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Morphology and Infraciliature of Some Cyrtophorid Ciliates (Protozoa, Ciliophora) from Freshwater and Soil

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Summary: Four little known cyrtophorid ciliates occurring in Austrian rivers and in soils from Australia and Madeira are described. *Trithigmostoma srameki* (ŠRÁMEK-HUŠEK, 1952) differs from its probably nearest relative, *T. bavariensis* (KAHL, 1931), by the limnetic habitat, the rounded posterior end of the right kinety field and the lower number of cytopharyngeal rods. The freshwater population of *Odontochlamys alpestris* FOISSNER, 1981 is very similar to the type population from an alpine soil. The apically positioned dorsal brush of *Chilodonella convexa* KAHL, 1931 consists of only four widely spaced cilia; it is thus transferred to the genus *Odontochlamys. Gastronauta derouxi* nov. spec. lives in mosses and soils and has about 7 groups of paired cilia along the anterior dorsal margin and a nonciliated postoral field.

Key words: Ciliophora; Cyrtophorida; Infraciliature; *Trithigmostoma srameki; Odontochlamys alpestris; Odontochlamys convexa* nov. comb.; *Gastronauta derouxi* nov. spec.

Introduction

Redescription from live and silver impregnated specimens is necessary for a huge number of incompletely described ciliate species. The following chilodonellids from freshwater, seawater, and soil have been sufficiently described in the last two decades by AUGUSTIN & FOISSNER (1989), BLATTERER & FOISSNER (1990), BUITKAMP (1977), DEROUX (1976a, b), DEROUX & DRAGESCO (1968), DRAGESCO & DRAGESCO-KERNEIS (1986), FOISSNER (1979a, b, 1981, 1988), FOISSNER & DIDIER (1981), FOISSNER et al. (1991), HOFMANN (1987), HOFMANN & BARDELE (1987), KAZUBSKI & MIGAŁA (1974), PACKROFF & WILBERT (1991), PÄTSCH (1974), RYDLO & FOISSNER (1986), SONG WEIBO (1991) and SONG WEIBO & WILBERT (1989): *Alinostoma burkli, A. plurivacuolata, Chilodonella cyprini, C. hexasticha, C. uncinata, Odontochlamys alpestris, O. gouraudi, Phascolodon vorticella, Pseudochilodonopsis acuta, P. algivora, P. caudata, P. fluviatilis, P. marina, P. mutabilis, P. piscatoris, P. polyvacuolata, P. similis, Thigmogaster nanus, T. pardus, T. oppositevacuolatus, T. potamophilus, T. schedoeublepharis* (formerly *Chilodonella*), *Trithigmostoma cucullulus, T. steini, T. bavariensis.* In this paper we redescribe three little known chilodonellids and a new chlamydodontid, *Gastronauta derouxi.*

Materials and Methods

Trithigmostoma srameki occurred on October 24, 1989 in the mesosaprobic River Traun near Steyrermühl, Oberösterreich, Austria, N 48°, E 13° 50′.

Odontochlamys alpestris has been found in several rivers in Austria (Ager, Traun) and Germany (Amper, Vils); once it was observed in activated sludge of the sewage disposal plant Siggerwiesen, Salzburg. The population described has been collected on April 21, 1989 in the alpha- to betamesosaprobic River Ager, Oberösterreich, Austria, N 48°, E 13° 40′.

Odontochlamys convexa occurred on February 1, 1987 in the upper soil layer (0−5 cm; litter and soil; pH = 6.5) near Erldunda between Ayers Rock and Alice Springs, Australia, S 25° 10′, E 133° 15′. Only few specimens were found.

Gastronauta derouxi nov. spec. was discovered on July 10, 1985 in a light reddish-brown soil grown with *Opuntia* sp. and tufts of grass (0−5 cm; pH = 4.8) at Garajau Kap, Madeira, Portugal, N 32° 50′, W 17°, about 150 m above sea level. A second population was collected on July 2, 1985 in the upper layer of a heavily saline soil (0−5 cm; pH 7.3) from the shore of Lake Baringo, Kenya, N 0° 40′, E 36°.

Material from raw cultures was used for the investigations. All species were studied in vivo and in protargol silver impregnated slides.

Trithigmostoma srameki was also investigated with the scanning electron microscope, and *O. alpestris* with the dry silver nitrate method. See FOISSNER (1991) for detailed protocols of the methods used.

All counts and measurements were performed at a magnification of ×1000 (1 measuring unit = 1.25 μm). Statistical procedures follow methods described in SOKAL & ROHLF (1981). Drawings of impregnated specimens were made with a camera lucida.

The taxonomy is according to CORLISS (1979) and FOISSNER (1988).

Description of the species

- Family Chilodonellidae DEROUX, 1970
- Genus *Trithigmostoma* JANKOWSKI, 1967
- *Trithigmostoma srameki* (ŠRÁMEK-HUŠEK, 1952) FOISSNER, 1988 (Figs. 1−20, Tables 1, 2)

1952 *Chilodonella hyalina* ŠRÁMEK-HUŠEK, Cslka. Biol., Praha 1:140 (description in Czech).

1954 *Chilodonella hyalina* ŠRÁMEK, 1952 − ŠRÁMEK-HUŠEK, Arch. Protistenkd. 100: 253 (description in German).

1988 *Trithigmostoma srameki* (ŠRÁMEK-HUŠEK, 1952) − FOISSNER, Hydrobiologia 162: 23 (replacement of original species name because of preoccupation).

Neotype material: 2 slides of protargol impregnated cells have been deposited in the collection of microscope slides of the Oberösterreichisches Landesmuseum in Linz, Austria.

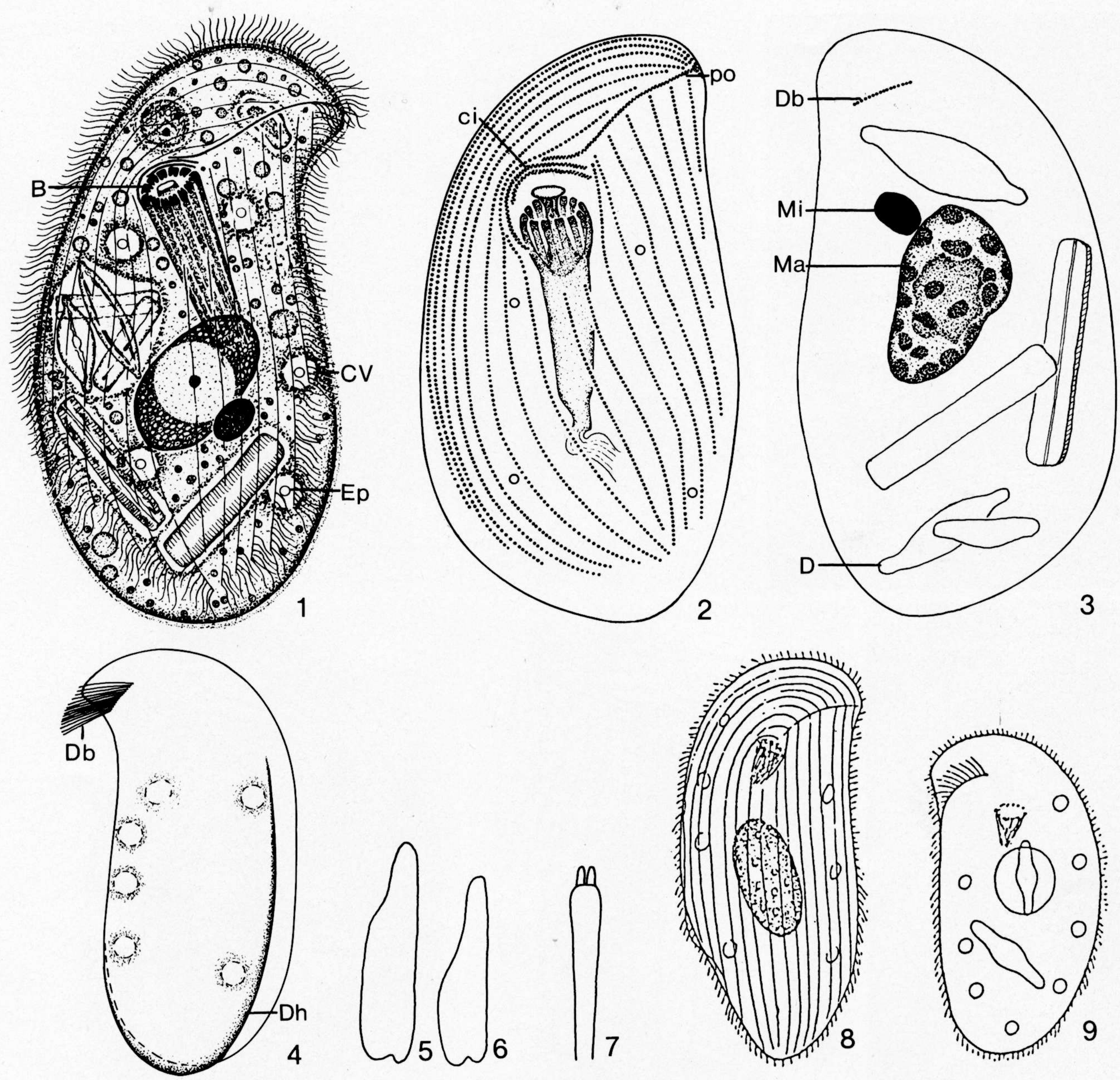
Redescription: In vivo 70−100 × 30−40 μm. Acontractile but highly flexible. Shape rather variable, similar to *T. cucullulus,* but more slender and right side often somewhat flattened at level of cytopharyngeal opening (Figs. 1, 4, 15, 17, 18). Anterior end bluntly pointed and snout-like projecting, posterior end broadly to narrowly rounded. Dorsal hump sometimes projecting above flat ventral surface posteriorly. Praeoral area about 3:1, postoral portion about 2:1 flattened (Figs. 4−6). Macronucleus in vivo about 25 × 13 μm, in mid-body, contains spherical chromatin bodies surrounding hyaline area having central globule. Micronucleus conspicuous, in vivo about 7 × 5 μm, adjacent to macronucleus (Figs. 1, 3, 10, 12). Usually 5−6 (rarely 8) contractile vacuoles along postoral body margins (Figs. 1, 2, 4, 8−10, 15). Cytopharyngeal rods toothed, form dorsally directed funnel. Pellicle coated by an about 1 μm thick, mucous layer (Figs. 1, 14). Cytoplasm colourless, with many 1−2 μm sized, greasily shining globules and food vacuoles containing various diatoms. Movement slowly gliding, thigmotactic.

Cilia of ventral side 5−6 μm long. Somatic and oral infraciliature very similar to other members of genus. Distance between right and middle postoral kinety slightly enlarged, as in *T. bavariensis* (Figs. 2, 11, 13, 15−18). Kineties of right field successively shortened posteriorly. Dorsal brush subapical, near left margin, crosses snout, cilia 10 μm long (Figs. 3, 4, 9, 12, 20).

Occurrence and ecology: This species is quite common in beta- to alphamesosaprobic rivers (e.g., Amper and Vils in Germany and Traun and Ager in Austria). Very likely it often has been mixed up with *T. cucullulus* or *T. steini*. In samples containing both, *T. srameki* and *T. cucullulus,* the former disappeared while the latter multiplied when the water became putrescent. We thus agree with ŠRÁMEK-HUŠEK (1952) that *T. srameki* prefers beta- to alphamesoaprobic conditions, whereas *T. cucullulus* develops best in alphamesoaprobic environments (FOISSNER et al. 1991).

Comparison with related species: The position of the dorsal kinety, the number and position of the contractile vacuoles, and the biotopes correspond with ŠRÁMEK-HUŠEK's findings (Figs. 8, 9). He obviously missed the slightly enlarged distance between the postoral kineties; it is in fact easily overlooked in vivo.

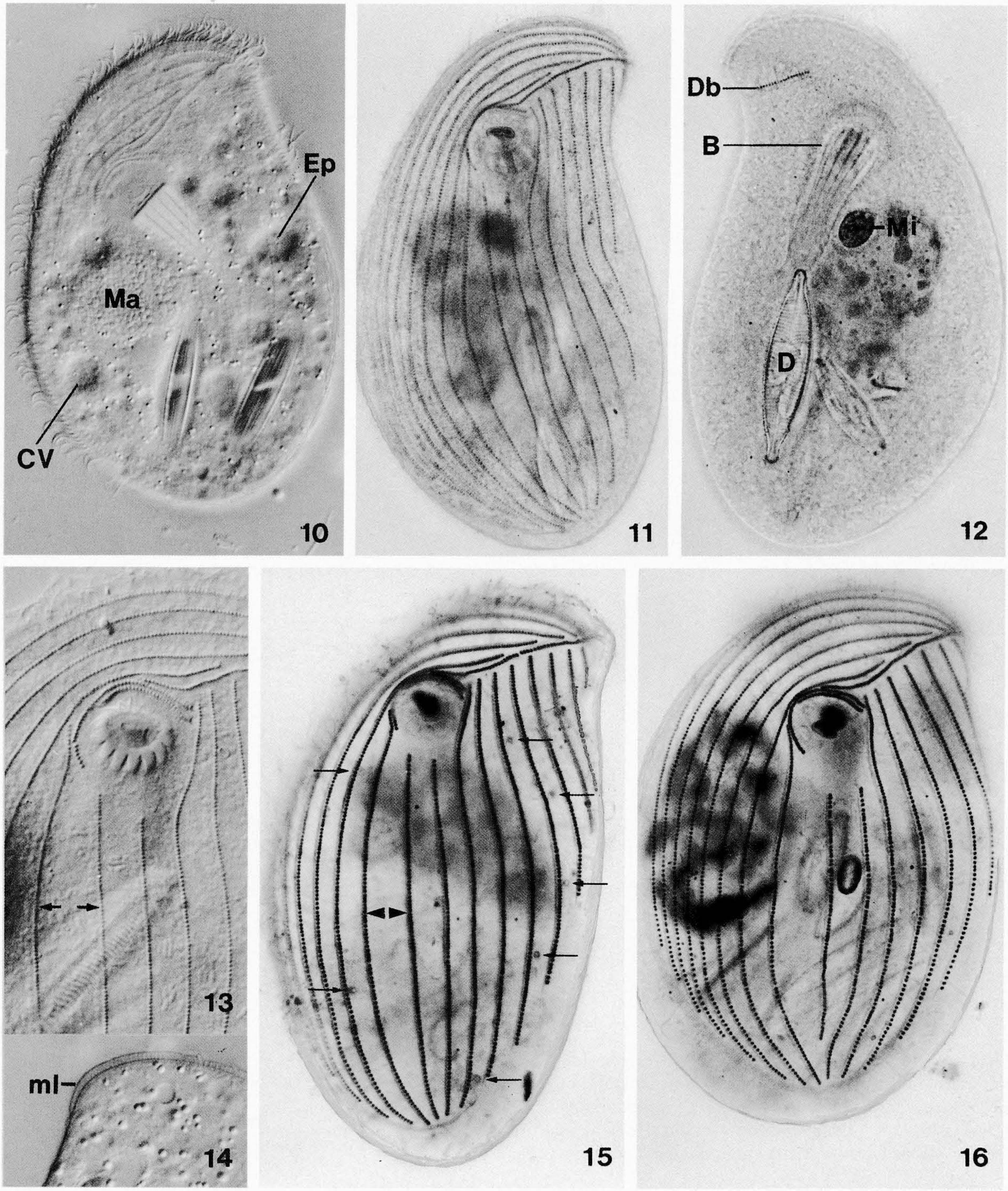
Trithigmostoma srameki is not easily separated from some other members of the genus, especially from *T. bavariensis* (Table 1). The only characters we found are the habitat (freshwater versus soil), the number of cytopharyngeal rods (11−14 versus 16−21) and the right ciliary field which is rounded posteriorly in *T. srameki* and transverse truncate in *T. bavariensis* (checked in three silver impregnated terrestrial populations). *Trithigmostoma cucullulus* (MÜLLER, 1786) is slightly larger than *T. srameki,* has more (19−22) ventral kineties, and the distance between the postoral kineties is not enlarged. Furthermore, its dorsal brush consists of much more cilia (29−40, $\bar{x}$ = 33).



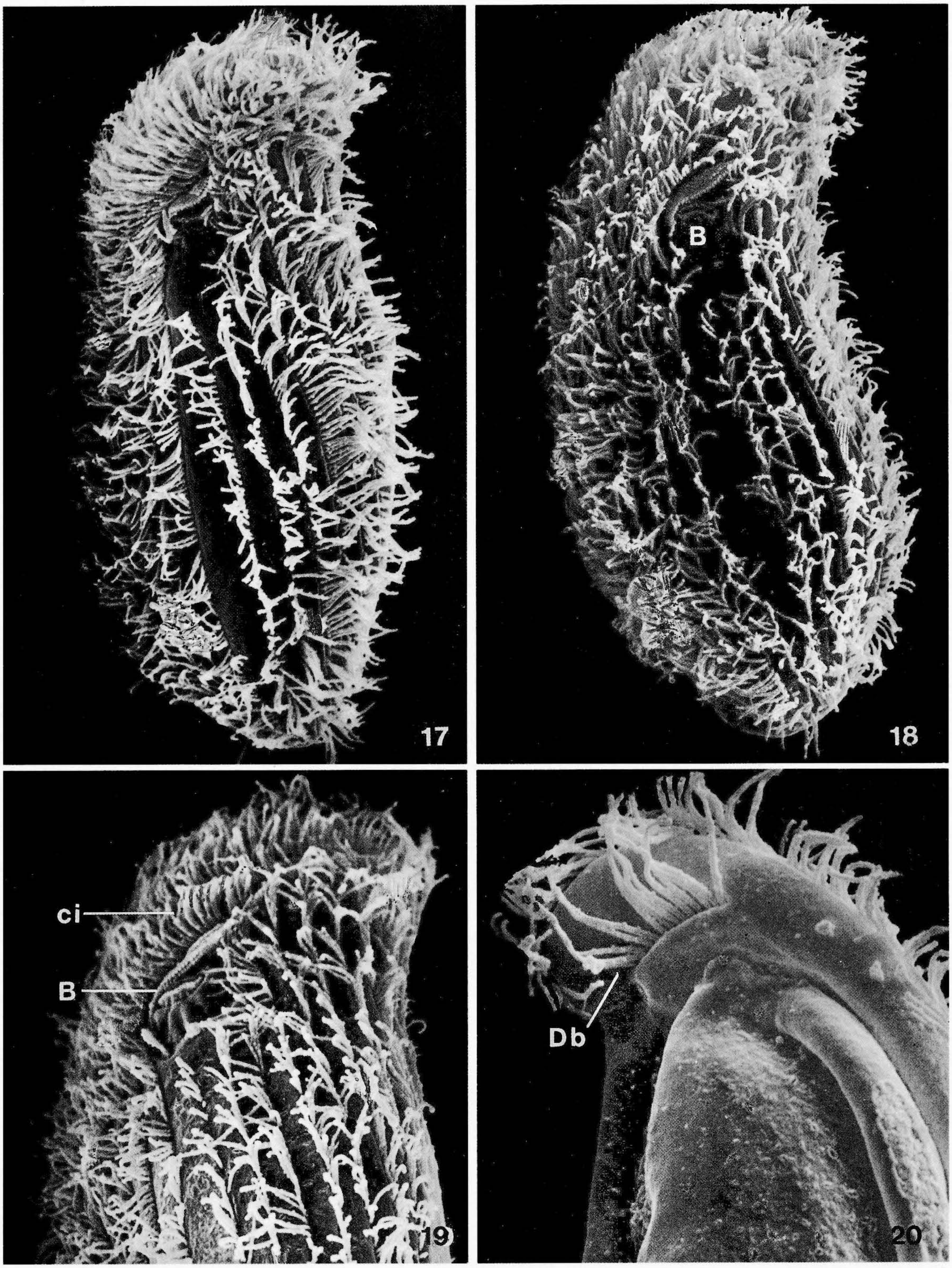
Figs. 1–9. *Trithigmostoma srameki* (Figs. 1, 4–9, from life; 2, 3, protargol impregnation. 8, 9, from ŠRÁMEK-HUŠEK 1952). – 1, 8. Ventral views, 85 µm, ? µm. – 2, 3. Infraciliature of ventral and dorsal side, 60 µm. – 4, 9. Dorsal views, 100 µm, ? µm. – 5, 6. Lateral views. – 7. Anterior end of cytopharyngeal rod. B = cytopharyngeal basket, ci = circumoral kinety, CV = contractile vacuole, D = diatom in food vacuole, Db = dorsal brush, Dh = dorsal hump, Ep = excretory pore of contractile vacuole, Ma = macronucleus, Mi = micronucleus, po = praeoral kinety.

◦ Genus *Odontochlamys* CERTES, 1891

The genus *Odontochlamys* is still insufficiently separated from *Chilodonella*. FOISSNER (1988) used the following characters: ventral kinety fields depressed, dorsal hump often strongly furrowed or with long processes, postoral non-ciliated field inconspicuous, anterior end of kineties of right field distinctly curved. He also suggested that the apical location of the dorsal brush is probably the most important criterion. This is confirmed by the reinvestigation of *Chilodonella convexa* KAHL, 1931 which has not only an apical dorsal brush but also meets most of the other criteria.



Figs. 10–16. *Trithigmostoma srameki* (Figs. 10, 14, from life; 11–13, 15, 16, protargol impregnation). – 10. Ventral view. – 11, 12, 15, 16. Infraciliature of ventral and dorsal side. Arrowheads mark postoral gap; arrows denote pores of contractile vacuoles. – 13. Oral infraciliature and cytopharyngeal basket of a lightly stained specimen. Arrows mark postoral gap. – 14. Anterior end showing mucous layer. B = cytopharyngeal basket, CV = contractile vacuole, D = diatom in food vacuole, Db = dorsal brush, Ep = excretory pore of contractile vacuole. Ma = macronucleus, Mi = micronucleus, ml = mucous layer.



Figs. 17–20. *Trithigmostoma srameki* (scanning electron micrographs). – 17, 18. Ventral views. – 19, 20. Ciliary pattern of anterior ventral and dorsal side. B = cytopharyngeal basket, ci = circumoral kinety, Db = dorsal brush.

Table 1. Comparison of *Trithigmostoma* species. Tba = *T. bavariensis* (2 populations; from FOISSNER 1988); Tcu = *T. cucullulus* (from RADZIKOWSKI & GOŁEMBIEWSKA 1977); Tcuc = *T. cucullulus* (from FOISSNER 1988); Tsr = *T. srameki;* Tst = *T. steini* (from RADZIKOWSKI & GOŁEMBIEWSKA 1977); Tste = *T. steini* (2 populations; from FOISSNER 1988). Data based on protargol impregnated specimens. Measurements in μm.

Character	Species					
	Tsr	Tba	Tcuc	Tcu	Tste	Tst
Body, length	49–79	60–115	67–118	90–150	77–180	180–320
Cytopharyngeal rods, number	11–14	16–21	11–17	10–16	12–20	10–21
Somatic kineties, number	16–18	16–18	19–22	16–22	25–33	28–35
Contractile vacuole pores, number	2–8	?	?	3–5	10–40	12–30
Basal bodies in dorsal brush, number	15–19	15–20	29–40	?	33–70	?
Dorsal brush, length	5.5–9	4–8	12–21	?	9–28	?
Distance between postoral kineties enlarged	yes	yes	no	no	no	no
Habitat	fresh-water	soil, litter	fresh-water	fresh-water	fresh-water	fresh-water

◦ *Odontochlamys alpestris* FOISSNER, 1981 (Figs. 21–36; Table 2)

1981 *Odontochlamys alpestris* FOISSNER, Zool. Jb. Syst. 108: 289.

Paratype material: 2 slides of protargol impregnated cells have been deposited in the collection of microscope slides of the Oberösterreichisches Landesmuseum in Linz, Austria.

Description: The limnetic population differs only slightly from the terrestrial type material. It is in vivo slightly larger (35–60 × 20–35 μm; $\bar{x}$ = 50 × 30 μm versus 30 to 50 × 19–25 μm), the anterior end is usually more pointed and the dorsal hump projects more distinctly above the flat postoral ventral surface (Figs. 21, 24). The kineties of the ventral side consist of more basal bodies and the non-ciliated postoral field is wider (Figs. 22, 30, 35). The dorsal brush consists of more (6–9; $\bar{x}$ = 7.4 versus 3–6; $\bar{x}$ = 4.1) cilia (Figs. 23, 24, 28, 36).

◦ *Odontochlamys convexa* (KAHL, 1931) nov. comb. (Figs. 37–44; Table 2)

1931 *Chilodonella convexa* KAHL, Tierwelt Dtl. 21: 240.

Neotype material: 2 slides of protargol impregnated cells have been deposited in the collection of microscope slides of the Oberösterreichisches Landesmuseum in Linz, Austria.

Redescription: In vivo 30–40 × 20–30 μm. Acontractile but very flexible. Oval, anterior end bluntly pointed, posterior end broadly rounded. Dorsal hump very conspicuous, having many irregular furrows and prominent anterior slope, distinctly projecting rather deeply depressed postoral ventral surface (Figs. 37–39). Preoral area about 3:1, postoral portion inconspicuously flattened (Fig. 39). Macronucleus in posterior half, ellipsoid, contains spherical chromatin bodies surrounding hyaline centre. Micronucleus spherical, in 60% of specimens rather distant from macronucleus (Figs. 37, 43, 44). 2 contractile vacuoles, the upper pore close below oral opening between 1st and 2nd inner kinety of right field, the other near posterior end between 3rd and 4th inner kinety of left field. Cytopharyngeal opening in median of cell. Cytopharyngeal rods toothed, form narrow (3–4 μm wide at distal end), dorsally and backwards directed funnel; distal half of rods 8–15 μm long, proximal portion very thin, in 2 out of 13 specimens cornucopia-shaped. Cytoplasm colourless. Probably feeds on bacteria. Movement slowly gliding, thigmotactic, attaches to soil particles.

Cilia of ventral side about 5 μm long. Infraciliature very similar to that of other species of genus, differing mainly in morphometric characters. Left ciliary field remarkably small, thus leaving wide gap between posterior ends of right and left ciliary field (Fig. 42).

Dorsal brush at anterior margin of cell, cilia about 6 μm long and remarkable widely spaced (Figs. 43, 44).

Occurrence and ecology: KAHL (1931) discovered *Odontochlamys convexa* in mosses. Later it has been recorded by WENZEL (1953) from Bavarian mosses and by WANG JIAJI

Table 2. Morphometric characterization of *Trithigmostoma srameki* (upper line), *Odontochlamys alpestris* (middle line), and *O. convexa* (lower line)[1].

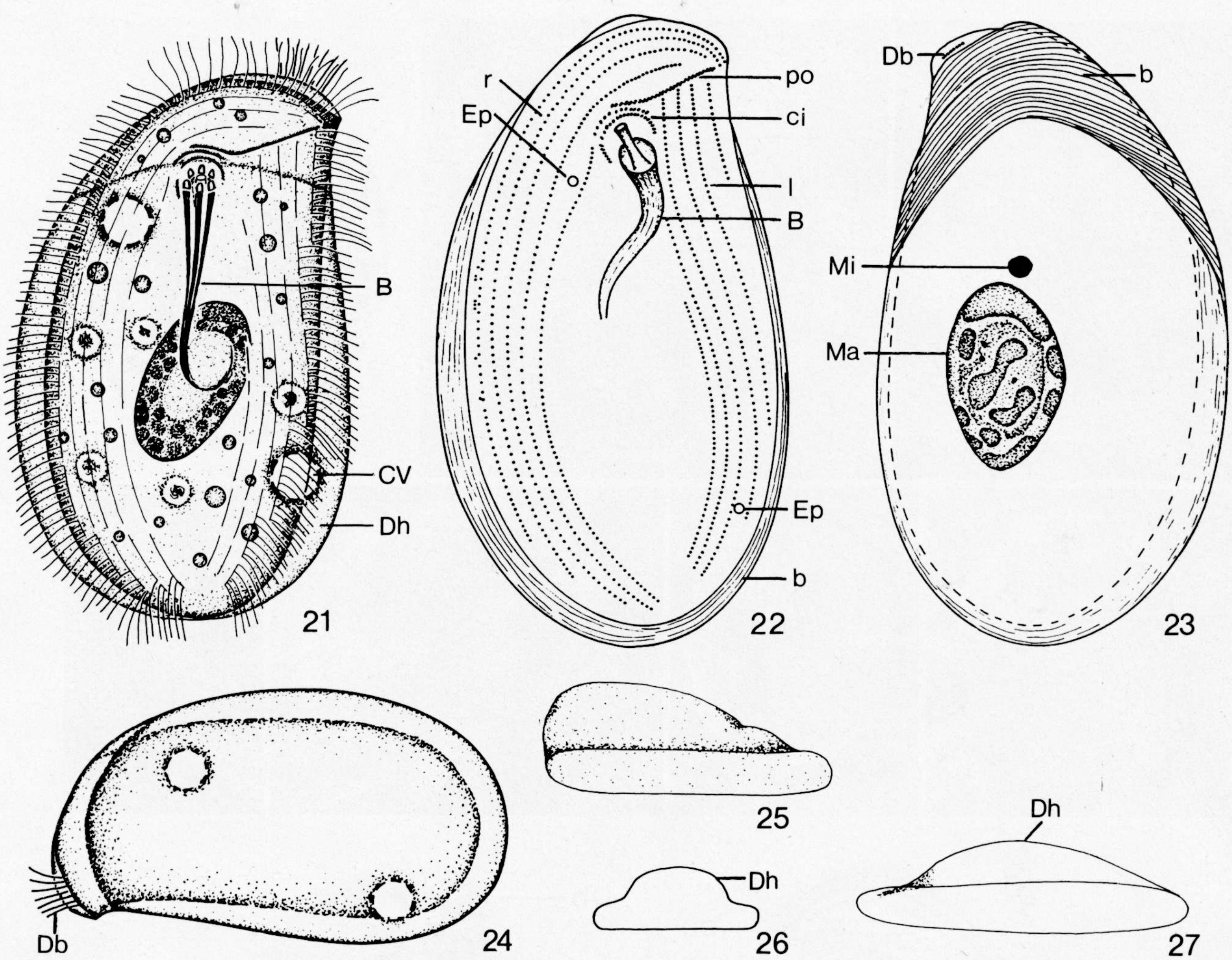
Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	66.5	66.5	10.0	2.7	15.1	49.0	79.0	14
	43.0	44.0	6.7	2.0	15.6	30.0	51.0	11
	28.9	28.5	3.0	0.9	10.5	25.0	33.0	12
Body, width	36.1	36.5	3.9	1.0	10.8	30.0	44.0	14
	27.5	27.0	3.5	1.0	12.7	23.0	33.0	11
	22.0	22.0	2.6	0.8	11.9	18.0	27.0	12
Anterior somatic end to inner circumoral kinety, distance	14.8	15.0	1.7	0.5	11.6	12.0	18.0	14
	5.7	6.0	1.0	0.3	17.6	4.0	7.5	11
	7.0	7.0	1.2	0.3	17.2	5.0	9.0	12
Anterior somatic end to posterior end of dorsal kinety, distance	8.7	9.0	2.5	0.7	28.7	4.5	15.0	14
	about 1−3 µm							
	about 0−2 µm							
Anterior somatic end to centre of macronucleus, distance	37.5	37.5	13.4	3.6	35.9	15.0	62.0	14
	23.6	24.5	0.8	0.3	10.8	19.0	28.0	10
	21.1	21.0	3.4	1.0	16.3	15.0	29.0	12
Anterior somatic end to anterior excretory pore, distance	–	–	–	–	–	–	–	–
	12.7	13.0	2.0	0.7	15.5	9.0	15.0	7
	11.8	12.0	1.8	0.6	15.4	9.0	15.0	10
Anterior somatic end to posterior excretory pore, distance	–	–	–	–	–	–	–	–
	31.8	31.0	6.1	2.1	19.1	24.0	42.0	8
	16.9	16.0	2.0	0.7	12.0	15.0	21.0	8
Distance between left and right kinety field	–	–	–	–	–	–	–	–
	10.8	10.0	2.6	0.8	23.7	7.5	15.0	10
	7.1	7.0	1.1	0.4	14.8	6.0	9.0	9
Macronuclei, number	1.0	1.0	0.0	0.0	0.0	1.0	1.0	14
	1.0	1.0	0.0	0.0	0.0	1.0	1.0	11
	1.0	1.0	0.0	0.0	0.0	1.0	1.0	12
Macronucleus, length	19.9	20.0	2.1	0.5	10.3	17.0	24.0	14
	12.6	12.0	2.9	0.9	22.7	9.0	18.0	11
	11.8	12.5	2.1	0.6	17.6	8.0	15.0	12
Macronucleus, width	10.5	10.0	1.6	0.4	15.2	9.0	15.0	14
	8.4	9.0	0.9	0.3	11.1	7.0	9.0	11
	6.4	6.0	0.8	0.2	12.4	5.0	8.0	12
Micronuclei, number	1.0	1.0	0.0	0.0	0.0	1.0	1.0	9
	1.0	1.0	0.0	0.0	0.0	1.0	1.0	11
	1.0	1.0	0.0	0.0	0.0	1.0	1.0	10
Micronucleus, length	5.1	5.0	0.6	0.2	11.8	4.5	6.0	9
	1.7	1.5	0.3	0.1	15.5	1.5	2.0	6
	2.2	2.0	0.4	0.1	19.2	2.0	3.0	10
Micronucleus, width	4.0	4.0	0.6	0.2	15.5	3.0	4.5	9
	1.7	1.5	0.3	0.1	15.5	1.5	2.0	6
	2.2	2.0	0.4	0.1	19.2	2.0	3.0	10
Cytopharyngeal rods, number	12.2	12.0	0.8	0.2	6.3	11.0	14.0	19
	not countable							
	8.9	9.0	–	–	–	8.0	9.0	8
Cytopharyngeal rods, length (only straight portion measured in *O. convexa*)	26.2	26.0	3.2	0.9	12.4	22.0	33.0	13
	16.0	16.0	2.2	0.7	14.0	12.0	20.0	9
	12.8	13.0	2.1	0.6	16.6	8.0	15.0	12

(continued)

Table 2. (continued).

Character	x̄	M	SD	SE	CV	Min	Max	n
Cytopharyngeal opening, diameter	7.1	7.3	0.4	0.1	6.3	6.5	7.5	14
	3.0	3.0	0.0	0.0	0.0	3.0	3.0	11
	3.3	3.0	0.5	0.1	13.9	3.0	4.0	12
Somatic kineties, total number	17.5	18.0	0.7	0.2	3.9	16.0	18.0	20
	11.1	11.0	–	–	–	11.0	12.0	11
	11.0	11.0	0.0	0.0	0.0	11.0	11.0	12
Somatic kineties of right kinety field, number	7.1	7.0	0.2	0.1	3.2	7.0	8.0	20
	5.0	5.0	0.0	0.0	0.0	5.0	5.0	11
	5.0	5.0	0.0	0.0	0.0	5.0	5.0	12
Somatic kineties of left kinety field, number	7.5	8.0	0.7	0.2	9.2	6.0	8.0	20
	6.1	6.0	–	–	–	6.0	7.0	11
	6.0	6.0	0.0	0.0	0.0	6.0	6.0	12
Postoral somatic kineties, number	3.0	3.0	0.0	0.0	0.0	3.0	3.0	20
	none							
	none							
Innermost kinety of left kinety field, length	–	–	–	–	–	–	–	–
	18.7	18.0	6.8	2.1	36.4	7.0	30.0	11
	3.1	2.5	1.3	0.4	41.5	2.0	5.0	10
Outermost kinety of left kinety field, length	–	–	–	–	–	–	–	–
	6.2	6.0	1.4	0.4	22.7	4.0	9.0	11
	1.3	1.0	0.5	0.1	36.2	1.0	2.0	12
Innermost kinety of left kinety field, number basal bodies	–	–	–	–	–	–	–	–
	38.5	45.0	15.4	4.3	40.1	18.0	60.0	13
	6.4	5.0	3.1	1.0	49.0	3.0	12.0	10
Outermost kinety of left kinety field, number basal bodies	–	–	–	–	–	–	–	–
	13.9	14.0	2.4	0.7	17.5	11.0	18.0	13
	3.2	3.0	0.8	0.2	26.4	2.0	5.0	12
Circumoral kineties, number	2.0	2.0	0.0	0.0	0.0	2.0	2.0	20
	2.0	2.0	0.0	0.0	0.0	2.0	2.0	11
	2.0	2.0	0.0	0.0	0.0	2.0	2.0	12
Praeoral kineties, number	1.0	1.0	0.0	0.0	0.0	1.0	1.0	20
	1.0	1.0	0.0	0.0	0.0	1.0	1.0	11
	1.0	1.0	0.0	0.0	0.0	1.0	1.0	12
Praeoral kinety, length	20.0	20.0	2.0	0.5	10.0	17.0	23.0	14
	7.4	7.0	0.8	0.3	10.8	6.0	9.0	10
	7.1	7.0	0.8	0.3	11.7	6.0	8.0	10
Dorsal brush, length	7.5	7.5	0.9	0.2	12.3	5.5	9.0	14
	3.2	3.0	0.3	0.1	10.7	3.0	4.0	11
	8.1	8.0	0.7	0.2	9.1	7.0	9.0	10
Dorsal brush, number of basal bodies	16.6	17.0	1.3	0.3	7.7	15.0	19.0	14
	7.4	7.0	1.0	0.3	13.4	6.0	9.0	12
	4.1	4.0	–	–	–	4.0	5.0	10
Contractile vacuole pores, number impregnated	4.8	5.0	1.6	0.4	32.1	2.0	8.0	17
	2.0	2.0	0.0	0.0	0.0	2.0	2.0	11
	2.0	2.0	0.0	0.0	0.0	2.0	2.0	8

[1]) Data based on randomly selected, protargol impregnated specimens. Measurements in µm. CV = coefficient of variation in %, M = median, Max = maximum, Min = minimum, n = number of investigated individuals, SD = standard deviation, SE = standard error of mean, x̄ = arithmetic mean.



Figs. 21–27. *Odontochlamys alpestris* (Figs. 21, 24–27, from life; 22, 23, protargol impregnation). – 21. Ventral view, 50 µm. – 22, 23. Infraciliature of ventral and dorsal side, 50 µm. – 24. Dorsal view, 50 µm. – 25, 27. Lateral views. – 26. Cross section in mid-body. B = cytopharyngeal basket, b = bundles of argyrophilic fibres, ci = circumoral kinety, CV = contractile vacuole, Db = dorsal brush, Dh = dorsal hump, Ep = excretory pore of contractile vacuole, l = left kinety field, Ma = macronucleus, Mi = micronucleus, po = praeoral kinety, r = right kinety field.

(1977) and SHEN YUNFEN (1981) from (limnetic?) biotopes in China. TIRJAKOVÁ & MATIS (1987) report *O. convexa* from mosses in Czechoslovakia; they provide, however, very misleading figures (arrangement of kineties and contractile vacuoles) indicating that they have mixed up it with other species (Figs. 40, 41). *Odontochlamys convexa* is a very rare species in our experience.

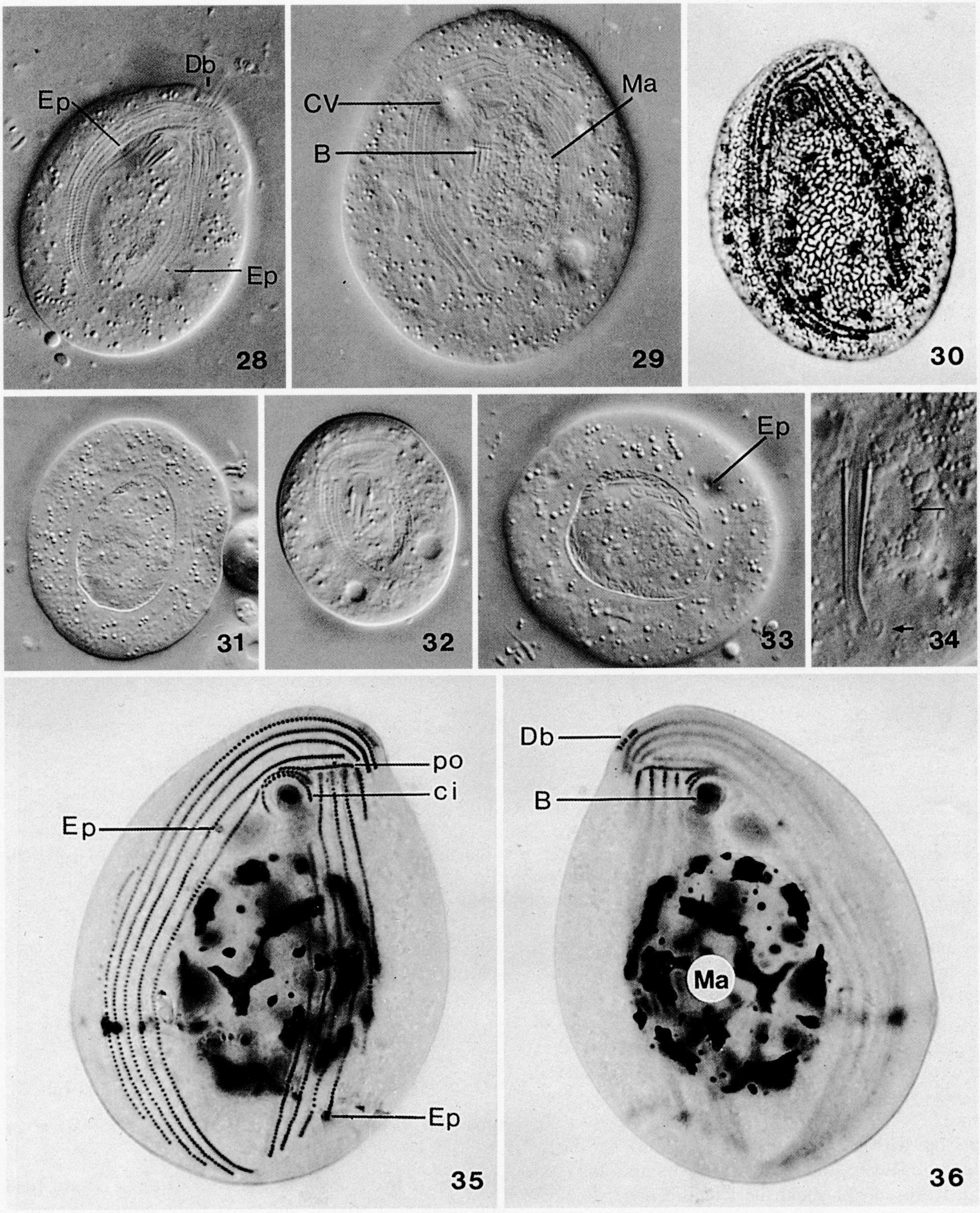
Comparison with related species (see also *O. alpestris*): Size, contour, shape of dorsal hump, and soil habitat leave no doubt about the identification, although KAHL (1931) has not seen the unique dorsal brush. The brush of *O. convexa* is most similar to that of *O. gouraudi* CERTES, 1891 (7–12 cilia, FOISSNER 1988; about 6 cilia, BUITKAMP 1977), whose dorsal side has, however, highly characteristic spines. Size and shape of *O. convexa* are rather similar to that of *O. alpestris*, whose brush cilia are, however, much more closely spaced.

◦ Family Chlamydodontidae STEIN, 1859
◦ Genus *Gastronauta* BÜTSCHLI, 1889
◦ *Gastronauta derouxi* nov. spec. (Figs. 45–56, Tab. 3)

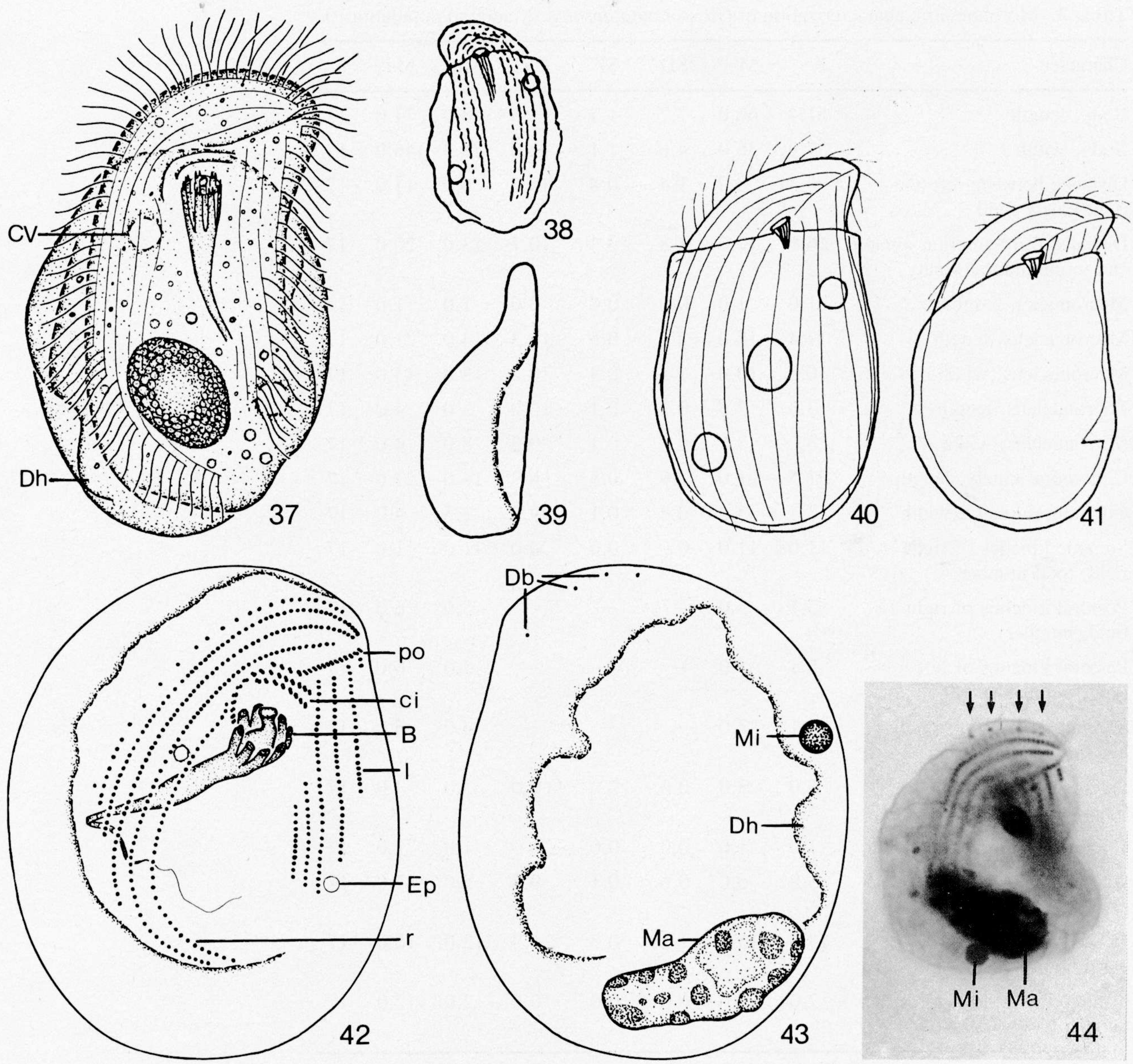
1968 *Gastronauta membranaceus* ENGELMANN – DEROUX & DRAGESCO, Protistologica 4: 392.

Diagnosis: In vivo about 60–70 × 40 µm. Postoral field non-ciliated. 5–6 left and 5–6 right postoral kineties, 6–8 right kineties, 4–6 praeoral kineties. Dorsal brush along anterior dorsal margin, consists of about 7 evenly spaced groups of paired basal bodies. In moss and soil.

Type location: Garajau Kap, Madeira, Portugal, N 32° 50′, W 17° 0′.



Figs. 28–36. *Odontochlamys alpestris* (Figs. 28, 29, 31–34, from life; 30, dry silver nitrate impregnation; 35, 36, protargol impregnation). – 28, 29, 31–33. Encysting specimens. – 30. Silverline system and infraciliature of ventral side. – 34. Cytopharyngeal apparatus. Short arrow marks spiraled proximal end of basket, long arrow denotes hyaline center of macronucleus. – 35, 36. Infraciliature of ventral and dorsal side. B = cytopharyngeal basket, ci = circumoral kinety, CV = contractile vacuole, Db = dorsal brush, Ep = excretory pore of contractile vacuole, Ma = macronucleus, po = praeoral kinety.



Figs. 37–44. *Odontochlamys convexa* (Figs. 37–41, from life; 42–44, protargol impregnation. 38, from KAHL 1931; 40, 41, from TIRJAKOVÁ & MATIS 1987). – 37, 38, 40, 41. Ventral views, 32 µm, 40 µm, 40 µm, 38 µm. – 39. Lateral view. – 42–44. Infraciliature of ventral and dorsal side, 33 µm. Arrows in Fig. 44 mark basal bodies of dorsal brush. B = cytopharyngeal basket, ci = circumoral kinety, CV = contractile vacuole, Db = dorsal brush, Dh = dorsal hump, Ep = excretory pore of contractile vacuole, l = left kinety field, Ma = macronucleus, Mi = micronucleus, po = praeoral kinety, r = right kinety field.

Type specimens: A holotype and a paratype of *G. derouxi* as 2 slides of protargol impregnated cells have been deposited in the collection of microscope slides of the Oberösterreichisches Landesmuseum in Linz, Austria.

Dedication: We dedicate this new species to Dr. GILBERT DEROUX who significantly contributed to the knowledge of cyrtophorid ciliates.

Description: Roughly elliptical, right side convex, left almost straight. Acontractile but very flexible. Dorsal hump distinct, sometimes projecting above deeply grooved ventral surface, with furrows and prominent anterior slope (Figs. 45, 46, 49). Anteriorly about 3:1, posteriorly 2:1 flattened (Fig. 48). Macronucleus in mid-body, ellipsoid, contains small, spherical chromatin bodies surrounding hyaline area having central globule. Micronucleus spherical, sometimes

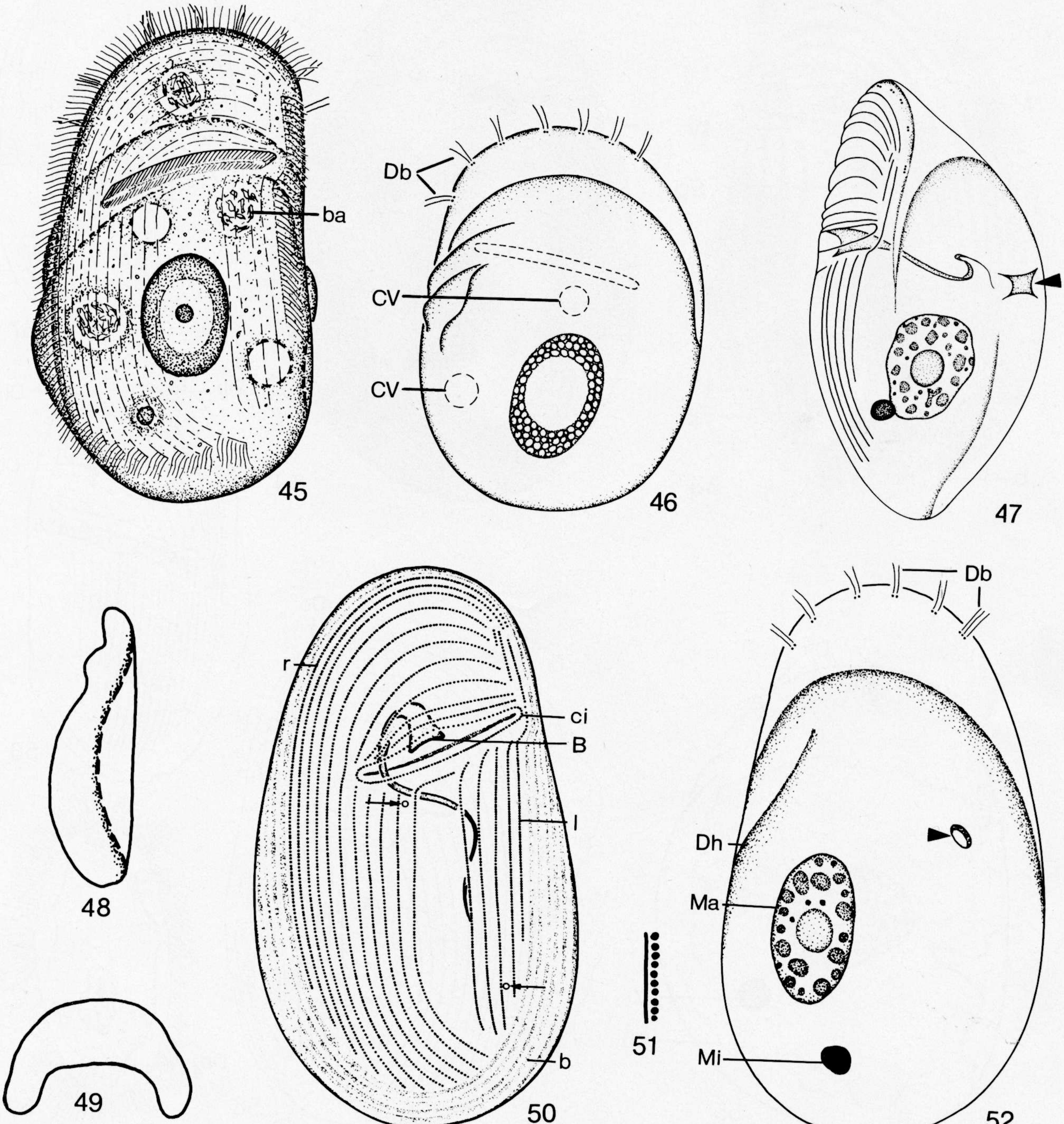
Table 3. Morphometric characterization of *Gastronauta derouxi* (Madeiran population)[1]).

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	61.4	60.0	7.2	1.7	11.6	48.0	77.0	17
Body, width	37.9	36.0	4.6	1.1	12.0	31.0	46.0	17
Distance between left and right kinety field	8.3	8.0	1.4	0.4	17.5	6.0	11.0	17
Distance from anterior somatic end to circumoral kinety	16.9	17.0	1.8	0.4	10.7	13.0	20.0	17
Macronuclei, number	1.0	1.0	0.0	0.0	0.0	1.0	1.0	17
Macronucleus, length	17.4	18.0	2.0	0.5	11.3	14.0	21.0	17
Macronucleus, width	10.5	10.0	1.1	0.3	10.1	8.0	13.0	17
Micronucleus, length	3.3	3.5	0.3	0.1	10.0	3.0	4.0	17
Micronucleus, width	3.2	3.0	0.3	0.1	9.3	3.0	4.0	17
Circumoral kinety, length	21.5	21.0	1.9	0.5	8.9	18.0	27.0	17
Circumoral kinety, width	3.1	3.0	0.3	0.1	9.8	2.5	4.0	17
Somatic kineties of right field, total number	11.0	11.0	0.0	0.0	0.0	11.0	11.0	17
Postoral kineties of right field, number	5.1	5.0	–	–	–	5.0	6.0	17
Postoral kineties of left field, number	5.1	5.0	–	–	–	5.0	6.0	17
Shortened praeoral somatic kineties, number	4.1	4.0	–	–	–	4.0	5.0	17
Praeoral vertical kinety fragments, number	3.0	3.0	0.0	0.0	0.0	3.0	3.0	17
Circumoral kineties, number	1.0	1.0	0.0	0.0	0.0	1.0	1.0	17
Dorsal brush, number groups of basal bodies	5.8	6.0	0.6	0.1	9.8	5.0	7.0	17
Dorsal brush, number basal bodies	13.5	13.0	1.2	0.3	8.8	12.0	16.0	17
Contractile vacuole pores, number	2.0	2.0	0.0	0.0	0.0	2.0	2.0	17

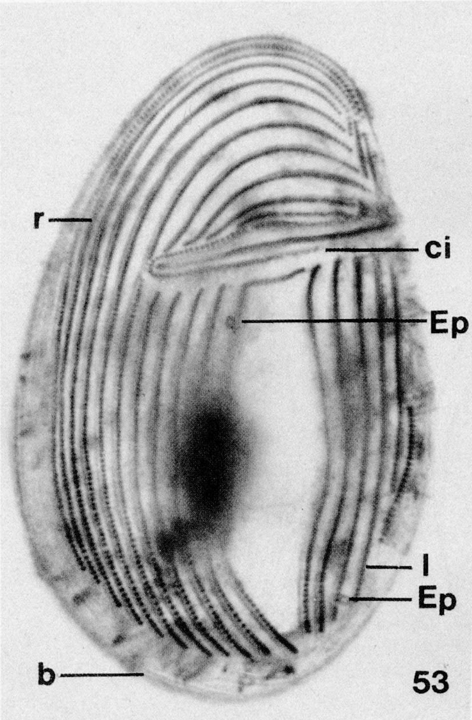
[1]) Data based on randomly selected, protargol impregnated specimens. Measurements in µm. CV = coefficient of variation in %, M = median, Max = maximum, Min = minimum, n = number of investigated individuals, SD = standard deviation, SE = standard error of mean, x̄ = arithmetic mean.

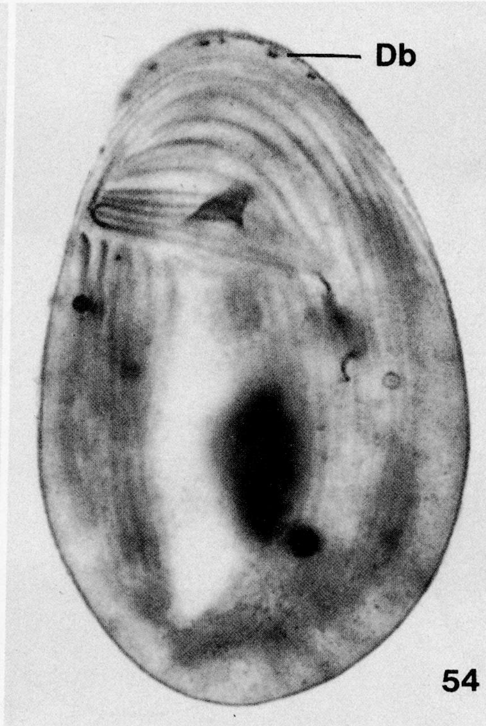
rather distant from macronucleus. 2 contractile vacuoles, the upper close below oral opening between 1st and 2nd inner kinety of right postoral field, the other near posterior end between 3rd and 4th (or 2nd and 4th; DEROUX & DRAGESCO 1968) inner kinety of left postoral field (Figs. 45, 50, 53, 56). Circumoral kinety narrow-elliptical, crosses almost entire width slightly above mid-body, its cilia form lamellated structure in vivo. Cytopharyngeal basket narrow (1/4–1/5 of circumoral kinety length), recognizable only after protargol impregnation, tapering and irregularly curved, extends to dorsal side (Figs. 47, 50). Cytoplasm colourless, with some food vacuoles probably containing bacteria and fungal spores. Movement slowly gliding, thigmotactic.

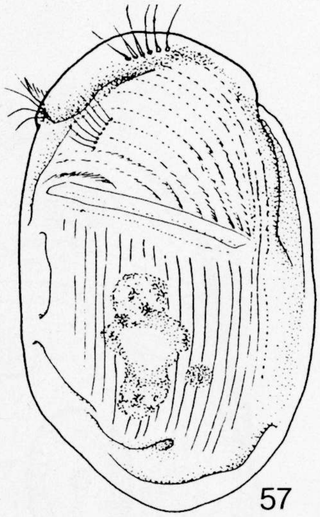
Ventral infraciliature very similar to that of *G. membranaceus*. 16–18 (mostly 16 in Madeiran, 18 in Kenyan population) ventral kineties separated by non-ciliated postoral field; accompanied by argyrophilic fibre at right (Fig. 51). 5 postoral kineties in right field, anterior end of inner kinety sharply bent to left crossing non-ciliated field. 6

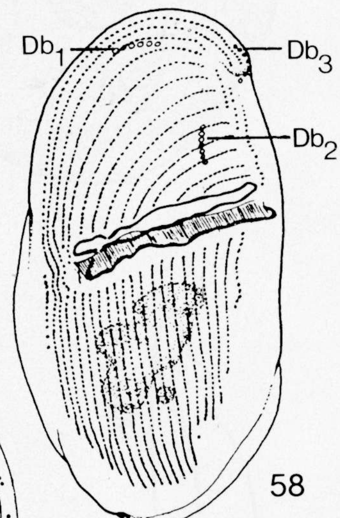


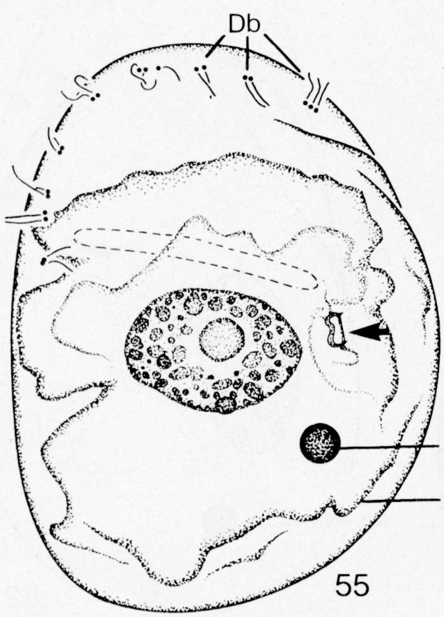
Figs. 45–52. *Gastronauta derouxi* (Figs. 45, 46, 48, 49, Kenyan population from life; 47, 50–52, Madeiran population after protargol impregnation). – 45. Ventral view, 70 µm. – 46. Dorsal view, 60 µm. – 47, 50, 52. Infraciliature of lateral, ventral and dorsal side, 57 µm, 66 µm. Arrows denote contractile vacuole pores; arrowheads mark refractile structure (cytopyge?). – 48. Lateral view. – 49. Cross section in mid-body. – 51. Kineties are accompanied by an argyrophilic fibre. B = cytopharyngeal basket, b = bundles of argyrophilic fibres, ba = bacteria in food vacuole, ci = circumoral kinety, CV = contractile vacuole, Db = dorsal brush, Dh = dorsal hump, l = left kinety field, Ma = macronucleus, Mi = micronucleus, r = right kinety field.

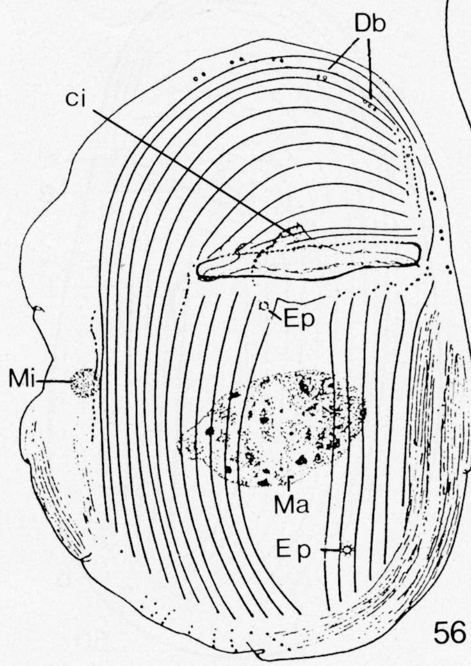


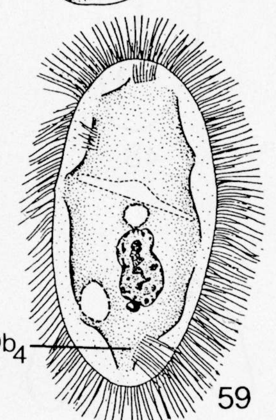






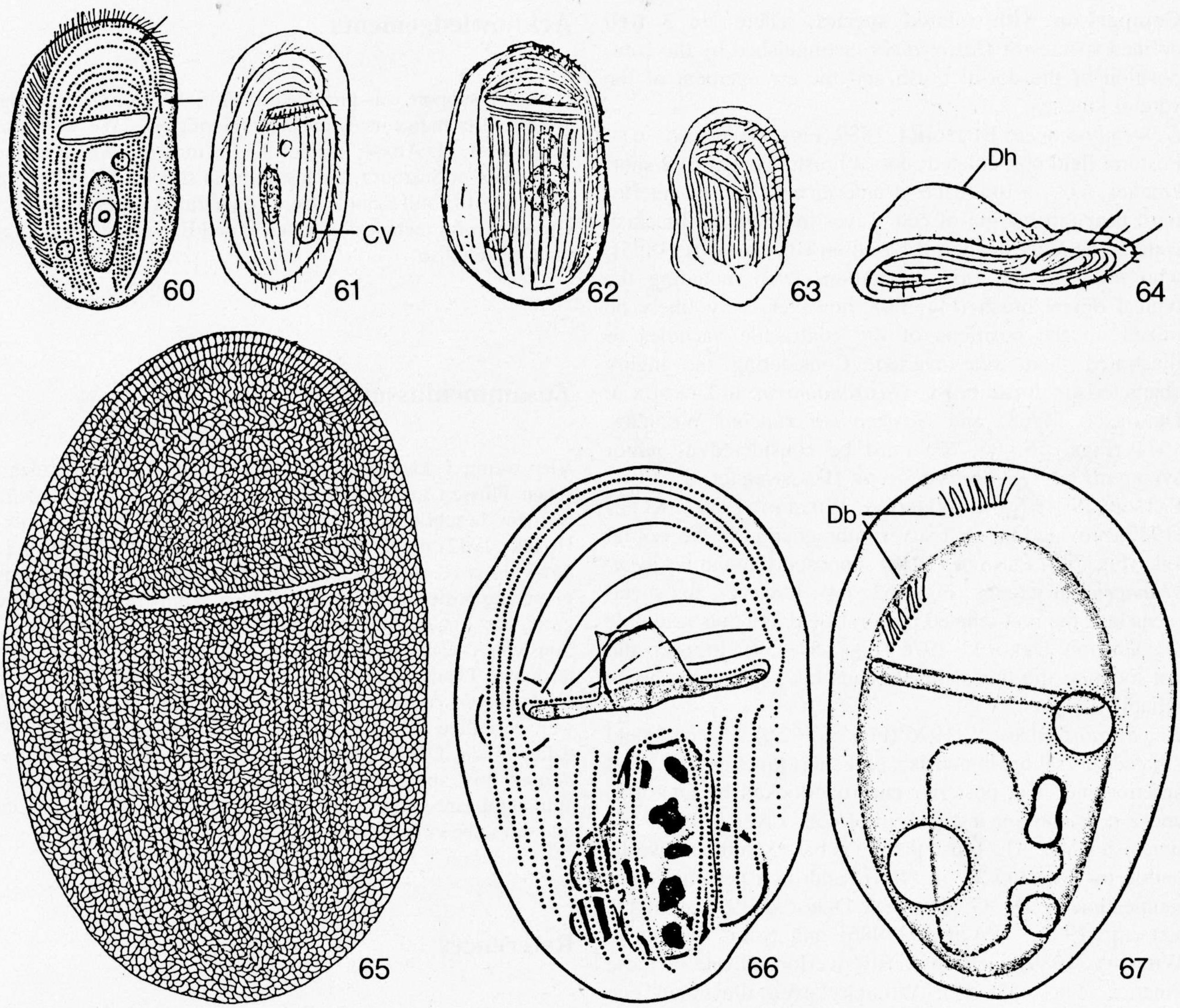






Figs. 53–56. *Gastronauta derouxi* (protargol impregnation; 56 from Deroux & Dragesco 1968). – 53, 54. Infraciliature of ventral and dorsal side of Madeiran population. – 55. Infraciliature of dorsal side of Kenyan population, 54 µm. Arrow marks refractile structure (cytopyge?). – 56. Infraciliature of ventral side, 72 µm. b = bundles of argyrophilic fibres, ci = circumoral kinety, Db = dorsal brush, Dh = dorsal hump, Ep = excretory pore of contractile vacuole, l = left kinety field, Ma = macronucleus, Mi = micronucleus, r = right kinety field.

Figs. 57–59. *Gastronauta clatratus* (Figs. 57, 58, from Deroux 1976b; 59, from Song Weibo & Wilbert 1989). – 57, 58. Morphology and infraciliature from life, nigrosin, and protargol preparations, 47 µm, 50 µm. – 59. Dorsal view from life and after protargol impregnation, 40 µm. Db_{1-4} = dorsal brush kineties 1–4.



Figs. 60–67. *Gastronauta membranaceus* (Figs. 60–64, from life; 65, dry silver nitrate impregnation; 66, 67, from life and protargol impregnation; 60, after BLOCHMANN 1895; 61, from KAHL 1931; 62–64, from PENARD 1922; 65, from KLEIN 1927; 66, 67, *G. runcina* from WILBERT 1971). – 60–64. Ventral and lateral views, 55 µm, 65 µm, ? µm, ? µm, ? µm. Arrows in Fig. 60 mark dorsal brush. – 65. Silverline system and infraciliature of ventral side, 70 µm. – 66, 67. Infraciliature of ventral and dorsal side, 60 µm. CV = contractile vacuole, Db = dorsal brush, Dh = dorsal hump.

kineties extend on right and anterior margin of cell. 4 (5–6 in Kenian population) praeoral kineties between right ciliary field and oral opeuing, and 3 short vertical kineties at left cell margin. Kineties of left field posteriorly shortened, slightly bent to left at circumoral kinety, leftmost row usually connected by loosely arranged basal bodies to leftmost vertical kinety (Figs. 47, 50, 53, 56).
Dorsal brush along anterior and anterior left dorsal margin, consists of 5–7 (8–10 in African population) evenly spaced groups (usually pairs, rarely triplets or singles) of 4 µm long cilia. Right of median, near mid-body, an argyrophilic structure, possibly the cytopyge (Figs. 46, 47, 52, 54, 55, 56).

Occurrence and ecology: *Gastronauta derouxi* occurred in a light reddish-brown soil grown with *Opuntia sp.* and tufts of grass in Madeira. It was also found in the upper layer of a heavily saline soil from the shore of Lake Baringo, Kenya. DEROUX & DRAGESCO (1968) collected it from wall and tree mosses near Roscoff, France. LEHLE (1992) shows a protargol impregnated specimen from a soil of the "Schwäbische Alb" (Germany). STOUT (e.g. 1961, 1970, determined as *G. membranaceus;* see below) found *G. derouxi* in the upper litter, the lower litter and the topsoil of lightly burnt sites in New Zealand and in soil samples from East Greenland (pH 6.6).

Comparison with related species: There are 3 well defined species of *Gastronauta* distinguished by the composition of the dorsal brush and the arrangement of the ventral kineties.

G. membranaceus BÜTSCHLI, 1889 (Figs. 60, 61, 65–67): Postoral field non-ciliated; dorsal brush consists of 2 short kineties, viz., a row each at anterior end and in anterior third near left margin of cell. Lives in fresh and brackish water. The identification is based on BLOCHMANN (1895), who provided the first illustration, even including the typical dorsal brush (Fig. 60); however, very likely he mixed up the positions of the contractile vacuoles or illustrated them side-inverted. Considering the highly characteristic dorsal brush, *Gastronauta sp.* in DEROUX & DRAGESCO (1968) and *Gastronauta runcina* WILBERT, 1971 (Figs. 56, 66, 67) must be considered as junior synonyms of *G. membranaceus (*FOISSNER et al. 1991; PÄTSCH 1974; SONG WEIBO & WILBERT 1989). KLEIN (1927) provided the first silver impregnation of the ventral side (Fig. 65). PENARD (1922) supposedly found *G. membranaceus* in mosses (Figs. 62–64); however, his specimens lack the non-ciliated postoral field and thus resemble *G. clatratus* DEROUX, 1976 (Figs. 57–59). PENARD did not mention the dorsal brush, thus his population cannot reliably assigned.

G. clatratus DEROUX, 1976 (Figs. 57–59): Postoral field ciliated; dorsal brush consists of 4 short kineties, viz., 1 at anterior end, 1 at posterior end (overlooked by DEROUX) and 2 near anterior left margin of cell. Lives in fresh and brackish water. The brush pattern is based on the reinvestigation by FOISSNER et al. (1991) and on a personal communication by Dr. G. DEROUX. DEROUX (1976b), JUTRCZENKI (1982), WILBERT (1986) and SONG WEIBO & WILBERT (1989) each obviously overlooked one of these kineties (Figs. 57–59); WILBERT even illustrated one kinety at the wrong cell margin.

Gastronauta derouxi nov. spec. (Figs. 45–56): Postoral field non-ciliated; dorsal brush consists of about 7 groups of evenly spaced, paired basal bodies along anterior dorsal margin. In moss and soil. DEROUX & DRAGESCO (1968) provided a description and illustrations (including four encystment stages and two stages of morphogenesis) of a moos dwelling *Gastronauta membranaceus* which obviously fits the diagnosis of *G. derouxi* (Fig. 56). Probably all soil records of *G. membranaceus* (e.g. BLATTERER & FOISSNER 1988; STOUT 1961, 1970) belong to *G. derouxi;* unfortunately, none is substantiated by an investigation of the dorsal brush. The Roscoff (France) population of *G. derouxi* differs from the type by having slightly more dorsal brush pairs (7–9) and more kineties in the right (12–13) and left (6) ciliary field; it is very similar to our African population (7–10 dorsal brush pairs, 5–6 preoral kineties, 13 and 5–6 kineties in the right and left ciliary field, respectively). Thus, we consider the French, the Madeiran and the Kenyan population as conspecific.

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Zusammenfassung

Vier wenig bekannte cyrtophoride Ciliaten aus österreichischen Flüssen und aus Böden von Australien und Madeira werden beschrieben. *Trithigmostoma srameki* (ŠRÁMEK-HUŠEK, 1952) unterscheidet sich von dem sehr ähnlichen *T. bavariensis* (KAHL, 1931) durch das limnische Habitat, das gerundete posteriore Ende des rechten Wimpernfeldes und die geringere Anzahl von Reusenstäben. Die Süßwasserpopulation von *Odontochlamys alpestris* FOISSNER, 1981 ist der terricolen Typuspopulation sehr ähnlich. Die Dorsalbürste von *Chilodonella convexa* KAHL, 1931 besteht meist nur aus 4 weit gestellten Cilien entlang des vorderen Randes; sie wird daher in die Gattung *Odontochlamys* versetzt. *Gastronauta derouxi* nov. spec. lebt in Moosen und Böden und hat etwa 7 Wimpernpaare entlang des vorderen Randes der Dorsalseite und ein unbewimpertes postorales Feld.

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