for this species but Klebs had used it for another species which Deflandre (1926) had reduced to a variety of *T. obovata*.

8. *Trachelomonas heduma* Conrad (figure 8)

Huber-Pestalozzi 1955, p 216, figure 415; *T. varians* Defl. f. *spiralis* Defl. 1926, p 58, figure 41.

Lorica usually spherical with diagonal unbranched spiral striae running to the left; pore with a circular thickening; cell contents not observed; lorica 23.6–14.5 × 20–3 μm.

Habitat: Stray in location 97a.

The organism agreed well with Conrad’s species measuring 22–27 × 19–23 μm; Conrad has reported 6–10 discoid chromatophores without pyrenoids and an eye-spot in this species.

Distribution in Indian region: Orissa (!).

9. *Trachelomonas curta* Da Cunha emend. Defl. 1926 (figure 9a, b)

Huber-Pestalozzi 1955, p 269, figure 425; = *T. volvocina* var. *compressa* Drez. 1925, p 265, figure 2; = *T. volvocina* var. *compressa* emend. Defl. 1926, p 56, figures 17–19, 21, 26–30; Skvortzov 1937, p 76, plate 10, figure 12.

Lorica a flattened smooth deep brown sphere; both poles uniformly arched; pore with a light ring-like thickening; chromatophores about 8–9, discoid and without pyrenoids; flagellum and eye-spot not observed; lorica 11.4–14 × 13.4–15.8 μm with pore 1.5–2.2 μm.

Habitat: Stray in locations 22 (September) and 135a (October).

Deflandre (1926) and Huber-Pestalozzi (1955) give two size groups, viz. 20–29 × 22.5–31 μm and 17–18 × 20–21 μm. The author’s specimens from West Bengal and Karnataka were nearer Skvortzov’s (1937) Burmese organism which measured 13.6 × 15.3 μm with pore 2 μm in diameter. Huber-Pestalozzi gives the number of chromatophores as 10–12, flagellum 2 times body length and eye-spot rodlike.

Distribution in Indian region: Burma (Skvortzov 1937) and Aurangabad (Ashtekar 1982), both as *T. volvocina* var. *compressa* Drez. emend. Defl.; West Bengal and Karnataka (!).
10. *Trachelomonas lismorensis* Playfair 1915

Deflandre 1926, p 66, figure 107; Huber-Pestalozzi 1955, p 272, figure 441.

Lorica spheroid and flattened, circular in apical view and with radially arranged spines; pore small and surrounded by a few small spines; in lateral view subglobose with the anterior pole flattened and the posterior pole broadly rounded, with radial spines of which the equatorial ones are longer; lorica dark yellowish brown, 20 μm in diameter with the spines up to 4 μm long; pore 2 μm.

The typical species known only from Australia.

var. *biseriata* Playfair 1915 (figure 10)

Deflandre 1926, p 66, figure 108; Huber-Pestalozzi 1955, pp 272-73, figure 443.

Lorica spheroid with the front and hind ends markedly compressed, with some spines of which one row above the equator and another below markedly longer; the spines at the anterior and posterior poles as well as the ones at the equator shorter; chromatophores numerous and without pyrenoids; lorica brown in colour, and excluding spines 17.6 μm in diameter; spines up to 6 μm long; pore 1.5-1.75 μm.

Habitat: Stray in location 136a.

Playfair gives the diameter of the organism as 20 μm. The Azhicode specimen was slightly smaller and the wall of the lorica was fairly thick.

Distribution in Indian region: Kerala (!).

11. *Trachelomonas tuberculata* Middelhoek

Huber-Pestalozzi 1955, p 274, figure 447A.

Lorica nearly spherical, broadly ellipsoid or ovoid with the front end slightly flattened; membrane very thick, yellowish or reddish brown, beset with prominent, loosely distributed, somewhat irregularly formed tubercles of which 5 surrounding the pore somewhat pointed and conical; with or without a well depressed collar; flagellum about 3 times the diameter of the lorica; chromatophores two; dimensions 19–24 × 20–22 μm.

The typical species not known from India.

var. *irregularis* Phillipose var. nov. (figura 11)

Varietas a species typica differens eo quod tubercula sunt irregularia magnitudinis, formae distributionisque, necnon densius composita; anulom quinque tuberculorum circa fistulam quoque absente; sunt vero duo parva plus minusve cuneiformia tubercul ad utraque latera fistulae disposita; lorica plene fulva; lorica 16.3 × 14.1 μm; fistula 4 μm.

Habitatio: In culturibus limi ex locatione 61 (NP 16, mense Septembri).

Differs from the typical species in the tubercles being irregular in size, shape and
distribution, and more closely arranged; the circlet of 5 tubercles around the pore also absent, only two small somewhat conical tubercles flanking the pore, one on each side; lorica deep brown and 16.3 × 14.1 µm; pore 4 µm.

*Habitat:* In cultures of silt from location 61 (NP 16, September).

Though the slight flattening of the lorica at the anterior end characteristic of the typical species was not observed, the organism obviously belong to *T. tuberculata* because of the nature of the tubercles and other features.

*Distribution in Indian region:* Orissa (!).

12. *Trachelomonas oblonga* Lemm. 1899 (figure 12a)

Lemmermann 1910, p 524; 1913, p 147, figure 278; Deflandre 1926, p 69, figures 117–118 and 120–124; Huber-Pestalozzi 1955, pp 278–79, figure 459.

Lorica elongate-ellipsoid, pore with or without an annular thickening; sometimes with a markedly depressed collar; membrane smooth, yellowish brown or dark reddish brown; chromatophores not observed; lorica 16–17.6 × 12.3–13.1 µm.

*Habitat:* Stray in locations 29 (March), 63 (NP 38, September, December), 72, 108 and 117; rather common in location 109 (December).

The organism agreed fairly well with the typical species measuring 12–19 × 10–13 µm. Chromatophores reported as two and projecting pyrenoids (see Fott 1959, figure 209c).

*Distribution in Indian region:* Burma (Skvortzov 1937; Skuja 1949, 9–15 × 7–12 µm); Gujarat (Kamat 1962, 15–17 × 12–13 µm); Kolhapur (Kamat 1963, 12–14 × 9–10 µm); Vidarbha (Kamat 1975); Nagpur (Kamat and Freitas 1976); Aurangabad (Ashtekar 1982); Kodaikanal (Suxena 1983, 13–15 × 11–12 µm); Kandesh, Maharashtra (Barhate and Tarar 1985); West Bengal, Orissa and Andhra Pradesh (!).

var. *australis* Playfair 1915 (figure 12b)

Deflandre 1926, p 70, figures 125–126; Huber-Pestalozzi 1955, p 280, figure 462.

Lorica subspherical or more or less quadrangular with rounded corners and always with a wide depressed collar; membrane smooth, yellowish brown; lorica 16.7 × 12.7 µm with collar 1 × 3 µm.

*Habitat:* Stray in location 80a.

The organism agreed well with Playfair's variety measuring 11–22 × 10–20 µm with collar 1 × 3–6 µm (see Deflandre 1926).

*Distribution in Indian region:* Kolhapur (Kamat 1963); Vidarbha (Kamat 1975); Orissa (!).
13. *Trachelomonas mucosa* Swireno

Deflandre 1926, p 72, figure 154; Huber-Pestalozzi 1955, p 283, figure 481.

Loria ellipsoid and with a small cylindrical collar 3-4.5 \( \mu m \) high; membrane smooth and maroon in colour; loria with a mucilaginous envelope \( 5 \mu m \) in thickness; flagellum 2-3 times body length; loria \( 44 \times 33 \mu m \).

The typical species (known only from Russia) not observed in the author's collections.

**var. sphaerica** Phil. et Radhkr. var. nov. (figura 13a)

Varietas a species typica differens eo quod loria est plus minusve sphaericalis necnon multio minoris magnitudinis; loria mucosa \( 15 \mu m \), non mucosa \( 12 \mu m \) diametri; collare \( 1.6 \mu m \) altitudinis et \( 1.8 \mu m \) latitudinis; membranum subrufum vertens ad flavum.

*Habitatio:* Abberrans in locatione 14 (Mense Februario).

Differs from the typical species in the loria being more or less spherical and much smaller in size; loria with mucus \( 15 \mu m \) in diameter, without mucus \( 12 \mu m \); collar \( 1.6 \mu m \) high and \( 1.8 \mu m \) broad; membrane reddish brown.

*Habitat:* Stray in location 14 (February).

*Distribution in Indian region:* Assam (!).

**var. subglobosa** Phil. et Radhkr. var. nov. (figura 13b)

Varietas a species typica differens eo quod loria est minor et subglobosaque, collari vere absente; fistula habet formae anularis crassitudinem; membranum loricæ subrufum vertens ad flavum coloris; loria mucosa \( 19-4-24.7 \times 18.8-21.2 \mu m \); non mucosa \( 17-21.2 \times 15.4-19.4 \mu m \); fistula \( 3.5-5.3 \mu m \) diametri.

*Habitatio:* Rara in locatione 14 (mense Februario).

Differs from the typical species in the loria being smaller and subglobose, and a collar is absent; pore with a rim; loria membrane reddish brown; loria with mucus \( 19-4-24.7 \times 18.8-21.2 \mu m \), without mucus \( 17-21.2 \times 15.4-19.4 \mu m \); pore \( 3.5-5.3 \mu m \) in diameter.

*Habitat:* Rare in location 14 (February).

*Distribution in Indian region:* Assam (!).

14. *Trachelomonas intermedia* Dangeard 1902 (figure 14a)

Lorica subspherical or broadly ellipsoid, yellowish to deep brown and finely punctate; pore with a ring-like thickening; chromatophores 4–5 and with double-sheathed pyrenoids; flagellum about 2-times body length; lorica 16.7–17.6 × 13–14 μm.

**Habitat:** Rare in location 151 (November) occurring as a scum along with other algae.

The usual dimensions given by a number of authors (see Deflandre 1926) are 16–23 × 14–19 μm and the number of chromatophores 4–5. Prowse (1959) gives the dimensions as 18–20 × 15–17 μm and the number of chromatophores as several and in his figure j of plate 1, 8 are indicated. Hortobágyi (1963) gives the number of chromatophores as 3–11. Further, according to him, the ornamentation of the lorica could either be in the form of punctae or larger elevations or tubercles.

Playfair’s (1915) *Trachelomonas granulosa* var. *subglobosa* (see Deflandre 1926, p 95, figure 403; Huber-Pestalozzi 1955, p 322, figure 642) in part, with lower dimensions of 19 × 17 μm is in all probability only a *T. intermedia* (also see below).

**Distribution in Indian region:** Burma (Skvortzov 1937; Skuja 1949); Hyderabad (Suxena 1955, 20–21 × 17–17.5 μm); Vidarbha (Kamat 1975); Aurangabad (Ashtekar 1982); Kashmir Valley and Ladak (Compere 1983); Tamilnadu (!).

**forma major** Philipose f. nov. (figura 14b)

Forma a species typica differens ob magnitudinem majorem (31.7 × 28.2 μm); lorica sphaericalis necnon subrufa vertens ad flavum coloris; membranum habet punctas prominentes seu granulationes; fistula in formae anularis crassitudine; chromatophores 10–11 necnon cum pyrenoidis dupliciter vaginati; flagellum circa unam et dimidiam partem longitudinis corporis.

**Habitatio:** Aberrans in locatione 33 (mense Maio).

Differs from the typical species in its larger size (31.7 × 28.2 μm); lorica subspherical and reddish brown; membrane with prominent punctae or granulations; pore with ring-like thickening; chromatophores 10–11 and with double-sheathed pyrenoids; flagellum about 1½ times body length.

**Habitat:** Stray in location 33 (May).

Playfair’s *Trachelomonas granulosa* var. *subglobosa* in part, with dimensions of 28 × 26 μm, could probably be referred to this variety. In Playfair’s variety the nature of the chromatophores is not known but in most other respects it agrees with the author’s material.

**Distribution in Indian region:** West Bengal (!).

15. *Trachelomonas neotropica* Balech. 1944 (figure 15)

Huber-Pestalozzi 1955, p 286, figure 487A.

Lorica broadly ellipsoid with the hind end sometimes slightly narrowed, and covered
with very small hyaline warts which are often visible only under high magnifications; pore without a collar but with a crown of 10–12 closely arranged sharply pointed spines (up to about 2 µm long) which are usually parallel or sometimes divergent; lorica 16.7–17.6 × 14.9–15.8 µm.

**Habitat:** Stray in locations 77 and 88.

The dimensions given by Balech are 16.5–17 × 15–16 µm with the pore 2–2.5 µm wide.

**Distribution in Indian region:** Orissa (!).

16. *Trachelomonas ovata* Roll (figure 16)

Huber-Pestalozzi 1955, p 286, figure 487B.

Lorica broadly ovoid or ellipsoid with the front and hind ends broadly rounded; without collar; membrane deep orange brown and slightly thickened at the opening of the pore; surface of lorica densely covered by very fine short rod-like spinules; lorica 59.8–60.7 × 40 µm with pore 6 µm in diameter; chromatophores numerous, discoid and without pyrenoids. Eye-spot, flagellum and paramylum bodies not observed.

**Habitat:** Stray in location 20.

The organism agreed well with Roll's species measuring 60–64 × 34–42 µm with pore 6–7.2 µm in diameter.

**Distribution in Indian region:** Assam (!).

17. *Trachelomonas cylindrica* Ehr. Sec. Playfair (figure 17a)


Lorica cylindrical with the sides parallel, posterior end broadly rounded with anterior end somewhat flattened; pore with a depressed collar; lorica smooth and 18 (including collar) × 8–8.3 µm with collar 1 × 2.5–3 µm.

**Habitat:** Stray in location 5c.

The organism agreed with Playfair's species measuring 16–20 × 8–10 µm with collar 1 × 3 µm.

**Distribution in Indian region:** Burma (Skvortzov 1937); Himachal Pradesh (Kamat 1968a) and Assam (!).

**var. decollata** Playfair 1915 (figure 17b)

Deflandre 1926, p 75, figures 172, 182–184; Huber-Pestalozzi 1955, p 290, figure 503; = *T. euchlora* var. *parvula* Conrad.
Differs from the typical species in the absence of a collar; lorida smooth, deep yellowish brown and $19 \times 8.8 \mu m$.

*Habitat:* Stray in locations 5c, 72, 76, 99a, 137 and 160a.

Dimensions given by Playfair for this variety are more or less the same ($16-20 \times 8-10 \mu m$).

*Distribution in Indian region:* Simla (Kamat 1968a); Vidarbh (Kamat 1975); Assam, Orissa, Kerala and Tamil Nadu (!).

18. *Trachelomonas hispida* (Perty) Stein emend. Defl. 1926 (figures 18a–b)


Lorida ellipsoid and usually covered densely with short conical pointed spines but sometimes the spines are irregularly distributed or they may be absent here and there; pore with or without an annular thickening and sometimes with a few long spines around the pore; with or without a very much depressed collar; membrane finely punctate or sometimes apparently smooth and yellowish or reddish brown; chromatophores 8–10 and with double-sheathed pyrenoids; flagellum usually about 1½–2 times body length, rarely shorter; eye-spot disc-like; lorida 20–26.3 × 15–8–22 μm.

*Habitat:* A wide spread species observed in locations 1a, 5b–d (June), 6, 6b, 28 (rather common, April), 32, 33, 37a, 40a, 46, 46a, 48, 52a, 56a, 61 (NP 5, common–May), 63 (NP 24, 26, 29, 31, 32, 34, 36–January–March and July–December), 68, 74, 75, 80a, 87, 88d, 90, 93, 93a (NP 5–November), 97, 100a, 106, 121, 136a, 136c, 137a, 137b, 139, 147, 148, 151 (very common, November), rare to rather common (December).

Usual dimensions of this species is 20–42 × 15–26 μm. However, Bhatia (1930) gives them as 74 × 34 μm.

*Distribution in Indian region:* Kashmir (Bhatia 1930); Burma (Skuvortzov 1937; Skuja 1949); Madras (Philipose 1940); Maharashtra (Kamat 1963, 18–20 × 12–16 μm; 1964, 21–24 × 19–21.5 μm; 1968; 1975); Himachal Pradesh (Kamat 1968a); Hyderabad (Venkateswarlu 1976); Karnataka (Bongale and Bharati 1980, in cultivated soils), Bijapur, Karnataka (Hegde and Bharati 1983); Kashmir and Ladak (Compére 1983); Assam, West Bengal, Bihar, Madhya Pradesh, Orissa, Andhra Pradesh, Kerala and Tamil Nadu (!).

var. *crenulatocollis* (Muskell) Lemm. 1910 (figures 18c, d)

Lemmermann 1910, p 526; 1913, p 150; Deflandre 1926, p 78, figure 228; Huber-Pestalozzi 1955, p 296, figure 526.
Lorica as in the typical species or as in variety *coronata* (see below) but the pore always provided with a cylindrical collar which is slightly widened towards the free end and is provided with teeth or spines; lorica (excluding collar) 26.4–31.7 × 19.4–20.3 μm, collar 3.5–5.3 × 3.5–5.3 μm; chromatophores discoid, numerous and without pyrenoids; eye-spot discoid.

*Habitat:* Rather common in location 78 (January); rare in location 92 (April); stray in location 64 (April); and rare in cultures of silt from location 61 (NP 16, September).

*Distribution in Indian region:* Orissa (!).

**forma glabra** Philipose f. nov. (figura 1Se)

Forma a var. *crenulatocollis* dicta differens eo quod loricam est perfecte glabrum pauloque angustior (31.7 × 14.4 μm, collare vero 5.3 × 5.3 μm); collare cylindricale in forma habens dentes tenues ad finem solutum; chromatophora sunt parvae, discoideae necnon numerosae sine pyrenoidis.

*Habitatio:* Aberrans in loco 92.

Differs from var. *crenulatocollis* in the lorica being perfectly smooth and slightly narrower (31.7 × 14.4 μm with collar 5.3 × 5.3 μm); collar cylindrical with fine teeth at free end; chromatophores small, discoid and numerous without pyrenoids.

*Habitat:* Stray in location 92.

*Distribution in Indian region:* Orissa (!).

**forma recta** Deflandre 1926 (figure 18f)

Deflandre 1926, p 78, figures 204–205 and 212; Huber-Pestalozzi 1955, p 296, figure 527.

Differs from var. *crenulatocollis* in the collar being perfectly cylindrical; lorica 24.6–26.4 × 17.6–19.4 μm, and with spines and punctae.

*Habitat:* Stray in locations 5d (April), 63 (November), 88, 102, 117 and 118.

*Distribution in Indian region:* Maharashtra (Kamat 1975); Karnataka (Bongale and Bharati 1980); Assam, Orissa and Andhra Pradesh (!).

**var. coronata** Lemmermann (figure 18g)

Lemmermann 1913, p 150; Deflandre 1926, p 78, figures 220–221; Huber-Pestalozzi 1955, p 296, figure 525.

Lorica usually slightly narrower than in the typical species and with dense short spines of uniform length; pore with a crown of slightly more robust spines which are
distinct or joined at the base; lorica deep brown and $30.8 \times 17.6$ $\mu$m without spines, and with spines $36.8 \times 20.3$ $\mu$m.

_Habitat:_ Rather common in location 78a; stray to rare in locations 5c, 22, 23, 76, 100a, 102, and in cultures of silt from location 61 (NP-16, September).

_Distribution in Indian region:_ Maharashtra (Kamat 1975); Karnataka (Hegde and Bharati 1986); Assam, West Bengal, Orissa and Andhra Pradesh (!).

19. _Trachelomonas allia_ Drezepolski 1925 emend. Defl. 1926 (figure 19a, b)

Deflandre 1926, p 79, figures 233 and 238; Huber-Pestalozzi 1955, p 297, figure 532; = _T. allia_ Drezepolski 1925, p 259, p 71; Prowse 1958, p 180, figure 6y.

Lorica cylindrical-ellipsoid with broad and uniformly rounded poles and parallel sides, and about $1/3$ times longer; densely covered with short, conical and pointed spines; pore without collar; membrane deep reddish to yellowish brown; lorica $26.3 \times 19.8$ $\mu$m.

_Habitat:_ Stray in location 19 (April).

The alga agreed in all respects with Drezepolski's species except in size. Drezepolski gives the dimensions as $30-35 \times 19-22.5$ $\mu$m, whereas Prowse gives them as $45-48 \times 30$ $\mu$m.

_Distribution in Indian region:_ Gujarat (Kamat 1962, $28-30 \times 13-16$ $\mu$m); Vidarbh (Kamat 1975); Aurangabad (Ashtekar 1982); Assam (!).

20. _Trachelomonas joyssagarensis_ Philipose _et_ Radhakrishnan sp. _nov._ (figure 20)

Lorica est ellipsoida habetque latera paululum arcuata necnon membranum crassum fulvi coloris denseque cooperto parvis, uniformibus acutisque spinis; collari absente; fistula satis magna habens anulum crassum refertum brevibus, tenuibusque dentibus regulariter dispositis; lorica $26.5 \times 20.2$ $\mu$m; fistula $4.7$ $\mu$m diametri.

_Typus:_ Figura 20.

_Habitatio:_ Aberrans in locatione 14 (mense Februario).

Lorica ellipsoid with slightly arched sides and with thick brown membrane which is densely covered with uniform pointed spines; without a collar; pore fairly large and with a thickened ring provided with short fine regularly arranged teeth; lorica $26.5 \times 20.2$ $\mu$m; pore $4.7$ $\mu$m in diameter.

_Type:_ Figure 20.

_Habitat:_ Stray in location 14.

_Distribution in Indian region:_ Assam (!).
21. *Trachelomonas kelloggii* Skv. emend. Defl. 1926\(^*\) (figure 21)

Deflandre 1926, p 87, figures 290–294 and 296; Huber-Pestalozzi 1955, p 300, figure 543.

Lorica subspherical or broadly ellipsoid with both poles provided with somewhat irregular rows of tubercles which are sometimes in the form of papillae or short spines particularly at the hind end where they are often pointed. The ornamentation sometimes reduced to simple granules or absent altogether; pore always without a collar and with or without an annular ring which is smooth or sometimes with conical tubercles which are low and well or ill developed; membrane fairly thick with fine dense punctae, and deep yellowish brown; lorica 36.7–37.5 × 32.9–33.8 \(\mu\)m with pore 7.5 \(\mu\)m in diameter.

*Habitat:* Very rare in location 14.

The usual dimensions of this species are 34–39 × 31–35 \(\mu\)m without spines (see Deflandre 1926; Huber-Pestalozzi 1955), but Hortobágyi gives them as 22.5 × 20 \(\mu\)m with pore 3 \(\mu\)m.

*Distribution in Indian region:* Assam (!).

22. *Trachelomonas bacillifera* Playfair 1915

Deflandre 1926, p 82; figure 255; Huber-Pestalozzi 1955, p 302, figure 553.

Lorica subspherical and densely covered with rod-like obtuse spines; membrane always deeply coloured reddish brown or yellowish-reddish brown; pore relatively narrow and without collar; lorica 35–40 × 33–38 \(\mu\)m (without spines).

The typical species not observed by the author, but reported by Kamat (1975) from Maharashtra.

*var. minima* Playfair 1915 (figures 22a, b)

Deflandre 1926, p 82, figures 244 and 254; Huber-Pestalozzi 1955, p 303, figure 556.

Lorica subspherical or elongate-ellipsoid and much smaller than the typical species; dimensions 23.8–25.2–27.5 × 17.6–19.4 \(\mu\)m; spines up to about 2 \(\mu\)m.

*Habitat:* Rare in location 14 and stray in location 48.

Dimensions given by Deflandre are 22–28 × 18–26 \(\mu\)m and 29 × 26 \(\mu\)m, the latter after Playfair.

*Distribution in Indian region:* Hyderabad (Suxena 1955, 23–24 × 18–19.5 \(\mu\)m); Maharashtra (Kamat 1975); Assam and Orissa (!).

*forma sparsispina* Deflandre 1926 (figure 22c)

Deflandre 1926, p 82, figure 253; Huber-Pestalozzi 1955, p 303, figure 557; = *T. hispida* var. niezabitowskii Drejepolski 1925, p 262, figure 53.
Differs from var. *minima* Playfair in the number of spines being much less and in their irregular disposition; lorica 21.1 × 16.7 μm.

*Habitat:* Very rare in location 14.

It is slightly smaller than Deflandre’s form which measures 27 × 22 or 25 × 20 μm, the latter after Drezepolski. The breadth in Drezepolski’s material given by Deflandre as 30 μm is probably a printing error which has been repeated by Huber-Pestalozzi 1955.

*Distribution in Indian region:* Assam (!).


Lorica ellipsoid with short robust conical distantly placed (2–4 in 10 μm) spines; pore without a collar but often with some spines of even length or longer than the rest of the spines and divergent or not; membrane yellowish to deep brown and smooth or finely punctate; dimensions 20–30 × 17–22 μm; spines up to 3.3 μm long.

The typical species not observed by the author but reported from Vidarbha (Kamat 1975), Karnataka (Bongale and Bharati 1980; Hosmani and Bharati 1983) and Aurangabad (Ashtekar 1982).

*var. major* Philipose et Radhakrishnan var. nov. (figure 23)

Varietas a species typica differens ob magnitudinem majorem formam obovoideam loricae, robustiores obtusasque spinas arctius (3–4 in 10 μm) magisque regulariter dispositas; spinis vero mediis circa fistulam longissimis; fistula sine collari, ad latera vero habens quattuor divergentes spinas; lorica sine spinis 45.4 × 24.2 μm, cum vero spinis 52.8 × 33 μm; spiniae 1.8–4.4 μm longitudinis.

*Habitatio:* Aberrans in locatione 14.

Differs from the typical species in its larger size, the obovoid shape of lorica, the more robust and obtuse spines which are arranged closer (3–4 in 10 μm) and more regularly, with the median spines and those around the pore longest; pore without a collar but flanked by about 4 divergent spines; lorica without spines 45.4 × 24.2 μm, and with spines 52.8 × 33 μm; spines 1.8–4.4 μm long.

*Habitat:* Stray in locatione 14.

In the typical species also the lorica is sometimes slightly obovoid (see figure 568b in Huber-Pestalozzi after Middelhoek 1948) but the nature and arrangement of the spines and the size of the lorica are different in the present organism. The chromatophores appeared to be 7, discoid and without pyrenoids and the flagellum more than body length as shown by Middelhoek. However, the discoid eye-spot shown by Middelhoek was not observed.
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Distribution in Indian region: Assam (!).

24. *Trachelomonas superb* Swirenko emend. Defl. 1926 (figure 24a)


Lorica ellipsoid with robust conical spines of variable length at fair distances (about 2–4 in 10 μm); pore with or without an annular ring but sometimes with a depressed dentate collar; membrane fairly thick, finely punctate, reddish brown or deep yellowish brown; lorica (excluding spines) 40 × 32.5 μm; cell contents not observed.

*Habitat:* Stray in location 63 (NP 26 and 36, March and September).

The usual dimensions of the lorica (excluding spines) are 38–55 × 30–39 μm and including spines 51 × 37 μm (see Deflandre 1926). Cell with discoid chromatophores and large stigma according to Swirenko. Presence or absence of pyrenoids not known.

Distribution in Indian region: Burma (Skvortzov 1937, 34–56 × 28–32 μm; Skuja 1949, 38 × 33 μm with pore 8 μm wide; Maharashtra (Kamat 1963, 35–40 × 25–28 μm; 1975); Kodaikanal, Tamilnadu (Suxena 1983, 49–51 × 36–37.5 μm); Orissa (!).

var. *coronata* Philipose var. nov. (figure 24b)

Varietas a species typica differens eo quod spinae super loricam restricta sunt ad coronam circiter 7 paululum divergentium spinarum plus minusve uniformium longitudinis circa fistulam necnon ad fere paucas spinas longitudinis variabilis in dimidia parte posteriori, pauloque magnitudinis minoris; lorica plene flava membrana numque valde punctatum; chromatophora circiter 8–10, discoideae dupliciterque pyrenoidis vaginatis; lorica 30.8 × 26.4 μm; spinae 7–9 μm longitudinis.

*Habitatio:* In limi culturibus ex locatione 61 (NP 16, mense Septembri).

Differs from the typical species in the spines on the lorica being restricted to a crown of about 7 slightly divergent long spines of more or less uniform length around the pore and to a few spines of variable length in the posterior half and the slightly smaller size; lorica dark brown, membrane strongly punctate; chromatophores about 8–10, discoid and with double-sheathed pyrenoids; lorica 30.8 × 26.4 μm; spines 7–9 μm long.

*Habitat:* In cultures of silt from location 61 (NP 16, September).

Though the typical species (see figure 269 in Deflandre 1926) could occasionally have a crown of spines around the pore, they are of variable length and in addition to the spines on the lorica. In the present variety they are more or less uniform in length and the rest of the lorica is devoid of spines except for 3 spines seen in the posterior half. The lorica is also slightly smaller. So, it is treated as a new variety.
25. *Trachelomonas horrida* Palmer

Deflandre 1926, p 85, figure 283; Huber-Pestalozzi 1955, pp 307–308, figure 579.

Lorica ellipsoid, verrucose, densely covered with robust prismatic spines which become pointed towards their extremities rather suddenly; collar depressed and with somewhat widened undulate border; collar sometimes absent; lorica 40 μm long.

The typical species not observed in the author's collections. However, Hosmani and Bharati (1983) have reported it from Karnataka. Their species measured 39.8–41.5 × 24.9–28.2 μm.

*var. moenacanthum* Skvortzov (figure 25)

Skuja 1949, p 164; Huber-Pestalozzi 1955, p 308, figure 581.

Differs from the typical species in the collar being well developed, cylindrical and with dents at the free end, and the spines on the lorica being reduced to very short prismatic ones and less dense; membrane covered with warts or verrucae as in type; lorica including collar 40–42 × 21.2 μm; collar 6–7.5 × 5–5.5 μm.

**Habitat:** Stray in location 14.

Huber-Pestalozzi does not give the dimensions of this variety. Skuja gives them as 37–39 (with collar) × 20–22 μm, with collar 5–7 × 5–6 μm. The Assam specimen was slightly larger.

**Distribution in Indian region:** Burma (Skuja 1949); Assam (!).

26. *Trachelomonas armata* (Ehr.) Stein 1878 (figure 26a)

Lemmermann 1910, p 527, figure 24 (p 517); Deflandre 1926, p 87, figures 312, 315, 319 and 320; Huber-Pestalozzi 1955, p 308, figure 582.

Lorica ellipsoid or slightly ovoid with rounded ends, anterior end frequently narrower; posterior end with a crown of well developed spines which are curved and more or less convergent, and of variable length, rarely reduced to knob-like projections or short papillae; pore with or without a ring-like thickening or sometimes with a slightly depressed collar; outer edge of pore usually denticulate; membrane smooth or with fine dense punctae, and deep yellowish brown; lorica 29.9–35.4 × 25.5–27.3 μm; spines 1–9 μm in length; chromatophores numerous, discoid and without pyrenoids.

**Habitat:** Stray to rare in locations 1a, 5b, 5c, 6b, 54, 63 (NP 32, September), 65, 76, 92, 100a, 136b, 137d and 142a.

The organism agreed well with the typical species measuring 29–37 × 22–29 μm with spines 1–9 μm long (see Deflandre 1926). Lemmermann gives the length of the lorica as 29–64 μm, probably including the spines.

**Distribution in Indian region:** Burma (Skuja 1949); Hyderabad (Zafar 1959);
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Bombay (Kamat 1964, 34–37.5 × 22–24 μm); Alibag, Maharashtra (Kamat 1968); Kerala (Suxena et al 1973, 36–37 × 25–26 μm); Vidarbh (Kamat 1975); Assam, Orissa, Andhra Pradesh and Kerala (!).

var. steinii Lemm. emend. Defl. 1926 (figure 26b)


Lorica as in the typical species but often larger, with one or more crowns of spines of varying lengths and thickness around the pore; hind end with well developed spines as in the typical species or with a mixture of well developed and ill developed spines; posterior spines sometimes divergent; apical spines occasionally obtuse; apical pore with or without an annular thickening and with or without a depressed collar bearing teeth at the outer edge; lorica 40–42 × 31–32 μm (without spines).

Habitat: Stray in locations 4, 6a and 136a; rather common in location 102 and common in location 136b.

The organism agreed fairly well with Lemmermann's variety which measures according to Deflandre (1926) 37–40 × 30–33 μm without spines. Skuja (1949) gives the length of the lorica as 45 μm with spines and 39 μm without, and width 33 μm.

Distribution in Indian region: Burma (Skuja 1949, 39 × 33 μm); Bombay (Gonzalves and Joshi 1946; Kamat 1964, 47–55 × 33–36 μm); Kolhapur (Kamat 1963, 40–50 × 30–35 μm); Alibag (Kamat 1968); Vidarbh (Kamat 1975); Assam, Andhra Pradesh and Kerala (!).

forma punctata (Swirenko) Defl. 1926 (figure 26c)

Deflandre 1926, p 88, figure 313; Huber-Pestalozzi 1955, p 309, figure 586; = T. armata var. punctata Swirenko; = T. armata var. steinii Bourrelly 1961, p 307, Plate 7, figure 2.

Differs from var. steinii Lemm. in the membrane being provided with small dense punctae; lorica 30 × 26 μm.

Habitat: Stray in location 63 (NP 62, September).

The organism agreed fairly well with Swirenko's variety but was slightly smaller, Swirenko's variety measuring 43–52 × 30–35 μm and Bourrelly's 50 × 40 μm. However, both these included the spines also.

Distribution in Indian region: Orissa (!).

var. duplex Playfair emend. Playfair 1921

Playfair 1921, p 133, plate 7, figure 5.

Lorica ovoid with the posterior end broader and covered not compactly with fine
short spine (not granulate); both anterior and posterior ends of lorica with a crown of medium-sized to fairly long spines; anterior spines more or less straight, acute (not bacillar) and about 12 in number; posterior spines also acute, recurved and about 10 in number; membrane brown; lorica $45 \times 35 \mu m$ with anterior spines about $8 \mu m$ and posterior ones $24 \mu m$.

The typical variety not observed by the author.

In his original description Playfair (1915) characterised the variety as having a granular membrane with about 12 anterior rod-like (bacillar) spines about $8 \mu m$ long and about 10 posterior pointed and slightly curved spines up to $12 \mu m$ long. Both Deflandre (1926) and Huber-Pestalozzi (1955) based their description of the variety on this description. Playfair (1921), however, had corrected his earlier description with a fresh figure and characterised the lorica as hispid with short spines and not granular, the anterior spines as acute and not bacillar, the dimensions of the lorica being retained as $45 \times 35 \mu m$, with posterior spines up to $24 \mu m$ long.

**forma jorhatensis** Philipose f. nov. (figures 26d, e)

Differs from var. **duplex** in the lorica having only about 7–9 straight or slightly curved spines at the anterior end and 5 recurved spines at the posterior end, the latter either regularly disposed or somewhat laterally (3 on one side and 2 on the other); membrane hispid; lorica $46–50 \times 35.5–36.5 \mu m$, cum spinis anterioribus ad $10 \mu m$ posterioribusque spinis usque ad $21.2 \mu m$.

**Habitatio:** Rara in locatione 17 (mense Octobri).

Differs from var. **duplex** in the lorica having only about 7–9 straight or slightly curved spines at the anterior end and 5 recurved spines at the posterior end, the latter either regularly disposed or somewhat laterally (3 on one side and 2 on the other); membrane hispid; lorica $46–50 \times 35.5–36.5 \mu m$ with anterior spines up to $10 \mu m$ and the posterior ones up to $21.2 \mu m$.

**Habitat:** Rare in location 17 (October).

**Distribution in Indian region:** Assam (!).

**var. malabarica** Philipose var. nov. (figure 26f)

Lorica est perfecte ovoidea habensque ad finem anteriorem corymbum brevium (3.5–5.3 $\mu m$) obtusarum, rectarumque vel paulo curvatarum spinarum necnon 3–4 longissimas (24.6–26.4 $\mu m$) crassas recurvatatasque spinas immixtas cum 4–5 spinis magnitudinis mediae (8.5–15 $\mu m$) cum nonnullis brevioribus (1.8–2.5 $\mu m$) acutis spinis irregulariter distributis; superficies tota loricae quoque est condensa cum brevioribus lateque separatis cuneiformibus spinis obtusis in forma vertentibus ad acutas; membranum plene fulvum; lorica $37 \times 32.6 \mu m$ (spinis exclusis).

**Habitatio:** Aberrans in locotione 138 (mense Octobri).

Lorica perfectly ovoid and with a cluster of short (3.5–5.3 $\mu m$) obtuse, straight or
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slightly curved spines at the anterior end and 3–4 very long (24–6–26-4 μm) stout recurved spines interspersed with 4–5 medium-sized (8.5–15 μm) and a number of very short (1.8–2.5 μm) acute spines irregularly distributed at the posterior end; entire surface of lorica also covered with very short widely spaced conical, obtuse to acute spines; membrane deep brown; lorica 37 × 32.6 μm (excluding spines).

Habitat: Stray in location 138 (October).

Distribution in Indian region: Kerala (!).

var. longispina Playfair emend. Deflandre 1926


Lorica as in the typical species but more ovoid, with the posterior and anterior ends broader and provided with a variable number (usually 4–10) of long well developed spines which are somewhat curved; the entire lorica also covered with short thick conical spines which are widely placed (about 4 in 10 μm), and usually yellowish, sometimes colourless; these spines are sometimes smaller and closer at the hind end; lorica light to deep brown; dimensions of lorica without spines 43–44 × 32–34 μm with short spines 5–6 μm and posterior ones up to 15 μm (after Playfair) or 41–45 × 32–34 μm with short spines 3–6 μm and posterior ones up to 15 μm (after Deflandre).

The typical variety was not observed by the author but reported from Maharashtra by Kamat (1975) and from Karnataka by Hosmani and Bharati (1983, 41.5–44.8 × 33.2–34.9 μm).

forma punctata Philipose f. nov. (figure 26g)

Forma a var. longispina differens eo quod loricae integrae membranum est punctatum; dimensione (spinis exclusis) 42 × 31.7 μm, cum vere spinis brevibus usque ad 6 μm, posterioribusque usque ad 15 μm longitudinis.

Habitatio: Aberrans in locandone 136a (mense Februario).

Differs from var. longispina in the entire lorica membrane being punctate; dimensions (excluding spines) 42 × 31.7 μm with short spines up to 6 μm and posterior ones up to 15 μm long.

Habitat: Stray in location 136a (February).

Distribution in Indian region: Kerala (!).

var. longa Deflandre 1926 (figures 26h,j)

Deflandre 1926, p 89, figures 332–333 and 337; Huber-Pestalozzi 1955, p 310, figure 591.
Lorica always narrower than in the typical species with the poles sometimes slightly flattened; anterior pole with one or more crowns of small spines as in var. steinii; pore without collar and with a few long spines; membrane fairly thick and with fine dense punctae and sometimes with a thickening at the hind pole; lorica light brown and 39–40 × 29–30 \( \mu m \).

**Habitat:** Rare in location 92 (April) and stray in location 152 (November).

The organism from location 152 was smaller (32.5 × 24 \( \mu m \)) with short spines at both ends, the posterior pole having two additional stout ones (figure 25j) and the membrane was smooth and the lorica colourless. Probably it was a juvenile form.

Dimensions of this variety as given by Deflandre are 41–43 × 29–30.5 \( \mu m \).

**Distribution in Indian region:** Orissa and Tamil Nadu (!).

27. *Trachelomonas dangeardiana* (Defl.) Huber-Pestalozzi 1955


Lorica usually ellipsoid, rarely ovoid, sometimes with arched sides and broadly rounded ends; posterior end with a crown of well developed pointed spines which are usually straight and divergent and of variable length; sometimes without such spines; pore with or without an annular thickening; membrane yellowish brown and densely covered with short stout rod-like spines; lorica 36–42 × 27–32 \( \mu m \).

The typical species not observed by the author.

**var. glabra** (Playfair) Deflandre 1926 (figure 27a)

Deflandre 1926, p 90, figures 338, 343; Huber-Pestalozzi 1955, p 311, figure 596; = *T. armata* var. glabra Playfair 1915.

Lorica and the posterior spines as in the typical species, membrane otherwise completely smooth, rarely punctate; lorica 35 × 28.5 \( \mu m \).

**Habitat:** Stray in location 76 (February).

Deflandre gives the dimensions as 34–46 × 28–34 \( \mu m \) (after Playfair) or 40 × 31 \( \mu m \) (after Deflandre).

**Distribution in Indian region:** Orissa (!).

**var. cylindrica** Philipose var. nov. (figure 27b)

Lorica a forma oblongata varians ad cylindratum cum 5–6 crassis magnitudinis intermediae paulumque curvatis spinis ad finem posteriorem; superficies loricae brevibus obtusiusque in forma ad habetes spinas condensae; membranum paulo
flavim coloris; fistula habet crassitudinem anularem; lorica 43 × 28 μm; fistula circa 9 μm diametri.

*Habitatio:* Rara locatione 106a, aberransque in locatione 136a (mense Februario).

Lorica oblong to cylindrical with 5–6 stout medium-sized somewhat curved spines at the hind end; surface of lorica covered with short obtuse to blunt spines; membrane light brown; pore with annular thickening; lorica 43 × 28 μm, apical pore 9 μm in diameter.

*Habitat:* Rare in location 106a and stray in location 136a (February).

The variety differs from the typical species in the oblong to cylindrical shape of the lorica and the posterior spines being somewhat curved and slightly convergent, and the small spines being not as stumpy.

*Distribution in Indian region:* Andhra Pradesh and Kerala (!).

28. *Trachelomonas eurystoma* Stein Sec. Playfair 1915

Deflandre 1926, pp 95–96, figures 418–419; Huber-Pestalozzi 1955, p 315, figure 611; Suxena 1979, p 123, plate 6, figure 65.

Lorica ovoid, broadly rounded; sides attenuated slightly towards the posterior pole; pore wide with a depressed collar which is undulate to emarginate and slightly retracted at the outer end; membrane light brown and with oblique to spiral striations running from right to left and made up of fine punctae or scrobiculations; lorica 26 × 19 μm with collar 1 μm high and 9 μm broad (Playfair), 26–27.5 × 19–20 μm with collar 1.1 × 5.5 μm (Suxena 1979).

The typical species not observed in the author's collections but reported from Himalaya (Suxena 1979).

*var. nuda* Szabados 1939 (figure 28)

Huber-Pestalozzi 1955, p 316, figure 616.

Lorica ovoid to heart-shaped, membrane smooth and light brown; collar depressed and about 1.5–2 μm high and 6 μm broad with smooth obliquely cut free end; lorica 24 × 17 μm.

*Habitat:* Stray to rare in locations 6 (June) and 159 (December).

The organism agreed fairly well with Szabados's variety. The collar in Szabados's variety is either 1 μm high and 3 μm broad with smooth, finely toothed or irregularly serrate margin or 3 μm high and 6 μm broad with obliquely cut collar. The organism from Assam and Vellore was more like the latter. Szabados gives the diameter of the lorica as 15–35 μm.

*Distribution in Indian region:* Assam and Tamil Nadu (!).
29. *Trachelomonas zorensis* Deflandre 1926 (figure 29)


Lorica ellipsoid with slightly arched sides and broadly rounded poles; pore without collar and with or without an annular thickening; membrane light yellowish brown and thickly covered with fine scrobiculae; chromatophores and flagellum not observed; lorica 16.5 × 14 μm.

*Habitat:* Stray in location 14 (February).

Deflandre gives the dimensions as 19–22 × 14–16 μm, and states that there are two chromatophores with diplo-pyrenoids and the flagellum is double the length of the body. Middelhoek (1951) also states that there are two chromatophores in his specimens measuring 22.8 × 19 μm. Hortobágyi (1957) gives the measurements as 15.7–23 × 14.2–19.8 μm with the pore 1.5–3 μm, which is more in agreement with the dimensions of the present form. Hortobágyi (1959) gives the number of chromatophores as 2 or 3. Huber-Pestalozzi (1955) gives the author of the species as Lefèvre which is obviously a mistake since Lefèvre's contributions appear to be subsequent to Deflandre's work on *Trachelomonas.*

*Distribution in Indian region:* Assam (!).

30. *Trachelomonas abrupta* Swir. emend. Defl. 1926


Lorica ellipsoid-cylindrical with slightly arched sides, sometimes parallel in part; poles broadly rounded; pore always without a collar; membrane thickly covered with fine scrobiculae and bright to light yellowish brown; chromatophores 10 and without pyrenoids; eye-spot present; lorica 22–30 × 12–19 μm.

The typical species not observed by the author, but reported from Burma (Skuja 1949, 29 × 20 μm) and Karnataka (Hegde and Bharati 1986).

var. *minor* Deflandre 1926 (figure 30a)


Lorica as in the typical species but smaller and densely punctate with the punctae sometimes indistinct; membrane fairly thick and bright yellowish brown; chromatophores about 10, discoid and without pyrenoids; lorica 22–23.1 × 9.9–11.4 μm, pore 3.5 μm in diameter; flagellum slightly longer than body.

*Habitat:* Stray in locations 14 (February) and 136a (February).

The organism agreed fairly well with Deflandre's variety measuring 15.5–22 × 9–12 μm.
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Distribution in Indian region: Bombay (Kamat 1964, 19.5-22×9-9.8 μm); Assam and Kerala (!).

**var. arcuata (Playf.) Defl. 1926** (figure 30b)

Deflandre 1926, p 93, figures 366–368; Huber-Pestalozzi 1955, p 320, figure 631; = *T. australis* var. *arcuata* Playfair 1915.

Lorica elongate-ellipsoid, not cylindrical, with the sides arched and poles broadly rounded; dimensions 28×21 μm, with pore 4.8 μm in diameter.

**Habitat:** Stray in location 13 (April).

The organism was slightly broader than Playfair’s variety which measures 20–27 × 14–17 μm (after Playfair) and 30×18 μm (after Deflandre).

Distribution in Indian region: Assam (!).

**31. Trachelomonas granulosa** Playfair 1915 (figure 31a)


Lorica ellipsoid with the sides arched, densely crowded with small granulations or fine pearls, collar very much depressed or absent; membrane yellowish to reddish brown; internal contents not observed; lorica 19.4×14.1 μm with pore 3.5 μm in diameter.

**Habitat:** In cultures of silt from location 61 (September).

The organism agreed fairly well with Playfair’s species (17–26×13–22 μm). Deflandre includes this species under “Species Inquirenda”. According to Hortobágyi (1963) there are numerous discoid chromatophores without pyrenoids and a flagellum about ¼ times body length in this species. He gives dimensions of 17–22.8×14–20.3 μm for the lorica with the diameter of pore 3.5 μm.

Distribution in Indian region: Orissa (!).

**var. crenulatocollis (Szab.) Huber-Pest. 1955**

Huber-Pestalozzi 1955, p 322, figure 644A; = *Trachelomonas intermedia* var. *crenulatocollis* Szabados.

Lorica ellipsoid, deep to reddish brown, coarsely punctate or with small lens-like elevations, 20–24.7×16–20 μm; collar short and widened towards the outside and with a few tooth-like protuberances 1.7–2.8 μm high and 5–5.4 μm broad at the pore.

Known only from Hungary.
forma obovata Philipose f. nov. (figure 31b)

Lorica plus minusve obovata habens marginem paululum irregularem; paulo flavi est coloris; dimensione 28-2 × 17-6 μm magnitudine, cum collari 1-8 μm altitudine, 7-9 μm vero latitudine; fistula habet 4 tubera; chromatophora parvae, numerosae discoideasque aunt sine pyrenoidis; flagellum paulo longius quam corpus.

Habitatio: Aberrans in locatione 23 (mense Junio).

Lorica more or less obovate with slightly irregular margin; light brown and 28.2 × 17.6 μm, with collar 1.8 μm high and 7-9 μm broad; pore with 4 protuberances; chromatophores small, numerous, discoid and without pyrenoids; flagellum slightly longer than body.

Habitat: Stray in location 23 (June).

Distribution in Indian region: West Bengal (!).

32. Trachelomonas scabra Playfair 1915 (figure 32a)


Lorica ellipsoid with both poles evenly rounded or the hind end acuminate; pore with a wide depressed collar; membrane scabrous but never with regular granulations, pale to medium yellowish brown; lorica 20–23 × 15–16.7 μm; pore 3.5 μm in diameter; flagellum about 3 times body length.

Habitat: Very rare to rare in locations 2, 19, 23, 28 (April), 29 (April), 45, 46, 63 (NP 24, November), 71, 88d, 100, 117 and 157; Rather common in locations 27 (May), 109 (December) and 151 (February and July), and very common in 151 (April).

Usual dimensions of this species are 20–23 × 15–20 μm (see Deflandre 1926).

Distribution in Indian region: Maharashtra (Kamat 1968, 1975); Uttar Pradesh (Hortobágyi 1969, 18 × 14.7 μm); Assam, West Bengal, Orissa, Andhra Pradesh and Tamil Nadu (!).

var. longicollis Playfair 1915 (figure 32b)


Differs from the typical species in the lorica having a long collar which is straight, oblique or sometimes curved, and with the outer end broadened; lorica 24.6–26.2 × 16.7–18.1 μm, collar 5.3–6.1 × 3.4 μm.

Habitat: Rather common in location 28 (April) and stray in locations 5b (June) and 63 (NP 24, November).
Usual dimensions of this variety are 22–33 × 16–19 µm with collar 5–7 µm high and 3–5 µm broad (see Deflandre 1926).

Distribution in Indian region: Assam, West Bengal and Orissa (!).

var. coberensis Deflandre 1926 (figure 32c)


Lorica subspherical, sometimes slightly attenuated towards the front, and with a cylindrical collar; membrane scabrous and light to bright yellowish brown; lorica 18.1–19.4 × 16.7–18.5 µm with collar 3.5 × 3.5 µm.

Habitat: Rare in location 28 (April, May, July), stray in location 63 (NP 24, November) and 102. Dimensions given by Deflandre are 18–20 × 17–19 µm with collar 3–4 × 3–4 µm.

Distribution in Indian region: West Bengal, Orissa and Andhra Pradesh (!).

var. labiata (Teiling) Huber-Pestalozzi 1955 (figure 32d)

Huber-Pestalozzi 1955, pp 324–325, figure 655A; = T. labiata Teiling.

Lorica ovoid to ellipsoid, yellowish brown, surface slightly flattened and covered with coarse warts; hind end sometimes slightly twisted on one side; pore with two lip-like folds; lorica 21.2–22 × 15.8–16.7 µm, pore 5.3 µm in diameter.

Habitat: Stray in locations 5c (June) and 14 (February).

The organism agreed with Teiling’s species (20–22 × 17–18 µm) except that it was slightly narrower.

Distribution in Indian region: Assam (!).

33. Trachelomonas szabadosiana Huber-Pest. 1955

Huber-Pestalozzi 1955, p 326, figure 661A; = T. ornata Szabados 1940 non T. ornata Skvortzov 1925.

Lorica ellipsoid with numerous broad-based processes on its surface, showing a net-like sculpturing; membrane rust brown; lorica 21 × 19.2 µm with pore 2 µm in diameter; flagellum twice as long as the body.

Known only from Hungary.

forma minor Philipose f. nov. (figura 33)

Lorica est minoris magnitudinis (17.6 × 14.0 µm) cumque processubus paucioribus.
Habitatio: Aberrans in Locotione 63 (NP 32, mense Octobri).

Lorica smaller (17.6 × 14.0 μm) and with fewer processes.

Distribution in Indian region: Orissa (!).

34. *Trachelomonas aspera* Da Cunha (figure 34)

Huber-Pestalozzi 1955, p 326, figure 662; *non T. aspera* (Skv.) Deflandre 1926, p 114, figure 618.

Lorica ellipsoid with both poles evenly rounded and light brown; surface with irregular tubercles and wrinkles giving the sides of the lorica an undulate appearance; pore with a straight collar of medium width and with smooth margin; chromatophores discoid and without pyrenoids; eye-spot prominent; flagellum 2–3 times body length; lorica 22 × 14–8 μm.

Habitat: Stray in locations 104 and 157.

The organism agreed well with Da Cunha’s species measuring 20–25 × 15 μm. *T. aspera* (Skv.) Deflandre 1926 (= *T. regularis* (Lemm.) Skvortzov) is actually *Strombomonas aspera* (Skv.) Deflandre 1930, p 607, figure 128, which Deflandre considers doubtful, since it is insufficiently described.

Distribution in Indian region: Andhra Pradesh and Tamil Nadu (!).

35. *Trachelomonas planctonica* Swirenko

Deflandre 1926, p 102, figures 494–499; Huber-Pestalozzi 1955, p 328, figure 668.

Lorica subspherical with the surface strongly punctate or finely scrobiculate; pore with a robust, blunt, conical collar with irregularly dentate margin; membrane thick and dark yellowish brown; with 8–10 chromatophores; lorica 14–30 × 17–22 μm; collar 4–5 μm broad, 2.5–4 μm high.

The typical species not observed by the author.

forma *minor* Philipose et Radhakrishnan forma nov. (figure 35)

Forma a species typica differens on magnitudinem minorem, videolicet, lorica 12.3 × 8.8 μm, collare 3.2 μm latitudinis necnon 2.3 μm altitudinis.

Habitatio: Aberrans in locotione 14 (mense Februário).

Differs from the typical species in its smaller size, viz. lorica 12.3 × 8.8 μm; collar 3.2 μm broad and 2.3 μm high.
Contributions to our knowledge of Indian algae—Eugleninae

Habitat: Stray in location 14 (February).

Distribution in Indian region: Assam (!).

36. *Trachelomonas volzii* Lemm. 1904

Lemmermann 1910, p 528; 1913, p 151, figure 281; Deflandre 1926, pp 105-106, figure 534; Huber-Pestalozzi 1955, p 333, figure 689.

Lorica ovoid to somewhat pear-shaped; posterior end rounded, sides slightly arched and attenuated towards the front; pore with a cylindrical collar surrounded by a characteristic conical membrane which binds the collar wall with the wall of the lorica at the pore margin; membrane with fairly dense granulations; lorica $32 \times 15 \mu m$ with collar $4 \mu m$ high.

The typical species known only from Sumatra, Java and France.

var. *cylindracea* Playfair 1915 (figures 36a, b)


Lorica more or less cylindrical with the sides parallel; posterior end broadly rounded; anterior end conical with the sides converging towards the front; collar straight, robust and provided with a basal annular ring; membrane smooth and light yellow; lorica $32\text{--}36 \times 15\text{--}16.7 \mu m$; collar $5.3 \mu m$ high and $3.5 \mu m$ broad.

*Habitat:* Rare in locations 92 and 136a; rather common in location 102.

The organism agreed fairly well with Playfair's variety measuring $34\text{--}38 \times 16 \mu m$ with collar $4\text{--}5 \mu m$ high and $4 \mu m$ broad. Prowse (1958, p 183, figures 6j, k) gives the dimensions as $32\text{--}42 \times 16\text{--}17 \mu m$.

Distribution in Indian region: Bombay (Kamat 1964, $34\text{--}38 \times 14\text{--}16 \mu m$, collar $4\text{--}5 \times 3.5\text{--}4 \mu m$); Vidarbha (Kamat 1973); Orissa, Andhra Pradesh and Kerala (!).

37. *Trachelomonas dubia* Swir. emend. Defl. 1926


Lorica ellipsoid-cylindrical with the sides parallel up to about $1/3$ of its length, sometimes slightly undulate or slightly convergent towards the anterior end; front end always broadly rounded to slightly flattened; hind end more or less rounded, sometimes slightly conical or distinctly pointed; pore with or without a ring-like thickening and always with a straight cylindrical fairly high collar which is cut straight; ring-like thickening of pore often markedly developed making it narrower than the collar; membrane smooth and yellowish to dark reddish brown; with 7–10 large chromatophores; flagellum 2–2½ times body length; lorica $22\text{--}26 \times 11\text{--}14 \mu m$.

Though both Deflandre and Huber-Pestalozzi state there are no pyrenoids in the
Chromatophores, Hortobágyi (1963, p 365, Tafel 66, figure 662) has recorded pyrenoids and rod-shaped paramylum bodies in this species. The typical species not observed in the author's collections.

**var. lata** Deflandre 1926 (figure 37)

Deflandre 1926, p 107, figure 792; Huber-Pestalozzi 1955, p 335, figure 699; = *T. euchlora* (Ehr.) Lemm. in Skuja 1926.

Differ from the typical species in the greater breadth of the lorica in relation to its length; internal contents not observed; lorica $25 \times 15.8 \mu m$ with collar $2.5 \times 3 \mu m$.

**Habitat:** Stray in location 28 (April).

Dimensions given by Deflandre are $24-27 \times 16 \mu m$.

**Distribution in Indian region:** Maharashtra (Kamat 1975); West Bengal (!).

38. *Trachelomonas hexangulata* (Swirenko) Playfair (figure 38)

Deflandre 1926, p 107, figures 545–551; Huber-Pestalozzi 1955, p 335, figure 702; = *T. ampullula* Playfair 1915.

Lorica nearly 6-sided in front view with rounded angles and the sides in the median region almost parallel, and front and hind ends conical; hind pole more or less truncate or sometimes broadly rounded; pore with or without a raised ring-like thickening which makes the pore narrower than the collar; collar cylindrical, straight or sometimes with a membrane cone joining the collar wall with the upper margin of the lorica; membrane smooth and light yellowish; lorica $25 \times 10.7 \mu m$ with collar $2 \times 3 \mu m$.

**Habitat:** Rather common in location 109 (December); stray in location 137 (September).

The usual range of dimensions of this species is $24-34 \times 10-16 \mu m$ with collar $2-5 \mu m$ high and $3-5 \mu m$ broad (see Deflandre 1926).

**Distribution in Indian region:** Bombay (Kamat 1964, $20-25 \times 8-10 \mu m$); Andhra Pradesh and Kerala (!).


Deflandre 1926, p 110, figures 592 and 571–578; Huber-Pestalozzi 1955, p 340, figure 719.

Lorica elongate-ellipsoid to ovoid with the hind end sometimes attenuated, irregularly ornamented with very short spines which are often reduced as pointed to obtuse denticulations; membrane sometimes rugged; pore small and topped by a broad conical, punctate, rugged or smooth collar which sometimes appears as a
continuation of the sides of the lorica and with the free end straight or slightly oblique and provided with irregular denticulations; lorica 42 × 22 μm; collar 7.5 × 4.5–6 μm.

Habitat: Stray in locations 80 (December) and 100a (February).

Dimensions given by Deflandre and Huber-Pestalozzi are 30–39 μm (without collar) and 36–47–50 μm (with collar) × 20–24 μm; collar 5.5–8 μm high, 7–11 μm at base and 4–6.5 μm at the opening.

Distribution in Indian region: Maharashtra (Kamat 1868); Karnataka (Hosmani and Bharati 1983, 30–30.6 × 23–23.4 μm); Orissa (!).

40. *Trachelomonas playfairi* Defl. 1924 (figure 40)


Lorica broadly ellipsoid or sometimes indistinctly rectangular with poles broadly rounded; pore constantly with a curved collar which is as broad as long and uniformly broad or slightly narrowed towards the free end which is cut more or less regularly; membrane smooth and yellowish brown; chromatophores numerous and with projecting double-sheathed pyrenoids; lorica 20–22.5 × 15–16 μm; collar 3 × 3–3.5 μm; eye-spot discoid.

Habitat: In cultures of silt from location 61 (NP 16, September), and in locations 76 (February), 93 (November) and 103a (December).

It agreed fairly well with Deflandre's species measuring 19–23 × 16–18.5 μm with collar 3–3.5 × 3.5 μm. Rino (1972) gives the dimensions as 22–26 × 18–23 μm with collar 3–5 μm.

Distribution in Indian region: Maharashtra (Kamat 1975). Orissa and Andhra Pradesh (!).

var. *hyalina* (Skvortzov) Hortobágyi 1969 (figure 40c)

Hortobágyi 1969, p 33, plate 5, figure 74; = *T. similis* var. *hyalina* Skvortzov 1937, p 80, plate 10, figure 27; Huber-Pestalozzi 1955, p 342, figure 723; Prowse 1958, p 183, figure 6g.

Lorica irregularly ellipsoid, hyaline, brown, smooth and not punctate; collar tubular, oblique and with smooth wall; lorica 22.5–15 μm with collar 3 × 2.5–2.8 μm; with several discoid chromatophores having double-sheathed pyrenoids; eye-spot streak-like.

Habitat: Stray in locations 6 (June) and 151 (April).

It compared well with Skvortzov's variety measuring 18.7–23 × 15–15.5 μm with
collar 2-2.5 μm and Hortobágyi's variety measuring 18.7-25 × 15.5-18 μm with collar 2-3 μm high and pore 2-4 μm.

**Distribution in Indian region:** Burma (Skvortzov 1937, see above); Uttar Pradesh (Hortobágyi 1969); Assam and Tamil Nadu (!).

41. *Trachelomonas similis* Stokes 1888 (figures 41a, b)

Deflandre 1926, p 111, figures 584 and 586-588; Skuja 1949, p 165, Tafel 36, figure 34; Huber-Pestalozzi 1955, p 342, figure 722; Rino 1972, p 164, plate 8, figure 4.

Lorica usually ellipsoid but sometimes ovoid with the poles rounded and more or less regularly punctate (rarely irregularly scrobiculate); pore with a collar which is always bent and with the free end irregularly dentate; membrane yellowish brown; chromatophores numerous and with double-sheathed pyrenoids; eye-spot an elongated disc; lorica 22.4-25.8 × 15-17.6 μm, collar 3-3.5 × 4.2-4.8 μm.

**Habitat:** Very rare to rare in locations 6 (June), 19 (April), 27 (May), 28 (April), 29 (February), 49 (December), 64 (April), 78 (January), 151 (January-April and October-December) and in cultures of silt from location 61 (NP 16, September).

The individuals from most locations agreed well with the typical species, measuring 22-40 × 14-23 μm with collar 3-3.5 × 4.5-5.5 μm, but in those from locations 29 and 151 the membrane was irregularly granulate to scrobiculate (see figure 41b). Rino also shows the lorica of *T. similis* as irregularly scrobiculate.

**Distribution in Indian region:** Madras (Philipose 1940, 22.5-25.8 × 15-16.3 μm); Burma (Skuja 1949, 26 × 14 μm, with neck 2.8 μm, pore 4 μm), Maharashtra (Kamat 1975), Assam, West Bengal and Orissa (!).

42. *Trachelomonas atrata* (Skv.) Deflandre

Huber-Pestalozzi 1955, p 343, figure 726; = *T. crebea* var. *atrata* Skv. 1925; = *T. troitzkajae* Skv. var. *planctonica* Skv. 1925.

Lorica ellipsoid with the posterior half having rows of somewhat distant hemispherical granulations; collar straight or bent and nearly as high as broad; membrane brown; chromatophores numerous; lorica 26-33 × 16-24 μm; collar 4-5-7 μm.

Known only from Manchuria.

**var. pustulosa** Conrad 1952 (figure 42)

Huber-Pestalozzi 1955, p 343, figure 727; = *T. decorata* (Skv.) Defl. var. *pustulosa* Conrad 1952.

Lorica ellipsoid with the collar cylindrical and always bent and the pore straight and smooth; anterior half of lorica completely smooth or with small scattered pearl-like granulations; posterior half with larger pearls or with numerous papillae which are joined in groups of 2-4 pearls; lorica 16.7 × 13.5-14 μm, collar 3.5-4.4 × 2-2.5 μm; chromatophore, paramylum and flagellum (recorded by Conrad) not observed.
Contributions to our knowledge of Indian algae—Euglenineae

Habitat: Stray in locations 29 (May) and 102 (December).

Conrad's variety measured $13-16 \times 10.5-13 \mu m$ with collar $2-4 \times 2 \mu m$.

Distribution in Indian region: West Bengal and Andhra Pradesh (!).

43. *Trachelomonas gregusii* Hortobágyi (figure 43)

Huber-Pestalozzi 1955, p 344, figure 729.

Lorica ellipsoid, yellowish brown and with ridge-like elevations which are seldom straight but mostly bent differently, and uniformly thick or only thick in places, of varying length and irregularly divided; when numerous, the ridges are thinner and flatter, when fewer more pronounced, thicker and more elevated; pore with a bent obliquely cut smooth collar narrowing towards the tip; chromatophores not observed; lorica $17.6 \times 15 \mu m$; collar $2.5 \times 2.5-3 \mu m$.

Habitat: Stray in location 2 (June), 5b (June) and 6 (June).

The organism agreed with Hortobágyi's species measuring $16.5-20 \times 14-16.5 \mu m$ with collar $2.5-3 \times 2.5-3 \mu m$.

Distribution in Indian region: Assam (!).

44. *Trachelomonas pseudocaudata* Defl. 1926


Lorica regularly ellipsoid and covered densely with stumpy and obtuse spines; pore with annular thickening and with a distinct straight cylindrical collar which is slightly widened towards the aperture and is denticulate; posterior part with a short hollow more or less pointed or obtuse tail which is forked and sometimes truncate and provided with 3-4 small spines; chromatophores numerous (about 8-10), discoid-polyhedral and without pyrenoids; total length of lorica $41-43.5 \mu m$ with breadth $22-23 \mu m$, collar $5-6 \mu m$ long and $5-5.5 \mu m$ broad at base; tail $3.5-6.5 \mu m$ long.

The typical species known only from France and Switzerland.

var. *elongata* Philipose var. nov. (figure 44)

Varietas a species typica differens eo quod lorica est longior ($54-55.5 \mu m$) necnon angustior ($18.0-18.4 \mu m$), habetque collare $5.4-6.6 \mu m$ longitudinis et $4.8-5.2 \mu m$ latitudinis, fistulamque $5.2-6.2 \mu m$ latitudinis; caudam $8.3-9.4 \mu m$ longitudinis, et $4.2 \mu m$ latitudinis ad radicem necnon $2.1 \mu m$ ad apicem; denticulationibus fistulae etiam clare signatis; chromatophora circa 12 necnon discoideae-polyhedralis sine pyrenoidis sicut in specie typica.

Habitatio: Rara in locatione 136a (mense Februario).

Differs from the typical species in the lorica being longer ($54-55.5 \mu m$) and
narrower (18–18.4 \( \mu \text{m} \)) with the collar 5.4–6.6 \( \mu \text{m} \) long and 4.8–5.2 \( \mu \text{m} \) broad, pore 5.2–6.2 \( \mu \text{m} \) wide; tail 8.3–9.4 \( \mu \text{m} \) long, 4.2 \( \mu \text{m} \) broad at base and 2.1 \( \mu \text{m} \) towards the tip; denticulations of the pore also more marked; chromatophores about 12 and discoid-polyhedral without pyrenoids as in the typical species.

**Habitat:** Rare in location 136a (February).

**Distribution in Indian region:** Kerala (!).

### 45. *Trachelomonas bernardinensis* Vischer emend. Defl. 1926 (figure 45)

Deflandre 1926, pp 118–119, figures 655–684 and 693; Huber-Pestalozzi 1955, p 352, figure 760; including var. *granulosa* Chodat.

Lorica elongate-ellipsoid with the sides usually regularly arched but sometimes slightly attenuated towards the anterior end; pore rarely with an annular thickening and provided with a wide collar which is very variable (cylindrical, subcylindrical, stumpy and conical or markedly widened at the rim) and always cut straight and almost smooth, serrate to dentate or with fine pointed spines of varying length; posterior end with a short hollow smooth tail which is also variable and is either pointed or stumpy and often open at the end; sometimes the tail is reduced to a knob; membrane deep brown and densely scrobiculate; chromatophores, stigma and flagellum not observed; cell filled with numerous discoid paramylum; lorica 37.8 × 16–17 \( \mu \text{m} \).

**Habitat:** Stray in locations 6 (June), 35 (July) and 92 (April).

Usual dimensions of this species range from 34–43 \( \mu \text{m} \) (including collar) × 18–22 \( \mu \text{m} \) with collar 2–6 \( \mu \text{m} \) high and 5.5–7.7 \( \mu \text{m} \) broad at base and 5.5–12 \( \mu \text{m} \) at the opening; tail 1–3.5 \( \mu \text{m} \) long (see Deflandre 1926).

**Distribution in Indian region:** Maharashtra (Kamat 1975); Assam, West Bengal and Orissa (!).

### 46. *Trachelomonas helvetica* Lemm. emend. Defl. 1926

Deflandre 1926, p 121, figures 620 and 630; Huber-Pestalozzi 1955, p 356, figure 770; = *T. helvetica* Lemm. 1910, p 529; = *T. conica* var. *caudata* Playfair 1915.

Lorica unequally ellipsoid to ovoid, anterior pole rounded; sides attenuated towards the posterior end into a short truncate tail; pore large and without collar, and ornamented with some spines; entire membrane densely covered with pointed spines; lorica 38–42 × 17.5–20 \( \mu \text{m} \), pore 5 \( \mu \text{m} \) wide.

The typical species is known only from Switzerland, Poland, Sweden and Australia.

var. *elongata* Bourrelly 1961 (figure 46a)

Bourrelly 1961, p 308, Plate 6, figure 4.
Contributions to our knowledge of Indian algae—Euglenineae

Differs from the typical species in the lorica being more elongated and narrower; lorica (including tail) 43·8 × 15·6 μm; pore 5·3 μm wide; tail 7·9 μm long.

Habitat: Stray in location 92 (April).

It agreed with Bourrelly's variety measuring 40–55 × 15–15·5 μm.

Distribution in Indian region: Orissa (!).

var. cucurbita (Skv.) Huber-Pest. 1955 (figure 46b)

Huber-Pestalozzi 1955, p 356, figure 771; = T. cucurbita Skvortzov; = T. helvetica var. hispida Skvortzov.

Differs from the typical species in its slightly smaller size and in the regularly rounded hind end; lorica (including tail) 33·5 × 15 μm; pore 3·5–4·4 μm.

Habitat: Stray in location 76 (February).

The variety usually measures 30–35 × 14·5–15·7 μm with the pore 4·2 μm wide.

Distribution in Indian region: Orissa (!).

47. Trachelomonas nadsonii Skvortzov 1925

Huber-Pestalozzi 1955, p 358, figure 774.

Lorica spindle-shaped with regularly arched sides and regular but not closely arranged spines; anterior end narrowed into a long broad neck with widened dentate mouth; posterior end narrowed into a tail; ornamentation of neck and tail as in the rest of the lorica; lorica smooth between the spines, 66·5 × 22·5 μm with neck 9·2 μm and tail 14·8 μm long; chromatophores numerous and discoid; paramylum bodies spherical.

Known only from Manchuria.

var. indica Skvortzov 1937

Skvortzov 1937, p 85, plate 12, figures 9–10.

Lorica spindle-shaped, 50–55 μm long, 17 μm broad with neck 8–8·5 μm long and 5–5·2 μm broad; tail more or less pointed; lorica membrane covered with irregular little broad spines or punctae; neck enlarged and serrated at the pore; differs from the typical species in the broader neck and punctate membrane.

Distribution in Indian region: Burma (Skvortzov 1937).

forma kausalyagangensis Philipose f. nov. (figurae 47a, b)

Forma a var. indica Skv. dicta differens eo quod habet caudam crassius paulo
bifurcatumque ad apicem; lorica quoque est paulum longior (59-61.6 μm), 17.6 μm lat., habens collum 7.9-8.8 x 5.3 μm, caudam 8.8-10.6 μm; fistula 6.3 μm diametri.

**Habitatio:** Rara in locacione 92 (mense Aprili).

Differs from var. *indica* Skvortzov in its stouter tail which is slightly bifurcate at the tip. The lorica is also slightly longer (59-61.6 μm), with breadth 17.6 μm, neck 7.9-8.8 x 5.3 μm and tail 8.8-10.6 μm; pore 6.3 μm in diameter.

**Habitat:** Rare in location 92 (April).

**Distribution in Indian region:** Orissa (!).

Other taxa of *Trachelomonas* reported from the Indian region are as follows:

1. *Trachelomonas abrupta* Swir. emend. Defl. 1926; Burma (Skuja 1949, p 164); Karnataka (Hegde and Bharati 1986, p 63).
3. *T. armata* (Ehr.) Stein var. *indica* Skvortzov 1937, p 83, from Rangoon. This variety with absence of long spines from its hind end and with a ring round the pore seems doubtful.
4. *T. armata* (Ehr.) Stein var. *ovata* Swirenko; Rangoon (Skvortzov 1937, p 83).
6. *T. australica* (Playf.) Defl. 1926; Burma (Skuja 1949, p 164); Himalaya (Suxena 1979, p 121).
19. *T. desikacharyii* Kamat 1963; Kolhapur (Kamat 1963, p 266); Rajasthan (Kamat 1967, p 52); Simla (Kamat 1968a, p 275).
20. *T. dybowskii* Drez.; Bombay (Kamat 1964, p 12); Rajasthan (Kamat 1967, p 52); Simla (Kamat 1968a, p 275); Vidarbh (Kamat 1975, p 467); Nagpur (Kamat and
Freitas 1976, p 122); Aurangabad (Ashtekar 1982, p 157).
(21) *T. eurystoma* (Stein) Playf. 1915; Himalaya (Suxena 1979, p 125).
(22) *T. globularis* (Awer.) Lemm.; Simla (Kamat 1968a, p 275); Kashmir (Comperé 1983, p 143).
(28) *T. hispida* (Perty) Stein var. *coronata-punctata* Skvortzov 1937; Rangoon (Skvortzov 1937, p 81).
(29) *T. hispida* (Perty) Stein var. *duplex* Defl. 1926; Burma (Skuja 1949, p 164).
(32) *T. horrida* Palmer var. *cretulatocollis* Skvortzov; Bombay (Gonzalves and Joshi 1946, p 176).
(33) *T. incertissima* Defl. 1926; Vidarbh (Kamat 1975, p 467).
(34) *T. irregularis* Swireenko; Uttar Pradesh (Hortobágyi 1969, p 32).
(35) *T. kelloggii* Skvortzov var. *effigurata* Skvortzov 1937; Rangoon (Skvortzov 1937, p 81).
(36) *T. klebsii* (Klebs) Defl. 1926; Ahmedabad (Kamat 1962, p 19). Bombay (Kamat 1964, p 12); Alibag (Kamat 1968, p 98); Vidarbh (Kamat 1975, p 467).
(37) *T. lacustris* Drez. 1925; Vidarbh (Kamat 1975, p 467).
(38) *T. lacustris* Drez. var. *ovalis* Drez. emend Defl. 1926; Kodaikanal (Suxena 1983, p 70).
(39) *T. lefevrei* Defl. 1926; Ahmedabad (Kamat 1962, p 19).
(40) *T. mammillosa* Prescott; Karnatakta (Bongale and Bharati 1980, p 104).
(41) *T. mangini* Defl. 1926; Vidarbh (Kamat 1975, p 468).
(42) *T. mucosa* Swireenko var. *hyalina* Skvortzov; Vidarbh (Kamat 1975, p 468).
(43) *T. nadsonii* Skvortzov var. *indicu* Skvortzov 1937; Rangoon (Skvortzov 1937, p 85).
(47) *T. obtusa* Palmer, Vidarbh (Kamat 1975, p 468).
(49) *T. ornata* Daday var. *maius* Kamat 1963; Kolhapur (Kamat 1963, p 266).
(52) T. piscatoris (Fischer) Stokes; Vidarbh (Kamat 1975, p 468).
(53) T. pulcherrima Playfair 1915; Burma (Skuja 1949, p 165); Kolhapur (Kamat 1963, p 267); Kandesh (Barhate and Tarar 1985, p 185).
(54) T. pulcherrima Playf. var. minor Playf.; Vidarbh (Kamat 1975, p 468).
(55) T. raciborskii Wolosz.; Vidarbh (Kamat 1975, p 468).
(56) T. richmondiae (Playf.) Defl. 1926 var. indica Skvortzov 1937; Rangoon (Skvortzov 1937, p 78).
(58) T. scabra Playf. var. ovata Playf. 1915; Alibag (Kamat 1968, p 98); Vidarbh (Kamat 1975, p 468).
(59) T. similis Stokes var. indica Skvortzov 1937; Rangoon (Skvortzov 1937, p 80).
(60) T. stokesi Drez. emend. Defl. 1926; Rangoon (Skvortzov 1937, p 80).
(61) T. stokesiana Palmer var. safeeuddinii Suxena 1979; Himalaya (Suxena 1979, p 123).
(62) T. stokesiana Palmer var. torquata (Conrad) Huber-Pest. 1955; Himalaya (Suxena 1979, p 123).
(63) T. suberrucosa Defl. 1926; Simla (Kamat 1968a, p 275).
(64) T. superba (Swir.) Defl. var. duplex Defl. 1926; Karnataka (Hosmani and Bharati 1983, p 134).
(65) T. superba (Swir.) Defl. var. swirenikiana Defl. 1926; Karnataka (Hegde and Bharati 1986, p 63).
(66) T. swirenikoi Skvortzov var. polonica (Skv.) Skv. 1937; Rangoon (Skvortzov 1937, p 85).
(67) T. sydneyensis Playf. 1915; Kolhapur (Kamat 1963, p 267); Vidarbh (Kamat 1975, p 468).
(68) T. teres Maskell; Aurangabad (Ashtekar 1982, p 157).
(69) T. vermiculosa Palmer; Kodaikanal (Suxena 1983, p 67).
(70) T. verrucosa Stokes 1887; Hyderabad (Suxena 1955, p 444).
(71) T. verrucosa Stokes var. granulosa (Playf.) Conrad; Burma (Skuja 1949, p 165- as T. volvocina Ehr. var. granulosa Playf.); Himalaya (Subba Raju and Suxena 1979, p 156).
(72) T. volvocina Ehr. var. depressa Conrad; Ahmedabad (Kamat 1962, p 20).
(73) T. volvocina Ehr. var. derephora Conrad; Rangoon (Skvortzov 1937, p 76); Hyderabad (Suxena 1955, p 444; Zafar 1959, p 558); Bombay (Kamat 1964, p 13); Vidarbh (Kamat 1975, p 468).
(74) T. volvocina Ehr. var. minuta Fritsch; Vidarbh (Kamat 1975, p 468).
(75) T. volvocina Ehr. var. papillata Lemm; Aurangabad (Ashtekar 1982, p 157).
(76) T. volvocina Ehr. var. papillato-punctata Skvortzov; Aurangabad (Ashtekar 1982, p 157).
(77) T. volvocina Ehr. var. punctata Playf. 1915; Alibag (Kamat 1968, p 98); Aurangabad (Ashtekar 1982, p 157).
(78) T. volvocinopsis Playf. var. coronata (Skv.) Bourrelly 1952; = T. indica Skv. var. coronata Skv. 1937; Rangoon (Skvortzov 1937, p 78).
(79) T. volvocinopsis Playf. var. khanneae (Skv.) Bourrelly 1952 = T. indica Skv. var. khanneae Skv. 1937; Rangoon (Skvortzov 1937, p 77).
(80) T. volvocinopsis Playf. var. punctata (Skv.) Bourrelly 1952; = T. indica var. punctata Skv. 1937; Rangoon (Skvortzov 1937, p 77).
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(81) *T. volvocinopsis* Playf. var. *tubigera* (Skv.) Bourrelly 1952; = *T. indica* Skv. var. *tubigera* Skv. 1937; Rangoon (Skvortzov 1937, p 77).


(84) *T. wermeli* Skvortzov; Vidarbh (Kamat 1975, p 468).

(85) *T. woycickii* Kocz.; Alibag (Kamat 1968, p 98).

(86) *T. woycickii* Kocz. var. *bombayensis* Kamat 1964; Bombay (Kamat 1964, p 13); Vidarbh (Kamat 1975, p 468).

(87) *T. woycickii* Kocz. var. *pusilla* Skvortzov 1925; Vidarbh (Kamat 1975, p 468); Aurangabad (Ashtekar 1982, p 157).

*Trachelomonas kashmiri* Bhatia (1930, p 363, figure 2) with ovate lorica bluntly pointed posteriorly, with a deeply crenulate funnel anteriorly, and with dimensions of $103 \times 66 \mu m$, and stated to resemble *T. eurystoma* Stein appears doubtful. So is the case with *T. drezei* Skvortzov non Conrad var. *indica* Skvortzov 1937, p 79 and *T. drezei* Skvortzov non Conrad var. *hispida* Skvortzov 1925; 1937, p 79. *T. paludosa* Skvortzov 1917; 1937, p 79 appears to be a *T. volzii* Lemm. 1904; *T. subglobosa* Skv. 1925 non Playfair emend. Defl. 1926 (See Skvortzov 1937, p 78, plate 10, figure 20) also appears doubtful.

Genus *STROMBOMONAS* Deflandre 1930

Cell as in *Euglena*, free swimming and with a single flagellum, within a rigid envelope (lorica) which is narrowed at the front end into a rather wide and more or less long neck; without clear demarcation between lorica and collar; lorica mostly narrowed towards hind end into a long point or rarely rounded; wall of lorica usually thin, very rarely thick, smooth or wrinkled, seldom with ornamentation like punctae, tubercles, perforations, spines or umbilicas as in *Trachelomonas*, but sometimes striated or ridged; thickness of lorica mostly due to deposits of iron, the lorica appearing as reddish brown or brown; the deposits in various forms like granulations or reticulations.

Chromatophores regularly numerous, very rarely two, disc-like or polygonal; pyrenoids absent in most instances; paramylum usually present, of different shapes and size and distributed all over the cell; eye-spot fairly large; flagellum as long as the lorica or shorter; vacuolar system as in other Euglenineae; protoplast joined to the lorica in young cells or separated in older cells and in some species.

Mostly in freshwater, rarely in brackishwater.

Key to the Indian species described

I. Lorica in cross section orbicular . . . Section I. *Rotundatae* Conrad

(A) Lorica smooth and without folds, grooves or wrinkles . . . . . . . Subsection 1. *Ergatae* Conrad

(1) Lorica sack-like and without tail . . . Group Saccatae

(a) Lorica hexagonal; hind end acute; neck absent; membrane very thick and verrucose; $37 \times 21 \mu m$. . . 48. *S. hexagonalis* sp. nov.

(b) Lorica flask-shaped and ovoid to spherical; neck short; membrane smooth; $52.65 \times 41.6-44.6 \mu m$. . . 49. *S. laganaeformis*

(c) Lorica elongate-roundish, ellipsoid or ovoid, obovoid or trapezoïd; membrane with fine or coarse tubercles . . . . . . . 50. *S. verrucosa*
(i) Lorica broadly cylindrical or ovoid; neck straight or oblique; 25-35 × 10-25 μm . . . . . . var. conspersa
(ii) Lorica irregularly obovate, neck short and broad; cut straight or obliquely; 33.8-37.5 × 11.3-23.6 μm . . . . . . var. obovata var. nov.
(iii) Lorica ovoid with short broad obliquely cut neck; wall thick and with papillae; 32 × (18-1) 21-6 μm . . . . . . var. borystheniensis
(iv) Front end of lorica markedly narrowed; neck with end cut straight 28 × 16 μm . . . . . . var. claviformis
Smaller form with irregular tubercles; 21 × 10.6 μm . . . forma minor f. nov.

(2) Lorica variable in shape and with tail . . Group Caudatae
(a) Lorica irregularly trapezoidal, narrowed in front and broadened behind; membrane with tubercles; pore irregularly emarginate; 20.5-50 × 10-28.8 μm . . . . . . 50. S. verrucosa
(i) Lorica usually small with base often slightly arched and with very short tail . . . . . . . var. genuina
(ii) Lorica with neck cut straight or obliquely, and often with scalloped free end; tail short and pointed; 37-50 × 20-27 μm . . . . . . var. zmiewika
(b) Lorica nearly cylindrical and vase-like to subhexagonal
(i) Lorica vase-like and smooth; sides arched convexly; neck broadened at end; hind end with a pointed tail; 38-57 × 22-28 μm . . . . . . 51. S. urceolata
Lorica with sides arched and with short neck markedly widened at end; (58-2-) 60 × (29-) 30 μm . . . . . . var. elegans
(ii) Lorica vase-like and subhexagonal with sides straight; neck markedly broadened at end, and with emarginate margin; hind end conical and ending in a point; 27.5-50-5 μm . . . . 52. S. vasseformis sp. nov.
(iii) Lorica subhexagonal with sides straight or concave; membrane wrinkled; tail pointed; 38-57 × 19.4-22-26 μm . . . . . . 53. S. girardiana
(c) Lorica nearly spherical with neck of variable length and pointed tail; 20-28 μm in diameter . . . . . . 54. S. praeliaris
(d) Lorica ellipsoid to spindle-shaped
(i) Lorica like a spinning top with front end broader; 34 × 18 μm . . . . . 55. S. napiformis
Lorica more oval with short widening neck and slightly longer tail; (34-) 48-53 × 24-25 (−27) μm . . . . . var. brevicollis
(ii) Lorica broadly ellipsoid with front and hind ends about the same width
(*) Membrane smooth; tail short and pointed; 34-37 × 22 μm . . . . . . 56. S. ovalis
Lorica smaller; 23 × 14 μm . . . forma minor f. nov.
(++) Membrane rugged; pore with an uniformly scalloped margin; tail short and stumpy; 41.4-43 × 23.7-24.3 μm . . . . . 57. S. madraspatensis sp. nov.
(iii) Lorica spindle-shaped and slightly elongated; collar short but
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relatively long; 25–38 \times 12–17 \mu m \ldots 58. \textit{S. fluviatilis}

(*) Lorica larger than in the typical species; 60–68.5 \mu m \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots }
Lorica trapezoid and with broad front and narrow hind ends; lorica slightly twisted; 35–40 (−42) × 18–22 μm . . . . . . var. *torta*  
(2) Lorica elongate fusiform-rhomboid with anterior and posterior halves triangular; with a medium-sized or long tail  
(a) Tail medium-sized, chromatophores small, discoid and without pyrenoids; 55.6–73.8–84 × 26.4–34.4–44 μm; tail alone 10.5–16 μm . . . . . . 68. *S. reisii*  
(b) Tail fairly long; chromatophores large and polyhedral and with diplopyrenoids; lorica 63.5–79.2× 27–30 μm; tail alone 19.8–27.3 μm . . . . . . 69. *S. indica* sp. nov.  
(B) Lorica quadrangular in cross section Subsection 2. *Quadrangulares* Huber-Pest. 1955  
Lorica rhomboid and winged in front view and sigmoid in side view; irregularly quadrangular in cross section; with a long (21.2–27.2 μm) straight tail; lorica 68.6× 31.7–41.5 μm . . . . . . 70. *S. tortuosa* sp. nov.

48. *Strombomonas hexagonalis* Philipose sp. nov. (Figura 48)  
Lorica plus minusve hexagonalen in forma, habetque in regione media patera recta vel paulo undulata; collo fere absente necon fistula valde magna margine irregulari; pars posterior in puncto acuto terminat; membranum valde crassum praesertium ad finem postiorem, fuscō coloris pauloque verrucosum; res in cellula non aut observatae; lorica 37× 21 μm, cum fistula 7.9–8.8 μm latitudinis.  
*Habitatio:* Aberrans in locatione 6 (mense Junio) et 92 (mense Aprili).  
*Typus:* Figura 48.  
Lorica more or less hexagonal in outline with the sides in median region straight or slightly undulate; neck almost absent and the pore very large and having an irregular margin; hind portion ending in an acute point; membrane very thick especially at the hind end, dirty brown and slightly verrucose; cell contents not observed; lorica 37× 21 μm with pore 7.9–8.8 μm in breadth.  
*Habitat:* Stray in location 6 (June) and 92 (April).  
*Type:* Figure 48.  
*Distribution in Indian region:* Assam and Orissa (!).

49. *Strombomonas laganaeformis* Huber-Pest. 1955 (figure 49)  
Huber-Pestalozzi 1955, p 372, figure 695A.  
Lorica fairly large (56.5× 42 μm with pore 11.3–12.6 μm wide), flask-shaped and ovoid to spherical with thick smooth wall, and hind end broadly rounded and the front ending gradually in a neck which is short and broad, but not distinct; cell contents not observed.
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Habitat: Stray in locations 28 and 29 (November–December).

The organism agreed fairly well with Huber-Pestalozzi's species measuring 52–65 x 41.6–43 μm with neck 13 μm broad.

Distribution in Indian region: West Bengal (!).

50. Strombomonas verrucosa (Dayad) Defl. 1930

Deflandre 1930, p 561, figure 2; Huber-Pestalozzi 1955, p 369, figure 790; = Trachelomonas hispida var. verrucosa Dayad.

Lorica rounded, broadly cylindrical with the base broadly rounded or top-shaped, often also nearly spherical or club-shaped; brownish or yellowish; surface of lorica with irregular granulations or stumpy elevations; lorica narrowed towards the anterior end abruptly into a neck which is obliquely cut or straight or sometimes widened with the margin sometimes toothed; base of lorica rounded and a little arched, slightly bent or pointed or sometimes ending in a short tail up to 12 μm long; chromatophores numerous and discoid; with an eye-spot; flagellum 3-times body length; lorica 20.5–50 x 10–28.8 μm, neck 4.2–7.2 μm broad.

The typical species not observed by the author but reported from Uttar Pradesh by Hertobágyi (1969, 36–43 x 20–22 μm, with neck 3–6.5 μm and tail 5–6.5 μm).

var. conspersa (Pascher) Deflandre 1930 (figures 50 a–c)


Lorica broadly cylindrical or sometimes irregularly short-cylindrical with the base broadened and without a tail, and the front end abruptly ending in a neck with the mouth irregularly cut; hind end slightly arched; lorica brownish to yellowish and irregularly granular; lorica 26.4–35.2 x 15–20 μm with the neck 6–6.5 x 5.3–6.5 μm.

Habitat: Stray to rare in locations 29 (April–May), 33 (April, June), 63 (NP 25, 27, March, July), 81 (December); common in location 28 (April, June) and 151 (February, April, July and November); abundant in location 61 (NP 17, May).

The organism agreed well with Pascher's species measuring 25–35 x 10–25 μm with neck 5–7 μm long.

Distribution in Indian region: West Bengal, Orissa and Tamil Nadu (!).

var. obovata Philipose var. nov. (figurae 50 d–f)

Lorica plus minusve obovoidea, extremitatem posteriorem rotundam et angustiorem, extremitatem vero anteriorem latiorem, neon in collum latum foramine paululum vel distinque oblique aliquantulum paulatim terminantem; murus loricæ aliquantulum undulatus; irregulariter verrucosus flavusque coloris; chromatophora...
numerosae, parvae sineque pyrenoidis: stigma prominens; flagellum circa unam et quartam par tem longitudinis loricae; loria 33·8–37·5 x 11·3–20·6 μm; collum 6·0–7·2 x 7·2–7·5 μm.

**Habitatio:** Rara in locatione 151 (mensibus Februarie–Novembri); aberrans in locatione 5 (mense Junio), 83 (mense Decembri) et 134 (mense Novembri).

Loria more or less obovoid with the hind end rounded and narrower, and the front end broader and ending somewhat gradually in a broad neck with the opening slightly or markedly oblique; wall of loria somewhat wavy, irregularly verrucose and yellowish brown; chromatophores numerous, small and discoid without pyrenoids; eye-spot prominent; flagellum about 1½ times the length of loria; loria 33·8–37·5 x 11·3–20·6 μm with the neck 6–7·2 x 7·2–7·5 μm.

**Habitat:** Rare in location 151 (February–November); stray in locations 5 (June), 83 (December) and 134 (November).

**Distribution in Indian region:** Assam, Orissa, Karnataka and Tamil Nadu (!).

**var. claviformis** (Defl) Defl. 1930

Deflandre 1930, p 569, figures 20–24; Huber-Pestalozzi 1955, p 371, figure 795; = *Trachelomonas claviformis* Deflandre 1927.

Loria ovoid and brown, distinctly attenuated towards the front end with a neck cut straight; posterior end broadly rounded and covered with small tubercles; loria 28 x 16 μm with the pore 4·4 μm broad.

The typical variety not observed by the author.

**forma minor** Philipose f. nov. (figure 50g)

Forma a var. typica differens eo quod dimensiones sunt minores necnon tubercula super loricam majora sunt irregulariorque; loria 21 x 10·6 μm cum fistula 4·4 μm latitudinis; chromatophora circa 9–10 sine pyrenoidis; flagellum breve.

**Habitatio:** Aberrans in locatione 29 (mense Decembri).

Differs from the typical variety in its smaller dimensions and the tubercles on the loria being larger and more irregular; loria 21 x 10·6 μm with the pore 4·4 μm in breadth; chromatophores about 9–10 without pyrenoids; flagellum short.

**Habitat:** Stray in location 29 (December).

**Distribution in Indian region:** West Bengal (!).

**var. borystheniensis** (Roll) Defl. 1930 (figure 50h)

Deflandre 1930, p 568, figure 17; Huber-Pestalozzi 1955, p 371, figure 793; = *Trachelomonas borystheniensis* Roll 1928.
Contributions to our knowledge of Indian algae—Euglenineae

Lorica ovoid with a short, broad, obliquely cut neck and undulate margin; membrane very thick; light brown and short thick papillae uniformly distributed over the surface; chromatophores numerous, small (about 3 μm); discoid and with double-sheathed pyrenoids; eye-spot oval and fairly large (2.3–3.3 μm); flagellum (observed only in one individual) exceptionally long (about 4 times the length of the lorica); lorica 24–26.3 x 18–19 μm, with neck 2.5 x 7–7.5 μm.

Habitat: Rather common in location 6 (June); very common (April) and rare (July–December) in location 151.

The organism agreed well with Roll’s species, though it was slightly smaller, the dimensions given by Roll being 32 x 21.6 μm with pore 8 μm in diameter, eye-spot 3 μm and chromatophores 3.4 μm in diameter. The author’s specimens were light brown compared to Roll’s specimens which were dark brown and Hortobágyi’s (1969) which were colourless.

Distribution in Indian region: Uttar Pradesh (Hortobágyi 1969, 28.6–34 x 20–21 μm, neck 6.5–7 x 2.5–4 μm); Assam and Tamil Nadu (!).

var. genuina Defl. 1930 (figure 50i)


Lorica usually small and trapezeoid to ellipsoid with the base often slightly arched and with a very short tail in the form of a pointed or obtuse often oblique papilla; chromatophores numerous, discoid and without pyrenoids; lorica 24-6 x 19-4 μm with neck 3-5 x 5.3 μm and tail 2-6 μm.

Habitat: Stray in location 33 (April) and 81 (December).

Huber-Pestalozzi (1955) states that though Deflandre treated it as a variety, according to normal botanical nomenclature it should not be separated from the typical species since it is not a characteristic form except for its smaller lorica.

Deflandre did not give the dimensions of this variety. There is also a certain degree of overlapping between the figures given by Deflandre for the typical species and this variety. Therefore, there is probably every justification for including it under the typical species.

Distribution in Indian region: West Bengal and Orissa (!).

var. zmiewika (Swireiko) Defl. 1930 (figures 50j–l)

Deflandre 1930, p 566, figures 6–10; Huber-Pestalozzi 1955, p 370, figure 791; = Trachelomonas zmiewika Swir. 1914; Deflandre 1926, pp 125–26, figures 757, 763 and 764.

Lorica ellipsoid with the front end narrowed into an obliquely cut or straight neck with notched or toothed margin, and with a more or less well developed, pointed, rarely stumpy tail; lorica irregularly granulate to scrobiculate and brown;
chromatophores numerous, discoid and without pyrenoids; flagellum slightly less
than the length of the lorica; lorica 37-9-43 × 21-25 μm with neck 5-3-5.8 × 5-3-6.4 μm
and tail 6.2-8-1-12.3 μm.

Habitat: Rather common to common in location 151 (April and July) and stray to
rare in March, May and August to November; stray in locations 27 (May), 28 (May),
46 (December), 63 (NP 26, September), 82 (December), 117 (December) and in
cultures of silt from location 61 (NP 16, September).

Deflandre and Huber-Pestalozzi give the dimensions as 37-50 × 20-27 μm.

Distribution in Indian region: Burma (as Trachelomonas zmiewika Swir., Skvortzov
1937, 34-42 × 20-23 μm); West Bengal, Orissa, Andhra Pradesh and Tamil Nadu (!).

51. Strombomonas urceolata (Stokes) Deflandre 1930

Deflandre 1930, p 586, figures 70, 71 and 73; Huber-Pestalozzi 1955, p 375, figure
804; = Trachelomonas urceolata Stokes 1887, 1888; Playfair 1921, p 134, plate 7,
figure 9; non T. urceolata Stokes sec. Playf. et Defl.- Deflandre 1926, p 126, figures
774-775.

Lorica vase-like, smooth, about twice as long as broad with the sides slightly
flattened, and continued somewhat abruptly towards the front end as a short
relatively broad neck which is frequently widened and usually cut straight; hind end
with a stout pointed and straight tail; chromatophores large, not many and without
pyrenoids; lorica 38-57 × 22-28 μm.

The typical species not observed by the author but reported from Maharashtra by
Kamat (1975).

var. elegans (Playf.) Defl. 1930 (figure 51)

Deflandre 1930, p 588, figure 72; Huber-Pestalozzi 1955, p 375, figure 804A; =
Trachelomonas napiformis var. elegans Playfair 1915; Deflandre 1926, p 124, figure
733; = T. gickthornii Skvortzov 1926.

Lorica more or less as in the type but with the sides slightly arched, attenuating
abruptly towards the front into a short neck with markedly widened and even
margin; hind end converging rapidly into a short, straight, pointed tail; membrane
smooth and deep yellow; lorica 58-5 × 29 μm.

Habitat: Stray in locations 19 (April), 58 (November), 63 (NP 26, December), 88
and 157 (December).

The variety agreed fairly well with Playfair's variety measuring 60 × 30 μm.

Distribution in Indian region: Assam, Orissa and Tamil Nadu (!).

52. Strombomonas vaseformis Philipose sp. nov. (figura 52)

Lorica est elongata in forma necnon hexagonalis habetque finem anteriorem
Contrihutions to our knowledge of Indian algae—Euglenineae

Habitatio: Averrarens in locatione 151 (mense Apri).

Typus: Figura 52.

Habitat: In cultures of silt from location 61 (September).

The organism agreed fairly well with the typical species in shape and other features but the lorica was smaller, the typical species measuring 38–57 × 22–26 μm.

Distribution in Indian region: Karnataka (as Trachelomonas girardiana (Playf.) Defl., Hegde and Bharati 1986); Orissa (!).

54. Strombomonas praetiaris (Palmer) Defl. 1930 (figure 54)

Deflandre 1930, p 578, figures 41–45 and 47–51; Huber-Pestalozzi 1955, p 376, figure 807; = Trachelomonas praetiaris Palmer.
Lorica nearly spherical with thin hyaline, more or less colourless membrane which is slightly scabrous and finely punctate; anterior end with a cylindrical neck which is slightly widened towards the tip and obliquely cut with smooth margin; neck also colourless but often indistinctly scabrous; hind end with a fairly long tail which is straight or oblique or sometimes slightly curved and punctate; internal contents of cell not observed; flagellum short; lorica 25–27 μm in diameter; neck 5.3–8.8 × 5.3 μm; tail 12.3–14 μm long.

**Habitat:** Stray in location 28 (April–May).

Measurements given by Palmer are, lorica 20–28 μm in diameter, neck 5–16 × 5–7 μm and tail 6.5–14 μm long.

**Distribution in Indian region:** West Bengal (!).

55. *Strombomonas napiformis* (Playf.) Defl. 1930 (figure 55a)

Deflandre 1930, p 590, figure 82; Huber-Pestalozzi 1955, pp 376–77, figure 809; = *Trachelomonas napiformis* Playfair 1915, p 33, plate 5, figure 10; Deflandre 1926, p 124, figure 732.

Lorica oval in the middle with the front end broadened and the hind end narrowed and the flanks rounded; with a short stout pointed tail from the hind end and a cylindrical neck which is nearly as long as broad at the front end: lorica smooth and 32–34 × 17.5–18 μm with neck 7–8 × 6–6.5 μm; tail 6.5 μm.

**Habitat:** Stray in location 28 (April) and 63 (NP 29, February).

**Distribution in Indian region:** West Bengal and Orissa (!).

var. *brevicollis* (Playf.) Defl. 1930 (figures 55b, c)

Deflandre 1930, p 591, figures 83–84; Huber-Pestalozzi 1955, p 377, figure 810; = *Trachelomonas napiformis* Playf. var. *brevicollis* Playf. 1921, p 135, plate 7, figures 12–14.

Lorica more markedly ovoid than in the type with rather short neck which widens like a vase, but with a longer tail; chromatophores (reported by Playfair as fairly large) small, numerous and discoid; flagellum shorter than the lorica; lorica 45–46.7 × 24.6–27 μm, neck 4.4–4.6 × 6–6.2 μm and tail 10–6 μm.

**Habitat:** Stray in locations 19 (April) and 157 (December), rare in locations 27 (May) and 88 (December) and rather common in location 28 (April); also stray in cultures of silt from location 151 (April–June and October–December).

The variety agreed well with the Australian organism measuring 48–53 × 24–25 μm (middle of lorica 36–38 μm long), neck 5–6 × 6–11 μm and tail 10–14 μm, but the eyespot shown as discoid by Playfair was much longer and somewhat curved and triangular in the specimen observed from location 151.
Distribution in Indian region: Maharashtra (Kamat 1975); Assam, West Bengal, Orissa and Tamil Nadu (!).

56. *Strombomonas ovalis* (Playf.) Defl. 1930 (figure 56a)


Lorica regularly ellipsoid with a short obliquely cut neck which is slightly widened towards the tip and with smooth margin; hind end rapidly narrowed to a short pointed tail; membrane smooth; lorica 30–35 × 20–21·2 μm; neck 4·4–6·2 × 6–6·5 μm; tail 5·3–6 μm long.

*Habitat:* Stray in locations 19 (April), 63 (NP 27, March), 103 (December), 125 (February) and 150 (February).

It agreed well with Playfair’s species measuring 34–37 × 22 μm with neck 4–6 × 6 μm and tail 6 μm.

Distribution in Indian region: Maharashtra (Kamat 1975), Assam, Orissa, Andhra Pradesh and Kerala (!).

forma *minor* Philipose f. nov. (figura 56b)

Lorica est minoris magnitudinis quam species typica in dimensione tantum 23 μm (colo caudaque inclusis) × 14 μm, cum collo 3·4 × 4·2 μm necnon cauda 5·2 μm; collum paulo latius est ad apicem labrumque habet; chromatophora numerosae et discoideae.

*Habitatio:* Aberrans in locatione 151 (mense Aprili).

Smaller than the typical species, measuring only 23 μm (including neck and tail) × 14 μm with the neck 3·4 × 4·2 μm and tail 5·2 μm; neck wider towards the tip and with a rim.

*Habitat:* Stray in location 151 (April).

Distribution in Indian region: Tamil Nadu (!).

57. *Strombomonas madraspatensis* sp. nov. (figurae 57a, b)

Forma loricae est ablata ellipsoida ad ovoideam varians habetque finem anteriorem prolongatam in breve crassumque collum cum fistula recta necnon margine regulariter dentata; finis posterior habet caudam brevem, truncam necnon asperum; membranum asperum est fulvique coloris; chromatophora numerosae, discoideae sunt sine pyrenoidis; grans paramyli parva est necnon ad instar virgulae in forma; flagellum breve; lorica 41·4–43 × 23·7–24·3 μm, collum vero 5·7–6 μm necnon cauda 9·3 μm.
Habitatio: Rara in locatione 151 (mense Aprili).

Typus: Figurae 57a, b.

Lorica broadly ellipsoid to ovoid with the anterior end produced into a short stout neck with the pore straight and with a regularly dentate margin; posterior end with a short, stumpy, rugged tail; membrane rugged and yellowish brown; chromatophores numerous, discoid and without pyrenoids; paramylum small and rod-shaped; flagellum short; lorica 41.4–43 × 23.7–24.3 μm, neck 5.7 × 6 μm and tail 9.3 μm.

Habitat: Rare in location 151 (April).

Type: Figure 57a, b.

Though the organism resembled S. verrucosa var. zmiewika in size, the lorica was ovoid and not trapezoid, the free margin of the neck was regularly dentate and the tail stout, stumpy, and not pointed. It also showed some resemblance to S. deflandrei (see Huber-Pestalozzi 1955, p 378, figure 12) in shape and some other features, but the neck was longer, the free margin of the neck was not irregular, the membrane of the lorica not wrinkled and the tail longer and not pointed, the dimensions of S. deflandrei being 40.5 × 24.3 μm with neck 3.7 × 6.8 μm and tail 2.7 μm. So it is treated as a new species and placed near S. deflandrei.

Distribution in Indian region: Tamil Nadu (!).

58. Strombomonas fluviatilis (Lemm.) Defl. 1930 (figure 58a)


Lorica ellipsoid to broadly spindle-shaped with a narrow or fairly broad neck which is cut straight or obliquely; hind end abruptly narrowed into a short straight or slightly bent tail; membrane light brown and slightly rugged due to small or large verrucae; lorica 30.8 × 16 μm with neck alone 5.3 × 4.4–5.3 μm and tail 2.6–4.4 μm.

Habitat: Stray in location 14 (December).

The organism agreed well with Lemmermann’s species measuring 28–38 × 12–17 μm. However, Hortobágyi (1957, 1969, p 32, figure 76) give the dimensions as 25–31.5 × 12.4–19 μm.

Distribution in Indian region: Burma (Skvortzov 1937, p 83, 23.8 × 10.2 μm, neck 2.5 μm broad, as Trachelomonas fluviatilis Lemm.); Uttar Pradesh (Hortobágyi 1969, 29–31.5 × 14.2–19 μm); Kerala (Suxena et al 1973); Maharashtra (Kamat 1975) and Assam (!).

var. undulata Philipose var. nov. (figurae 58b, c)

Varietas a species typica differens eo quod latera loricae sunt irregulariter undulata;
lorica 26.4–31.5 \times 12.3–14.4 \mu m, cum collo 5.3–6.0 \times 4.4–6 \mu m necnon cauda 2.6–3.0 \mu m.

**Habitat**:
Aberrans in locatione 23 (mense Junio) necnon testinis piscium ex locatione 29 (mense April).

Differs from the typical species in the sides of the lorica being irregularly undulate; lorica 26.4–31.5 \times 12.3–14.4 \mu m with neck 5.3–6 \times 4.4–6 \mu m and tail 2.6–3 \mu m.

**Habitat**:
Stray in location 23 (June) and in the gut contents of fish from location 29 (April).

**Distribution in Indian region**:
West Bengal (!).

**var. levis** (Lemm.) Defl. 1930 (figure 58d)

Deflandre 1930, p 581, figures 55–56; Huber-Pestalozzi 1955, p 379, figure 817; = *Trachelomonas fluviatilis* var. *levis* (Lemm.) Skvortzov (1925) 1926; = *Trachelomonas affinis* Lemm. 1905; Deflandre 1926, p 127, figure 784.

Differs from the typical species in its larger dimensions; membrane smooth; lorica 63.4 \mu m long.

**Habitat**:
Stray in location 58 (November).

The organism agreed with Lemmermann's variety which is 60–68.5 \mu m in length.

**Distribution in Indian region**:
Orissa (!).

**Strombomonas rotunda** (Playf.) Defl. 1930 (figure 59)

Deflandre 1930, p 593, figure 58; Huber-Pestalozzi 1955, p 380, figure 821; = *Trachelomonas gibberosa* var. *rotunda* Playfair 1915, plate 5, figure 19; Deflandre 1926, p 128, figure 736.

Lorica transversely ellipsoid with the body broader than long; with a relatively large straight neck having parallel sides and widened like a vase at the end which is smooth; tail fairly long, stout and obtuse; chromatophores small, numerous discoid and without pyrenoids; flagellum shorter than the lorica; lorica 25.5 \times 16.7 \mu m; neck 5.3–7 \times 5.3 \mu m; tail 9–7 \mu m long.

**Habitat**:
Stray in locations 5d (April), 19 (April), 27 (May), 61 (NP 15, May), 108 (December), 150 (February) and 151 (February).

The organism agreed fairly well with Playfair's species which measures 28 \times 17 \mu m, with neck 8 \times 6 \mu m and tail 10 \mu m.

**Distribution in Indian region**:
Assam, West Bengal, Orissa, Andhra Pradesh, Kerala and Tamil Nadu (!).
60. *Strombomonas cuneata* (Playf.) Defl. 1930

Deflandre 1930, p 594, figure 89; Huber-Pestalozzi 1955, p 381, figure 826; = *Trachelomonas cuneata* Playf. 1921, p 135, plate 7, figure 15.

Lorica trapezeoid with the sides nearly straight or arched and converging towards a cuneiform posterior; anterior part subtriangular and narrowing to a neck with a vase-like end having a smooth margin; membrane hyaline and scabrous; lorica $50 \times 20 \, \mu m$, neck $6 \, \mu m$ broad and tail $14 \, \mu m$ long.

Known only from Australia.

var. *minor* Philipose var. nov. (figura 60)

Varietas a species typica differens ob dimensiones minores, videlicet, lorica $42 \, \mu m$ (collo caudaque inclusis) $\times 15-7 \, \mu m$, cum collo sole $6-4 \, \mu m$ longitudinis necnon $7 \, \mu m$ ad fistulum, ore quoque irregulariter incisa; lorica varians in forma ab leni ad paulo scabram; chromatophora 6–8 discoideae sineque pyrenoidis; grana paramyli sunt parva necnon virgulata.


Differs from the typical species in its smaller dimensions, viz. lorica $42 \, \mu m$ (including neck and tail) $\times 15-7 \, \mu m$, with neck alone $6-4 \, \mu m$ long and $7 \, \mu m$ broad at the pore; mouth also irregularly incised; lorica smooth to slightly scabrous; chromatophores 6–8, discoid and without pyrenoids; paramylum small and rod-like.

Habitat: Stray in location 151 (April–June, August–October).

Distribution in Indian region: Tamil Nadu (!).

61. *Strombomonas schauinslandii* (Lemm.) Defl. 1930 (figures 61a,b)

Deflandre 1930, p 594, figures 90–96; Huber-Pestalozzi 1955, pp 381–82, figure 827; = *Trachelomonas schauinslandii* Lemm. 1904; 1913, p 154, figure 305; Deflandre 1926, p 129, figure 779.

Lorica cuneiform with the sides rounded, gradually tapering to the hind end as a short tail, and converging rapidly to the front as a cylindrical straight fairly long neck which is cut straight and with smooth margin; membrane scabrous; lorica $26–32 \times 13-5–17-5 \, \mu m$.

Habitat: Stray in locations 28 (April, July–August), 33 (April), 61 (NP 20, May) and 109 (December).

Lemmermann’s species measured $27–33 \times 14–20 \, \mu m$.

Distribution in Indian region: West Bengal, Orissa and Andhra Pradesh (!).
62. *Strombomonas gibberosa* (Playf.) Defl. 1930 (figures 62a–c)

Deflandre 1930, p 595, figures 97–101 and 103; Huber-Pestalozzi 1955, p 382, figure 828; = *Trachelomonas gibberosa* Playfair 1915, plate 5, figure 16; Deflandre 1926, p 128, figure 759.

Lorica broadly rhomboid with the median region somewhat angular, sides nearly straight or slightly concave or convex; converging rapidly to the front as a neck and to the hind end as a tail; neck usually obliquely cut but sometimes widened like a vase towards the pore; tail hollow, straight or sometimes slightly oblique and pointed; generally with a thin transverse membrane at its base; membrane smooth or rugged; chromatophores small, numerous, discoid and without pyrenoids in material from locations 23 and 27; lorica 46–53–65 × 26.4–29.3–36.7 μm; neck 2.6–3 × 7 μm; tail alone 8.8–12.3 μm.

*Habitat:* Rare in locations 23 (June), 27 (May); stray in locations 4 (May), 61 (NP 11, May), 63 (NP 25, March), 103 (December) and 109 (December).

The organism from various locations agreed fairly well with the typical species, but the transverse membrane at the base of the tail was not always observed.

*Distribution in Indian region:* Assam, West Bengal, Orissa and Andhra Pradesh (!).

var. *tumida* (Playf.) Defl. 1930 (figure 62d)

Deflandre 1930, p 598, figure 107; Huber-Pestalozzi 1955, p 383, figure 833; = *Trachelomonas gibberosa* var. *tumida* Playfair, 1921, p 135, plate 7, figure 17.

Differs from the typical species in the neck being short and the tail almost absent; instead the sides of the lorica converge towards the posterior and join sharply to form a small projection; lorica 52 × 38.7 μm; neck 7–8 μm long, with the caudal point up to 5 μm.

*Habitat:* Stray in location 103 (December).

The organism agreed fairly well with Playfair’s variety measuring 53 × 39 μm with the neck 7 μm and tail 3 μm, but the tail was slightly longer and there was a transverse partition at the base of the tail, as in the typical species.

*Distribution in the Indian region:* Andhra Pradesh (!).

var. *perlonga* Defl. 1930 (figure 62e)

Deflandre 1930, p 597, figure 104; Huber-Pestalozzi 1955, p 382, figure 830; = *Trachelomonas ensifera* Drezenpolski 1925, Tafel II, figure 102.

Shape of the lorica as in the typical species, but with a very long cylindrical neck and a long stout pointed tail; lorica 52–54.5 × 19.4–21.2 μm.

Deflandre’s variety measured 52 × 20 μm.
Distribution in Indian region: Andhra Pradesh (!).

**var. kalingensis** Philipose var. nov. (figures 62f, g)

Varietas a species typica differens eo quod cauda non est aperte separata nec acute cuneiformis necnon ob praesertiam nodi vel cardinis in regione media; membranum transversum absente ad radicem caudae; lorica paulo flavi coloris glabraque; chromatophora numerosae, parvae, discoideae sineque pyrenoidis; lorica 68.4–70.4 × 35–37 μm, collo solo 7.9–8.3 μm, caudaque circa 19.4–23.5 μm.

Habitatio: Rara in locatione 92 (mense Aprili).

Differs from the typical species in the tail being not clear cut and sharply conical, and in the presence of a joint or hinge in the equatorial region; a transverse membrane absent at the base of the tail; lorica light brown and smooth; chromatophores numerous, small, discoid and without pyrenoids; lorica 68.4–70.4 × 35–37 μm with neck alone 7.9 × 8.3 μm and tail about 19.4–23.5 μm.

Habitat: Rare in location 92 (April).

Distribution in Indian region: Orissa (!).

63. **Strombomonas longicauda** (Swir.) Defl. 1930 (figure 63)


Lorica rhomboidal with rounded angles; sides converging rapidly towards the neck as well as towards the tail; neck with the end widened and obliquely cut with the margin indistinctly denticulate; tail long, conical and straight or oblique; membrane brownish, slightly wrinkled and sometimes granular; chromatophores not observed; lorica (total) 52 × 27–28 μm, neck 10.6–11.4 × 6.5–7 μm and tail 19.4–21.2 μm.

Habitat: Stray in locations 61 (NP 11, May) and 102 (December).

Deflandre and Huber-Pestalozzi give dimensions as 44–53 × 20–29 μm with neck 12 × 7 μm and tail 21 μm.

Distribution in Indian region: Orissa and Andhra Pradesh (!).

64. **Strombomonas ensifera** (Daday) Defl. 1930 (figure 64a)

Deflandre 1930, p 601, figures 111–113 and 115; Huber-Pestalozzi 1955, p 384, figure 835; = *Trachelomonas ensifera* Dayad 1905; Lemmermann 1913, p 154, figure 304; = *T. ensifera* Dayad emend. Defl. 1926, p 127, figures 743–744 only.

Lorica very large, rhomboid in the median region and angled or sometimes rounded.
narrowing towards the front end into a fairly long obliquely cut neck and towards
the hind end into a long, stout, hollow and pointed tail separated from the body by a
transverse membrane; membrane smooth, clear brown, relatively thin and slightly
deformed; chromatophores not observed; lorica 121–125 × 45–48 μm, with neck
30 × 8 μm and tail 43–48 μm.

**Habitat:** Stray in locations 6 (June), 61 (NP 11, May) and 75 (December).

It agreed with the typical species measuring 120–134 × 38–55 μm with neck 7–10 μm
broad and tail 42–70 μm long.

**Distribution in Indian region:** Assam and Orissa (!).

**var. verrucosa** Philipose var. nov. (figure 64b)

Varietas a species typica differens eo quod lorica est formae irregularis ab rugata ad
verrucosam necnon dimensiones minores, videlicet, 61.6 × 35 μm, collum vero
15 × 7 μm, fistulam 8.8 μm diametri necnon caudam 26.4 μm longitudinis; lorica est
paulo fulvi coloris; chromatophora numerosae, discoideae sineque pyrenoidis; stigma
prominens; flagellum brevius quam lorica ipsa.

**Habitatio:** Aberrans in locatione 61 (NP 13, mense Iulio).

Differs from the typical species in the lorica being irregularly wrinkled to verrucose
and the smaller dimensions, viz. 61.6 × 35 μm with the neck 15 × 7 μm, pore 8.8 μm in
diameter and the tail 26.4 μm long; lorica light brown; chromatophores numerous,
discoid and without pyrenoids; stigma prominent; flagellum shorter than the lorica.

**Habitat:** Stray in location 61 (NP 13, July).

Hortobágyi (1957, p 8, figure 142) has recorded a fairly similar form from Hungary
as *Trachelomonas ensifera* Daday. Apart from the organism being distinctly granular
to verrucose the dimensions are also smaller, viz. 53–56 × 25–33 μm with the pore
6 μm whereas in the typical species of *Strombomonas ensifera* (= *Trachelomonas
enrifera*) the dimensions are much larger (see above) and the lorica is smooth and
slightly deformed. So, Hortobágyi's organism appears to be the same as the one from
Cuttack.

**Distribution in Indian region:** Orissa (!).

65. *Strombomonas tambowika* (Swir.) Defl. 1930 (figure 65)

Deflandre 1930, p 576, figures 38–41; Huber-Pestalozzi 1955, p 386, figure 842;
= *Trachelomonas tambowika* Swir. 1914; Deflandre 1926, p 123, figures 734–735.

Lorica ellipsoid or ovoid with the front end prolonged into a straight neck with
denticulate margin; hind end with a long, straight or slightly bent tail; membrane
yellowish brown, smooth but with irregular constrictions or wrinkles; lorica
48 × 30 μm.
Habitat: Very rare in location 28 (May).

Swireenko's species measured 50–55 × 27–30 μm.

Distribution in Indian region: West Bengal (!).

66. **Strombomonas subcurvata** (Proshk-Lawr.) Defl. 1930 (figure 66)


Lorica suboval, slightly compressed, spirally recurved to slightly sigmoid with the hind end acuminate; neck widened towards the pore and with denticulate margin; membrane hyaline with irregularly arranged large granules; cell contents not observed; lorica 48.6 × 27 μm with neck 6.2–7 × 6 μm.

Habitat: Stray in location 63 (NP 25, January).

The organism conformed fairly well to Proshkina-Lawrenko's species measuring 50–55 × 24–28 μm with neck 4.8–8.4 × 6–7.2 μm.

Distribution in Indian region: Orissa (!).

67. **Strombomonas triquetra** (Playf.) Defl. 1930


Lorica triangular in cross section with the upper portion of the body rectangular in side view with the sides straight and parallel; lower part of the body rapidly converging into a tail; neck straight and short with a truncate and not widened end; membrane finely scrobicular; lorica 40 × 20 μm.

Known only from Australia.

**var. torta** Rino (figures 67a–d)

Rino 1972, p 169, plate 9, figures 7–10.

Differs from the typical species in the lorica being contorted and trapezoid in side view with the anterior end slightly broader, sides nearly straight or more or less constricted and attenuated towards the posterior end into a short pointed tail or rarely with the hind end obtuse to rounded and without a tail; anterior end abruptly attenuated into a short broad obliquely cut neck with a smooth margin; chromatophores numerous and discoid; paramylum either few and rod-like or sometimes absent; lorica 36–42 × 18.9–22 μm, with neck 4.4–5.3 × 6.9–7.5 μm; tail when present about 1.8–3.5 μm: eye-spot not observed; flagellum less than body length.
Contributions to our knowledge of Indian algae—Euglenineae

Habitat:  Rather common in location 27 (May) and stray in locations 2 (June), 151 (May) and 159 (December).

The organism agreed fairly well with Rino's species measuring $35-40 \times 18-22 \mu m$, but in the Indian material the tail was not always present. Rino's specimens had also a flagellum of body length.

Distribution in Indian region:  Assam, West Bengal and Tamil Nadu (!).

68. Strombomonas reisii Rino 1972 (figures 68a–d)

Rino 1972, p 168, plate 9, figures 5–6.

Lorica elongate, about twice as long as broad, fusiform-rhomboïd with the median region angular; posterior half of lorica triangular with somewhat convex sides and narrowing into a medium-sized tail at the hind end; anterior half of lorica also triangular but with slightly concave, rarely slightly convex sides and converging towards the apex to terminate in a short obliquely cut neck with the pore having smooth or slightly irregular margin; in vertical section circular in median region, and triangular seen from anterior and posterior ends; membrane sparsely or densely granular; chromatophores numerous, small, discoid and without pyrenoids; paramylum small and rod-like; eye-spot triangular; flagellum less than body length; lorica (total) $55.6-73.8 \times 26.4-34.4 \mu m$, with neck $4.4 \times 7.8-8.6 \mu m$ and tail $10.6-14.6-16 \mu m$.

Habitat:  Rather common in location 27 (May) and stray to rare in location 151 (May, November).

The organism agreed with Rino's species measuring $84 \times 44 \mu m$, but was slightly smaller. The granulation of the lorica was also sometimes more prominent and crowded. Rino did not observe a flagellum and eye-spot.

Distribution in Indian region:  West Bengal and Tamil Nadu (!).

69. Strombomonas indica Philipose sp. nov. (figurae 69a–d)

Lorica elongate, fusiform-rhomboidea necnon triquetra; anterior posteriorque dimidia partes loricæ aunt formæ triangularæ cum lateribus convexis vel paululum concavis; finis anterior habet brevem, latum, oblique sectile collum cum fistula triangula habens marginem glabrum vel paulo irregularum; finis posterior prolongata est in caudam satis longam, de more rectam, aliquando paululum curvatum acutamque; a fronte posteriorique extremitate visa, lorica est triangulara; membranum irregulariter granulatum videtur; chromatophora numerosae, largiores polyhedralesque aunt necnon cum pyrenoidis projiciensibus dupliciterque vaginatis; stigma elongatum ad instar disci; flagellum brevius quam lorica; lorica (tota) $63.5-70.5 \times 27-28 \mu m$, colle $3.5-4.4 \times 5.7-7.2 \mu m$ necnon cauda $19.8-24.6 \mu m$.

Habitatio:  Rara in locatione 61 (NP 9 et 16, mense Maio).
M T Philipose

Typus: Figurae 69a–d.

Lorica elongate, fusiform-rhomboid and triquetrate; anterior and posterior halves of lorica triangular in outline with the sides convex or slightly concave; anterior end with a short broad obliquely cut neck with triangular pore having smooth or slightly irregular margin; posterior end prolonged into a fairly long, usually straight, sometimes very slightly bent, pointed tail; viewed from front and hind ends lorica triangular; membrane irregularly granulate; chromatophores numerous, fairly large and polyhedral with double-sheathed projecting pyrenoids; eye-spot elongate and disc-like; flagellum shorter than the lorica; lorica (total) 63.5–70.5 × 27–28 μm, neck 3.5–4.4 × 5.7–7.2 μm and tail 19.8–24.6 μm.

Habitat: Rare in location 61 (NP 9 and 16, May).

Type: Figures 69a–d.

Distribution in Indian region: Orissa (!).

70. Strombomonas tortuosa Philipose sp. nov. (figurae 70a–c)

Lorica rhomboidea, aligerque a fronte, necnon sigmoidea ab latere visa, irregulariter quadrangula in sectione optica dicte; habet breve, latum oblique sectile collum ad finem anteriorem necnon longiore de more rectam caudam ad finem vero posterioriorem; membranum irregulariter punctata ad granulata; lorica 65.0–73.2 × 29.9–33.2 μm cum collo 3.5–6.2 × 7–7.9 μm; fistula 7–8.8 μm diametri necnon cauda 21.2–27.3 μm longitundinis; res internae non sunt observatae.

Habitatio: Aberrans in locationibus 61 (NP 16, mense Decembri) et 92 (mense Aprili).

Typus: Figurae 70a–c.

Lorica rhomboid and winged in front view and sigmoid in side view, irregularly quadrangular in optical cross section; with a short wide obliquely cut neck in front end and with a fairly long usually straight tail at the hind end; membrane irregularly punctate to granulate; lorica 65–73.2 × 29.9–33.2 μm with neck 3.5–6.2 × 7–7.9 μm, pore 7–8.8 μm in diameter and tail 21.2–27.3 μm long; internal contents not observed.

Habitat: Stray in locations 61 (NP 16, December) and 92 (April).

Type: Figures 70a–c.

Though the organism showed some resemblance to S. reisii and S. indica in size and general shape it had a sigmoid lorica which was irregularly quadrangular and not triquetrate in cross section and the tail was longer.

Distribution in Indian region: Orissa (!).
Contributions to our knowledge of Indian algae—Euglenineae

Other taxa of Strombomonas reported from the Indian region are as follows:

1. *S. australica* (Playf.) Defl. 1930 (= *Trachelomonas caudata* var. *australis* Playf. 1915); = *T. longissima* Defl. 1926 (Burma, Skuja 1949, p 165).
3. *S. maxima* (Skv.) Defl. 1930; Vidarbh (Kamat 1975, p 468).
5. *S. urceolata* (Stokes) Defl. var. *indica* Skvortzov 1937; Burma (Skvortzov 1937, p 84).

Skvortzov’s (1937, p 82) *Trachelomonas rangoonensis* and *T. rangoonensis* var. *curvata* could most probably be only a *Strombomonas verrucosa* var. *borysthienensis* (Roll) Defl. 1930.

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S. ensifera (Daday) Defl. 65. S. tamhowika (Swir.)
Defl. 66. S. subcurvata (Prosch-Lawr.) Defl. 67. a-d. S. triqueta (Playf.) Defl. var. toria Rino. 68. a. S. reissi Rino. b and c. Strombomonas reissi Rino. d. Optical cross section of same. 69. a. S. indica sp. nov. b and c. S. indica sp. nov. d. Optical cross section of the same from tail end. 70. a-c. Three views of the S. tortuosa sp. nov.
Same magnification.—(18g, 24b, 26a and f-i); (19a and b, 25, 26b); (20, 22a-c); (26j, 27b, 31b, 32a, 36a and b, 44, 47a and b); (28, 37, 46a and b); (26j, 30b, 31a, 32d); (32b, 32c); (33, 34, 38, 42, 43); (48, 50g, i, k and l; 53, 55c); (50a-c); (50d-f, 50b and j, 57a and b); (52, 56b); (58b and c, 59, 61a and b, 62b and c, 67a-d, 68b); (58d, 62f and g); (62e, 63); (62d, 64a); (69b and c, 70a-c).