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Morphology and biometry of some soil hypotrichs (Protozoa, Ciliophora) from Europe and Japan

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CONTENTS

SYNOPSIS. The morphology and the infraciliature of 18 species of hypotrichous ciliates from various soils of Europe and Japan have been investigated by living observation and protargol staining. All species are characterized biometrically: *Holosticha islandica* nov. spec.; *H. sylvatica* Foissner, 1982; *Paruroleptus lepisma* Wenzel, 1953; *Birojimia terricola* nov. gen., nov. spec.; *Wallackia bujoreani* (Lepsi, 1951) nov. comb. (basionym: *Paraholosticha bujoreani* Lepsi, 1951); *Paraurostyla granulifera* nov. spec.; *Amphisiella polycirrata* nov. spec.; *A. quadrinucleata* nov. spec.; *Uroleptoides binucleata* Hemberger, 1985; *Hemisincirra inquieta* Hemberger, 1985; *H. vettersi* nov. spec.; *Terricirra matsusakai* nov. gen., nov. spec.; *Oxytricha islandica* nov. spec.; *O. lanceolata* Shibuya, 1930; *O. longigranulosa* nov. spec.; *Steinia muscorum* Kahl, 1932; *Urosoma octonucleata* nov. spec.; and *Euplotes corsica* nov. spec. Additionally, the ventral and dorsal infraciliature of the limnetic species *Laurentiella strenua* (Dingfelder, 1962) nov. comb. (basionym: *Paruroleptus strenuus* Dingfelder, 1962) is described. *Uroleptus muscorum* Kahl, 1932 is transferred to the new urostylid genus *Birojimia*: *B. muscorum* (Kahl, 1932) nov. comb. *Hemisincirra viridis* (Foissner, 1982) Foissner, 1984 and *H. livida* Berger & Foissner, 1987 are now included in the new oxytrichid genus *Terricirra*: *T. viridis* (Foissner, 1982) nov. comb. and *T. livida* (Berger & Foissner, 1987) nov. comb.

INTRODUCTION

Recently, we published the morphology of 18 species of hypotrichs from soils of Europe and Asia (Berger & Foissner, 1987). Some other new soil hypotrichs from these continents were described elsewhere (Foissner, 1986, 1987*a,b*; Berger & Foissner, 1988*a,b*). The present paper is concerned with the description of further hypotrichs from Austria, the Federal Republic of Germany, France, Iceland, Portugal, Spain and Japan.

MATERIALS AND METHODS

For the material see Table 1. The culture and staining methods were as given in Foissner (1979, 1982). The body shape of the living specimens was drawn from slides without cover slips. Details were studied on slightly to heavily squeezed individuals using an oil immersion objective (100 ×; eyepiece, 10 ×) and bright field illumination. Drawings of the protargol impregnated specimens were made with a camera lucida. One section of the scales in the drawings corresponds to 10μm. All counts and measurements were performed at a magnification of 1000 × (1 unit of the ocular micrometer = 1.4μm). The data in the Tables are based on protargol impregnated specimens. All measurements in μm. The statistical procedures are described in Sokal & Rohlf (1981). The following sample statistics were calculated: $\bar{x}$, arithmetic mean; M, median; SD, standard deviation; SE, standard error of the arithmetic mean; CV, coefficient of variation in %; Min, Max, minimum and maximum value; n, sample size.

The terminology is according to Kahl (1932), Borror (1972), Curds (1975), and Corliss & Lom (1985).

One slide of holotype specimens and 1 slide of paratype specimens of the new species and 1 neotype-slide of each other species described have been deposited in the British Museum (Natural History) in London. The reference numbers of the slides are shown in Table 1.

DESCRIPTIONS OF SPECIES

Holosticha islandica nov. spec.

DIAGNOSIS. *In vivo* about 80–100 × 25 μm, long ellipsoid. Subpellicular granules yellowish, spherical (< 0.5 μm). Usually 6–7 midventral pairs and 3–4 transverse cirri. 17 adoral membranelles and 16 macronuclear segments on average. 3 dorsal kineties.

Table 1. Localities of the populations and reference numbers of the type-slides (protargol silver impregnated) deposited in the British Museum (Natural History) in London

Species (Reference numbers)	Date	Locality
Amphisiella polycirrata 1988 : 2 : 1 : 1, holotype 1988 : 2 : 1 : 2, paratype	July 1985	Slightly redish-brown soil grown with *Opuntia ficus-indica* and tufts of grass (0 – 5 cm). pH = 4.8. Sea-level: *c.* 150 m. Garajan Kap, Madeira,Portugal.
Amphisiella quadrinucleata 1988 : 2: 1: 3 holotype 1988 : 2 :1: 4 paratype	20.3.1985	Yellowish soil with poorly decomposed needles. pH = 3.8. Sea-level: 10 – 20 m. Mea-Shima, Amakusa, Kumamoto Prefecture, Japan.
Birojimia terricola 1988 : 2: 1 : 5 holotype 1988 : 2: 1 : 6 paratype	6.4.1985	Brown soil of a deciduous forest with many fragments of leaves and roots. pH = 3.8. Sea-level: 5 – 10 m. Biro-Jima, Amakusa, Kumamoto Prefecture, Japan.
Euplotes corsica 1988 : 2 : 1: 7 hapantotype 1988 : 2 : 1 : 8 hapantotype 1988 : 2 : 1 : 9 parahapantotype	Summer 1985	Fine, grey soil of a saline pool on the base of a vineyard at Etang d'Urbino, Corsica, France.
Hemisincirra inquieta 1988 : 2 : 1: 10	8.8.1985	Litter and dark (volcanic) upper soil layer of a heath with dwarf shrubs (dominated by *Betula nana, Empetrum nigrum, Vaccinium uliginósum, Arctostáphylos úva-úrsi*). pH = 5.5. Sea-level: 120 m. Gooa Foss, Bardårdalur, North-Iceland.
Hemisincirra vettersi 1988 : 2 : 1 :11 holotype 1988 : 2 : 1 : 12 paratype	9.8.1985	Soil with tufts of *Alchemilla alpina* of a postglacial basalt desert. pH = 6.2. Sea-level: 340 m. Dettifoss, Neisland, Sökullsá a Fjellum, Iceland.
Holosticha islandica 1988 : 2 : 1 : 13 paratype	8.8.1985	See *Hemisincirra inquieta*.
Holosticha sylvatica 1988 : 2 : 1 : 14	20.3.1985	See *Amphisiella quadrinucleata*.
Laurentiella strenua		A protargol slide of this fresh-water species was kindly supplied by Dr J. Martin, Spain.
Oxytricha islandica 1988 : 2 : 1 : 15 holotype 1988 : 2 : 1 : 16 paratype	7.8.1985	Soil of a pasture with *Deschámpsia caespitósa* and moss, about 100 m far from the beach. pH = 5.8. Sea-level: 30 m. Peninsula Vatnsney 'Hvitserkur', Iceland.
Oxytricha lanceolata 1988 : 2 : 1 : 17	July 1985	Redish soil of a heath with grass. Sea-level: *c.* 1800 m. Pico de Arieiro, Madeira, Portugal.
Oxytricha longigranulosa 1988 : 2 : 1 : 18 holotype 1988 : 2 : 1 : 19 paratype	6.4.1985	Brown soil of a deciduous forest with many fragments of leaves and roots. pH = 3.5. Sea-level: 682 m. Mt. Kura-Take, Amakusa, Kumamoto Prefecture, Japan.
Paraurostyla granulifera 1988 : 2 : 1 : 20 holotype 1988 : 2 : 1 : 21 paratype	6.4.1985	Brown soil of a deciduous forest with many fragments of leaves and roots. pH = 4.8. Sea-level: 470 m. Mt. Ryu-Ga-Take, Amakusa, Kumamoto Prefecture, Japan.
Paruroleptus lepisma	July 1985	See *Amphisiella polycirrata*.
1988 : 2 : 1 : 22	29.10.1982	Upper soil layer (0 – 5 cm) of a salt-steppe in the so-called 'Hölle' in Seewinkel. Mull at the edge of a small salt lake about 100 m north-east of the Oberen Stinkersee. Sea-level: 115 m. Burgenland, Austria.
Steinia muscorum 1988 : 2 : 1 : 23	Autumn 1985	Litter (0 – 3 cm) of a beechforest. Bergheim, Salzburg, Austria.
Terricirra matsusakai 1988 : 4 : 10 : 1 holotype 1988 : 4 : 10 : 2 paratype	25.3.1985	Soil of a rice field of Kyokushi. pH = 4.5. Kumamoto Prefecture, Japan.
Uroleptoides binucleata 1988 : 2 : 1 : 24 1988 : 2 : 1 : 25	7.8.1986	Litter and upper soil layer of a deciduous forest with *Pinus sylvéstris*. pH = 4.2. Berlin, FRG.
Urosoma octonucleata 1988 : 2 : 1 : 26 holotype 1988 : 2 : 1 : 27 paratype	July 1985	See *Amphisiella polycirrata*.
Wallackia bujoreani 1988 : 2 : 1 : 28 neotype	Summer 1985	Sandy brown soil with litter of grass, 10 m away from a small river. pH = 4.1. Sea-level: 500 – 600 m. Near the reservoir Ajaccio, Corsica, France.

TYPE LOCATION. Soil of a heath with dwarf shrubs, Gooa Foss, Bardårdalur, North-Iceland.

DESCRIPTION (Figs 1–4, Tables 1, 2). Left and right body margin straight, both ends rounded. About 2:1 flattened. Macronuclear segments *in vivo* 6–8 × 3–4 µm, most of them lying distinctly left of the median, 2–3 pieces are always situated right of the median at about the level of the cytostome. Contractile vacuole in about the middle of the cell, during diastole with inconspicuous channels. Subpellicular granules irregularly and loosely arranged. Cytoplasm colourless, with some 1–4 µm large, yellowish fat globules and 5–8 µm large food vacuoles with bacteria and fungal spores.

Adoral zone of membranelles about 28% of body length, bases of the largest membranelles *in vivo* *c.* 5 µm wide. Buccal area flat and narrow. Bases of the frontal cirri only slightly enlarged. Midventral rows terminate in about the middle of the cell. Marginal rows distinctly separated

Table 2. Biometrical characterization of *Holosticha islandica* (upper line) and *Holosticha sylvatica* (lower line)

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	74.5	75.0	6.0	1.670	8.1	66.0	86.0	13
	127.0	126.0	9.0	2.724	7.1	112.0	140.0	11
Body, width	20.5	21.0	2.7	0.739	13.0	16.0	25.0	13
	52.0	49.0	8.3	2.512	16.0	43.0	70.0	11
Adoral membranelles, number	17.5	17.0	0.8	0.215	4.4	16.0	19.0	13
	44.1	44.0	3.7	1.099	8.3	39.0	49.0	11
Adoral zone of membranelles, length	20.6	21.0	0.7	0.180	3.2	19.0	21.0	13
	44.5	43.0	2.9	0.888	6.6	40.0	49.0	11
Macronuclear segments, number	16.0	16.0	0.8	0.226	5.1	14.0	17.0	13
	56.0	56.0	4.1	1.228	7.3	50.0	61.0	11
Posterior macronuclear segment, length	5.6	6.0	1.1	0.311	20.0	4.0	7.0	13
	6.1	7.0	1.5	0.436	23.7	4.0	8.0	11
Posterior macronuclear segment, width	3.2	3.0	0.6	0.166	18.5	3.0	5.0	13
	4.1	4.0	0.7	0.211	17.1	3.0	5.0	11
Micronuclei, number	2.2	2.0	1.6	0.451	75.5	1.0	7.0	13
	2.2	2.0	0.4	0.122	18.5	2.0	3.0	11
Posterior micronucleus, length	1.6	1.6	0.1	0.037	8.5	1.4	1.8	13
	3.0	3.0	0	0	0	3.0	3.0	11
Posterior micronucleus, width	1.5	1.5	0.1	0.021	5.1	1.4	1.6	13
	3.0	3.0	0	0	0	3.0	3.0	11
Left marginal row, number of cirri	17.9	18.0	1.6	0.436	8.8	14.0	20.0	13
	37.2	39.0	4.3	1.292	11.5	31.0	43.0	11
Right maringal row, number of cirri	17.9	18.0	1.9	0.532	10.8	15.0	21.0	13
	40.9	42.0	4.7	1.417	11.5	30.0	47.0	11
Left midventral row, number of cirri[1]	5.5	6.0	0.5	0.144	9.4	5.0	6.0	13
	16.7	16.5	1.5	0.444	8.8	14.5	19.5	11
Right midventral row, number of cirri	6.7	7.0	1.0	0.263	14.2	5.0	8.0	13
	–	–	–	–	–	–	–	0
Frontal cirri, number[2]	3.0	3.0	0	0	0	3.0	3.0	13
	7.0	7.0	0	0	0	7.0	7.0	11
Buccal cirri, number	1.0	1.0	0	0	0	1.0	1.0	13
	1.0	1.0	0	0	0	1.0	1.0	11
Frontoterminal cirri, number	2.0	2.0	0	0	0	2.0	2.0	13
	2.0	2.0	0	0	0	2.0	2.0	11
Ventral cirri near the transverse cirri, number	–	–	–	–	–	–	–	0
	2.0	2.0	0	0	0	2.0	2.0	11
Transverse cirri, number	3.6	4.0	0.7	0.180	18.0	2.0	4.0	13
	8.3	8.0	1.1	0.333	13.3	6.0	10.0	11
Caudal cirri, number	1.5	2.0	0.7	0.183	42.9	0	2.0	13
	4.0	4.0	0.6	0.191	15.8	3.0	5.0	11
Dorsal kineties, number	3.0	3.0	0	0	0	3.0	3.0	13
	5.0	5.0	0	0	0	5.0	5.0	11
Distance 1[3]	–	–	–	–	–	–	–	0
	88.9	88.0	5.3	1.609	6.0	81.0	98.0	11

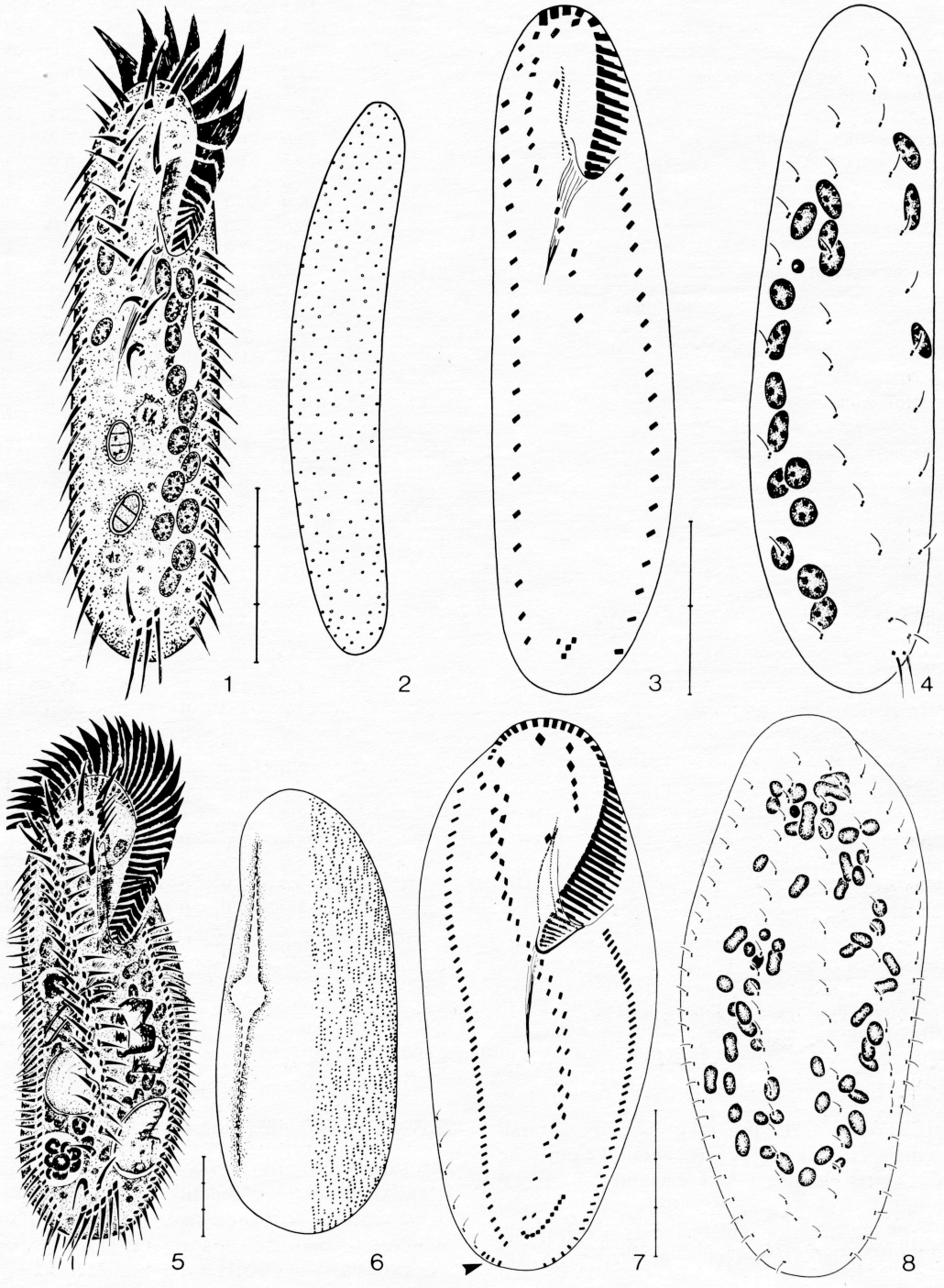
[1] For *H. sylvatica* the number of midventral pairs is listed
[2] In *H. sylvatica* the cirri behind the left frontal cirrus are included.
[3] Distance 1, distance between the anterior end of the cell and the posterior end of the midventral rows.

posteriorly, cirri *in vivo c.* 10 µm long. Usually a small cirrus (ventral cirrus ?) near the *in vivo* about 14 µm long transverse cirri. Dorsal kineties 1 and 2 slightly shortened anteriorly, kineties 2 and 3 usually with a small caudal cirrus each. Left of the anterior end of kinety 3 constantly a single basal body pair. Dorsal cilia *in vivo c.* 3 µm long.

COMPARISON WITH RELATED SPECIES. *Holosticha islandica* resembles *H. tetracirrata* Buitkamp & Wilbert, 1974, which has 2 inconspicuous caudal cirri too (Foissner, 1982). However, it differs in some important biometrical characters *viz.* number of adoral membranelles, dorsal kineties, macronuclear segments, midventral pairs and by the possession of subpellicular granules from *H. tetracirrata*.

Holosticha sylvatica Foissner, 1982

DISCUSSION AND ADDITIONAL OBSERVATIONS (Figs 5–8, Tables 1, 2). Although the population from Japan is of the same size as the type material (Foissner, 1982) it has a distinctly higher number of macronuclear segments (Japanese population x̄ = 56, extremes = 50–61; type material 32, 28–36), adoral membranelles (44, 39–49; 35, 33–38), right (42, 30–47; 32, 28–40) and left marginal cirri (37, 31–43; 31, 25–35), pairs of midventral cirri (17, 14.5–19.5; 13, 10–15), cirri behind the left frontal cirrus (4; 1–2), and caudal cirri (4, 3–5; 2). Borror & Wicklow (1983) observed 2–5 cirri behind the left frontal cirrus and 12–19 pairs of midventral cirri in 5 populations of this species. Because of the obviously high intraspecific variability of these characters we give a complete biometrical



Figs 1–4 *Holosticha islandica* from life (Figs 1, 2) and after protargol impregnation (Figs 3, 4). **1, 2** Ventral and lateral view. Figure 2 shows the arrangement of the yellowish subpellicular granules. **3, 4** Infraciliature in ventral and dorsal view.

Figs 5–8 *Holosticha sylvatica* from life (Figs 5, 6) and after protargol impregnation (Figs 7, 8). **5, 6** Ventral and dorsal view. The right side of Figure 6 shows the arrangement of the colourless subpellicular granules. **7, 8** Infraciliature in ventral and dorsal view. Arrow head, caudal cirri.

Table 3 Biometrical characterization of *Paruroleptus lepisma*

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	132.6	130.0	8.1	2.238	6.1	120.0	147.0	13
Body, width	38.9	39.0	3.5	0.964	8.9	34.0	46.0	13
Adoral membranelles, number	33.0	33.0	1.9	0.519	5.7	29.0	36.0	13
Adoral zone of membranelles, length	36.2	36.0	2.5	0.699	7.0	31.0	41.0	13
Macronuclear segments, number	2.0	2.0	0	0	0	2.0	2.0	13
Posterior macronuclear segment, length	17.5	18.0	2.4	0.676	14.0	13.0	21.0	13
Posterior macronuclear segment, width	8.2	8.0	0.9	0.249	11.0	7.0	10.0	13
Distance between the macronuclear segments	2.7	3.0	2.0	0.548	73.3	0	7.0	13
Micronuclei, number	2.3	2.0	0.6	0.175	27.3	1.0	3.0	13
Posterior micronucleus, length	4.0	4.0	0.5	0.127	11.4	3.0	5.0	13
Posterior micronucleus, width	2.9	3.0	0.3	0.087	11.1	2.0	3.0	13
Left marginal row, number of cirri	28.8	28.0	1.8	0.496	6.2	26.0	32.0	13
Right marginal row, number of cirri	27.5	28.0	1.9	0.526	6.9	24.0	30.0	13
Left midventral row, number of cirri	18.9	19.0	1.9	0.512	9.8	15.0	22.0	13
Right midventral row, number of cirri	19.5	19.0	1.8	0.501	9.3	16.0	23.0	13
Distance 1[1]	109.9	110.0	7.5	2.066	6.8	98.0	122.0	13
Frontal cirri, number[2]	4.0	4.0	0	0	0	4.0	4.0	13
Buccal cirri, number	1.0	1.0	0	0	0	1.0	1.0	13
Frontoterminal cirri, number	3.0	3.0	0	0	0	3.0	3.0	13
Ventral cirri near the transverse cirri, number	1.0	1.0	0	0	0	1.0	1.0	13
Transverse cirri, number	4.0	4.0	0	0	0	4.0	4.0	13
Distance 2[3]	8.4	8.0	1.8	0.500	21.5	7.0	13.0	13
Caudal cirri, number	3.0	3.0	0	0	0	3.0	3.0	13
Dorsal kineties, number	5.0	5.0	0	0	0	5.0	5.0	13

[1]Distance 1, distance between the anterior end of the cell and the posterior end of the midventral rows.
[2]The cirrus behind the right frontal cirrus is included.
[3]Distance 2, distance between the posterior transverse cirrus and the posterior end of the cell.

characterization of the Japanese population and describe some additional and deviating observations.

Close beneath the pellicle there are very many, less than 0.5 µm diameter colourless subpellicular granules, arranged in short longitudinal rows. Cytoplasm filled with 2–5 µm large, fat globules, many food vacuoles containing globular cyanobacteria, fungal spores, and ciliates (*Colpoda inflata*), and some pieces of quartz. There is always an accumulation of fat globules in the frontal area. Cytoproct left, near the posterior end of the cell. Movement rapid.

Bases of the largest adoral membranelles *in vivo c.* 8 µm wide. Left marginal row terminates at the posterior end of the cell, marginal cirri about 13 µm long. Midventral rows terminate shortly before the transverse cirri. Caudal cirri exist at the posterior end of the dorsal kinety 5 only, a feature which is recognizable from the original description too (Foissner, 1982). This unusual position is also described in *Keronella gracilis* Wiackowski, 1985.

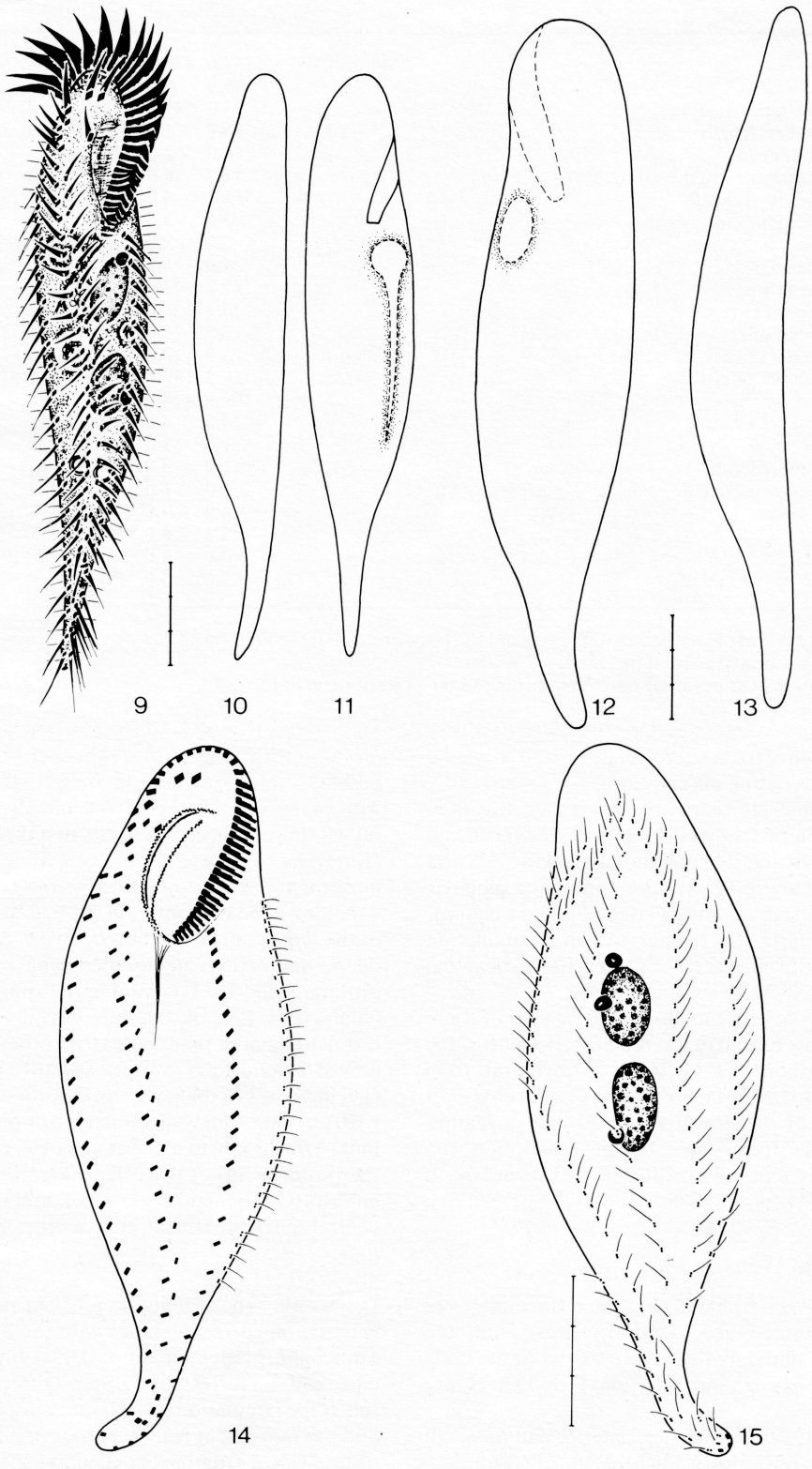
Paruroleptus lepisma Wenzel, 1953

REDESCRIPTION (Figs 9–15, Tables 1, 3). The infraciliatures of the 2 populations studied are identical. Thus, from the population of Burgenland only the *in vivo* aspect of the body shape and some deviating and additional characters are described.

In vivo 160–200 × 45–55 µm, slender, anterior end rounded, conspicuously tapered posteriorly. Slightly (10–20%) contractile, very flexible. Not or slightly flattened dorso-ventrally. Macronuclear segments *in vivo c.* 22–25 × 11–14 µm, lying slightly left of the median of the cell. Micronuclei spherical (4 µm, Madeira) or ellipsoid (8 × 5 µm, Burgenland). Contractile vacuole close behind the adoral zone of membranelles, during diastole with a posterior channel. Subpellicular granules absent. Cytoplasm colourless, especially in the posterior part with many crystals. Food vacuoles 5–15 µm, with bacteria, fungal spores, flagellates, cysts of naked amoebae, testaceans (*Euglypha* sp.), and ciliates. Slow to moderately fast movement.

Adoral zone of membranelles *c.* 27% of body length, bases of the largest membranelles *in vivo* 7–8 µm wide. Buccal area deep, undulating membranes long, distinctly bent in the protargol slides. 3 frontal cirri and buccal cirrus slightly enlarged. Bases of the left cirri of the midventral pairs distinctly smaller than those of all other cirri. Midventral rows almost extend to posterior. Distance between the marginal cirri increases in the posterior direction. Marginal cirri *in vivo c.* 20 µm long. Transverse cirri inconspicuous, *in vivo c.* 22 µm long. Dorsal kineties 1–3 not shortened, with caudal cirri at the posterior tip of the cell, rows 4 and 5 slightly shortened anteriorly. The middle part of kinety 1 extends onto the ventral surface. Dorsal cilia motile, *in vivo* about 5–7 µm long.

DISCUSSION. The identification of our population as *P. lepisma* is based on correspondence with the body shape, the ventral infraciliature, the number of dorsal kineties and length of the cilia, and the terrestrial habitat. Differences exist in the body size (type population 90–100 µm; our population 160–200 µm) and the movement (rapid; slow to moderately fast). It can be distinguished from the congeneric species by the body size, the number of transverse cirri, dorsal kineties, and macronuclear segments, and the habitat (Kowalewski, 1882; Stokes, 1886; Kahl, 1932; Horváth, 1933; Wang & Nie, 1935; Gelei, 1954; Reuter, 1961; Vuxanovici, 1963; Grolière, 1975; Foissner, 1980, 1982, 1984; Berger & Foissner, 1987).



Figs 9–15 *Paruroleptus lepisma* from life (Figs 9–13) and after protargol impregation (Figs 14, 15). **9–11** Ventral and lateral views of the population from Madeira. **12, 13** Dorsal and lateral view of the population from Burgenland. **14, 15** Infraciliature in ventral and dorsal view of the population from Madeira.

Table 4 Biometrical characterization of *Birojimia terricola*

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	180.1	186.0	26.7	7.577	14.6	126.0	215.0	12
Body, width	37.2	36.5	3.8	1.107	10.3	32.0	43.0	12
Adoral membranelles, number	39.1	40.0	3.1	0.883	7.8	35.0	43.0	12
Adoral zone of membranelles, length	54.6	55.0	5.2	1.495	9.5	46.0	63.0	12
Macronuclear segments, number	60.7	61.0	3.5	0.995	5.7	55.0	65.0	12
Posterior macronuclear segment, length	5.6	6.0	1.2	0.358	22.2	4.0	7.0	12
Posterior macronuclear segment, width	4.1	4.0	0.8	0.229	19.4	3.0	5.0	12
Posterior micronucleus, length	3.5	3.5	0.6	0.224	15.6	3.0	4.0	6
Posterior micronucleus, width	2.7	3.0	0.5	0.211	19.4	2.0	3.0	6
Left marginal row, number of cirri	47.3	48.0	4.7	1.345	9.8	40.0	53.0	12
Right marginal row 1, number of	41.2	40.5	5.5	1.590	13.4	32.0	49.0	12
cirri/distance[1]	14.6	15.0	2.5	0.733	17.4	8.0	18.0	12
Right marinal row 2, number of	28.9	29.0	5.0	1.433	17.2	22.0	38.0	12
cirri/distance[1]	44.3	43.5	11.6	3.354	26.2	29.0	63.0	12
Right marginal row 3, number of	19.1	20.0	4.7	1.357	24.6	13.0	27.0	12
cirri/distance[1]	70.3	75.0	13.9	4.023	19.8	35.0	88.0	12
Right marginal row 4, number of	6.9	7.0	3.4	0.973	48.7	3.0	13.0	12
cirri/distance[1]	135.4	139.0	27.6	7.955	20.3	92.0	200.0	12
Midventral pairs, number/distance[2]	13.2	13.0	2.2	0.619	16.3	10.5	16.5	12
	107.2	106.0	18.3	5.291	17.1	75.0	133.0	12
Enlarged frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	12
Buccal cirri, number	1.0	1.0	0	0	0	1.0	1.0	12
Frontoterminal cirri, number	1.8	2.0	0.7	0.207	39.1	0	3.0	12
Ventral cirri near the transverse cirri, number	1.8	2.0	0.5	0.131	25.8	1.0	2.0	12
Transverse cirri, number	5.2	5.0	0.8	0.241	16.2	4.0	6.0	12
Caudal cirri, number	3.6	3.0	1.6	0.466	44.0	2.0	7.0	12

[1]For the designation of the right marinal rows see Figure 17. Upper line, number of cirri; lower line, distance between the anterior end of the cell and the anterior cirrus.
[2]Upper line, number of midventral pairs; lower line, distance between the anterior end of the cell and the posterior end of the midventral rows.

BIROJIMIA nov. gen.

DIAGNOSIS. Slender, posteriorly converging Urostylidae with 1 left and 2 or more right marginal rows. 3 slightly to distinctly enlarged frontal cirri. Transverse and caudal cirri present.

TYPE-SPECIES. *Birojimia terricola* nov. spec.

COMPARISON WITH RELATED GENERA. *Birojimia* differs from *Uroleptus* Ehrenberg, 1832a, and *Paruroleptus* Kahl, 1932 by having more than 1 right marginal row. It can be distinguished from *Urostyla* Ehrenberg, 1832*b* by the slender, posteriorly converging body shape, the lower number of frontal cirri, and especially by its single left marginal row (Kahl, 1932; Borror & Wicklow, 1983).

The second species which has to be included in the new genus is *Uroleptus muscorum* Kahl, 1932: *Birojimia muscorum* (Kahl, 1932) nov. comb. This is evident from the redescription of Foissner (1982), who combined it with *Paruroleptus*.

The successive reduction of the number of cirri in the right marginal rows of *B. terricola* strongly supports the idea of Borror (1979) and Berger *et al.* (1985) that marginal rows and dorsal kineties are very probably homonomous structures.

Birojimia terricola nov. spec.

DIAGNOSIS. *In vivo* about 155 × 40 µm. Midventral rows terminate roughly in the middle of the cell. About 6 right marginal rows, successively shortened anteriorly from left to right. 39 adoral membranelles, 5 transverse cirri, and 61 macronuclear segments on average.

TYPE LOCATION. Soil in Biro-Jima, Amakusa, Kumamoto Prefecture, Japan.

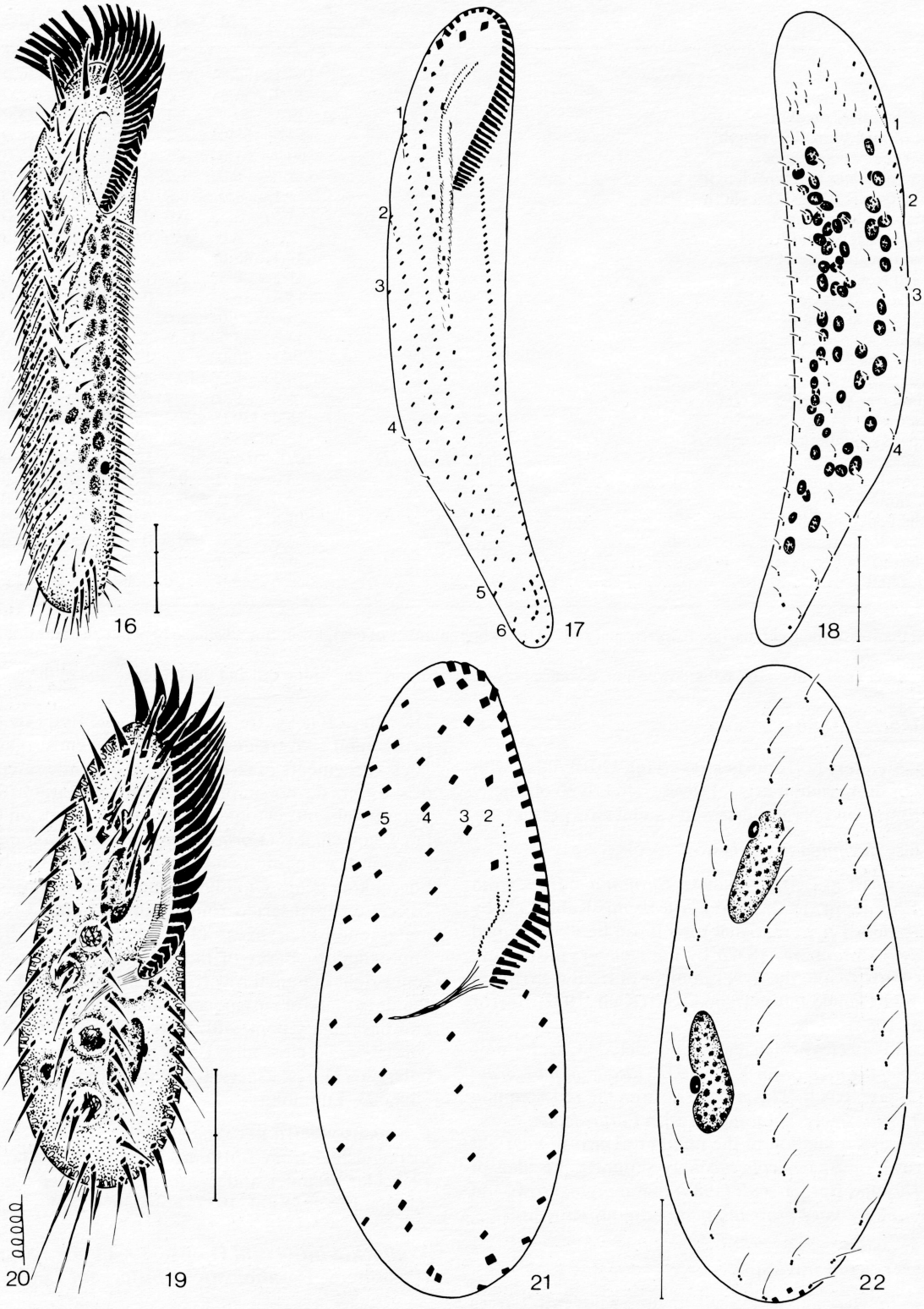
DESCRIPTION (Figs 16–18, Tables 1, 4). Body slender, slightly twisted and converging posteriad. Both ends rounded. Macronuclear segments *in vivo* 6–7 × 4–5 µm, micronuclei *in vivo c.* 6 × 4 µm, do not impregnate with protargol. Subpellicular granules absent, cytoplasm colourless. Feeds on fungi, flagellates, and ciliates (*Vorticella astyliformis, Colpoda fastigata*).

Adoral zone of membranelles *c.* 30% of body length, buccal area deep. Undulating membranes long, slightly bent. Buccal cirrus inserted roughly in the middle of the paroral membrane. Pharyngeal fibres conspicuous after protargol impregnation. Bases of the frontal cirri distinctly enlarged. Inner right marginal row (row 1) not shortened, extends onto the dorso-lateral surface anteriorly. Rows 2–6 consist of cirri and basal body pairs with typical dorsal cilia. Rows 5 and 6 consist of 2–3 cirri only. Bases of the transverse cirri scarcely enlarged. Dorsal kinety 1 usually with 2 caudal cirri. Dorsal cilia *c.* 3–4 µm long.

COMPARISON WITH RELATED SPECIES. The new species can be distinguished from *Birojimia muscorum* by the lack of subpellicular granules and the distinctly higher number of right marginal rows (Kahl, 1932; Foissner, 1982).

Wallackia bujoreani (Lepsi, 1951) nov. comb. (basionym: ***Paraholosticha bujoreani*** Lepsi, 1951)

REDESCRIPTION (Figs 19–22, Tables 1, 5). *In vivo* about 70 × 25 µm, ellipsoid, body margins converging anteriad, both ends rounded. Macronuclear segments lying distinctly left of the median, with small chromatin bodies and adjacent micronuclei. Contractile vacuole in about the middle of the cell, distinctly displaced inwards, positioned dorsally at the level of the proximal part of the adoral zone of membranelles.



Figs 16–18 *Birojimia terricola* from life (Fig. 16) and after protargol impregnation (Figs 17, 18). **16** Ventral view. **17, 18** Infraciliature in ventral and dorsal view. 1–6, right marginal rows 1–6.

Figs 19–22 *Wallackia bujoreani* from life (Figs 19, 20) and after protargol impregnation (Figs 21, 22). **19** Ventral view. **20** Colourless, short ellipsoid extrusomes close beneath the pellicle. **21, 22** Infraciliature in ventral and dorsal view. 2–5, frontoventral rows 2–5.

Table 5 Biometrical characterization of *Wallackia bujoreani*

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	67.4	67.0	7.7	2.309	11.4	52.0	80.0	11
Body, width	24.4	22.0	5.1	1.527	20.8	17.0	36.0	11
Adoral membranelles, number	25.3	25.0	1.4	0.407	5.3	23.0	27.0	11
Adoral zone of membranelles, length	33.8	35.0	3.3	0.980	9.6	25.0	36.0	11
Macronuclear segments, number	2.0	2.0	0	0	0	2.0	2.0	11
Posterior macronuclear segment, length	12.4	12.0	2.0	0.607	16.3	10.0	17.0	11
Posterior macronuclear segment, width	4.7	4.0	1.0	0.304	21.3	4.0	7.0	11
Micronuclei, number	2.0	2.0	0	0	0	2.0	2.0	11
Posterior micronucleus, length	2.6	3.0	0.5	0.161	20.3	1.8	3.0	11
Posterior micronucleus, width	1.4	1.5	0.3	0.091	21.4	1.0	2.0	11
Left marginal row, number of cirri	8.9	9.0	0.8	0.251	9.3	8.0	10.0	11
Right marginal row, number of cirri	10.5	10.5	1.1	0.342	10.3	9.0	12.0	10
Frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	9
Frontoventral rows, number[1]	4.0	4.0	0	0	0	4.0	4.0	11
Frontoventral row 2, number of cirri[1]	2.2	2.0	0.4	0.133	19.2	2.0	3.0	10
Frontoventral row 3, number of cirri[1]	3.0	3.0	0.5	0.149	15.7	2.0	4.0	10
Frontoventral row 4, number of cirri[1]	11.8	12.0	1.4	0.423	11.9	10.0	14.0	11
Frontoventral row 5, number of cirri[1]	13.2	13.0	1.3	0.377	9.5	11.0	15.0	11
Caudal cirri, number	3.0	3.0	0	0	0	3.0	3.0	7
Dorsal kineties, number	3.0	3.0	0	0	0	3.0	3.0	11

[1]For the designation of the frontoventral rows see Figure 21. Frontoventral row 1 is not included.

Table 6. Biometrical characterization of *Laurentiella strenua*

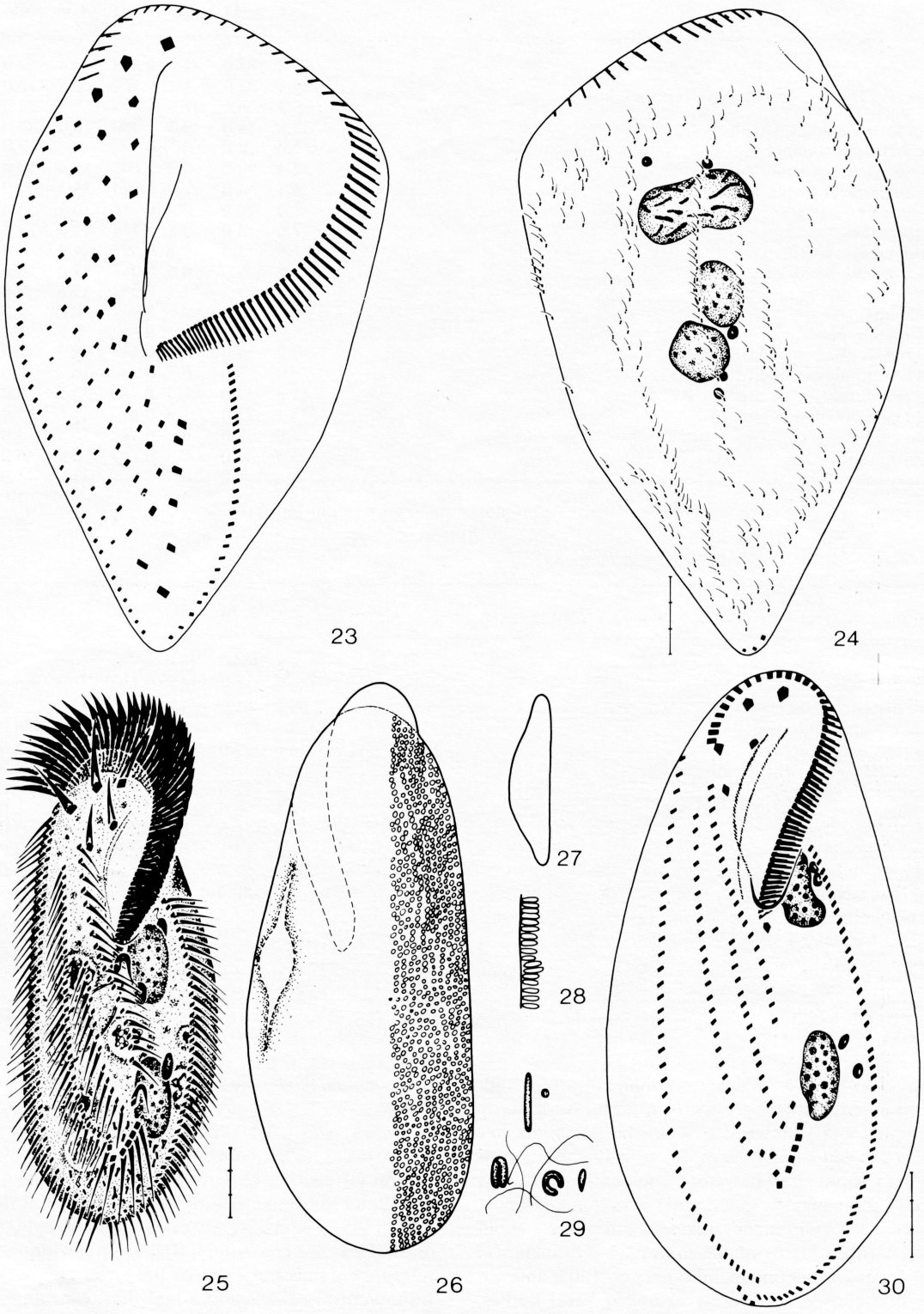
Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	268.6	260.0	28.7	8.651	10.7	240.0	325.0	11
Body, width	159.6	155.0	16.6	4.995	10.4	140.0	196.0	11
Adoral membranelles, number	65.8	65.0	1.9	0.569	2.9	64.0	70.0	11
Adoral zone of membranelles, length	134.3	130.0	9.5	2.870	7.1	120.0	150.0	11
Macronuclear segments, number	4.6	4.0	1.8	0.529	38.6	2.0	7.0	11
Posterior macronuclear segment, length	36.1	32.0	11.7	3.541	32.5	20.0	56.0	11
Posterior macronuclear segment, width	22.4	22.0	6.6	1.974	29.3	11.0	32.0	11
Micronuclei, number	7.5	6.0	7.1	2.129	94.7	2.0	24.0	11
Posterior micronucleus, length	3.8	3.5	0.7	0.223	19.3	3.0	5.6	11
Posterior micronucleus, width	3.5	3.5	0.4	0.126	11.8	3.0	4.2	11
Left marginal row, number of cirri	28.8	29.0	1.7	0.501	5.8	27.0	32.0	11
Right marinal row, number of cirri	39.7	40.0	1.9	0.574	4.8	37.0	42.0	11
Frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	11
Frontoventral rows (including buccal row), number	5.8	6.0	0.9	0.263	15.0	5.0	7.0	11
Transverse cirri, number	5.6	5.0	0.8	0.244	14.4	5.0	7.0	11
Caudal cirri, number	3.0	3.0	0	0	0	3.0	3.0	11

Extrusomes colourless, c. 1.5 μm in diameter, ellipsoid, irregularly arranged, impregnate with protargol. Cytoplasm colourless, with some yellowish, *c.* 4 μm large cytoplasmic crystals and some food vacuoles (5–7 μm in diameter) containing bacteria. Rapid jerky movement, sometimes becoming stationary for a moment.

Adoral zone of membranelles '*Gonostomum*-like', about 50 % of body length, bases of the largest membranelles *in vivo c.* 4 μm wide. Undulating membranes short, the anterior (endoral ?) one consists of loosely arranged basal bodies. Anteriormost cirrus of the frontoventral rows 1–3 slightly enlarged. Frontoventral rows 2 and 3 restricted to the frontal area, frontoventral rows 4 and 5 about body length, the posterior 2 cirri of each row slightly separated. Right marginal row shorter than the frontoventral row 5, marginal cirri *in vivo c.* 12 μm long. Dorsal kinety 1 slightly shortened anteriorly, dorsal cilia *in vivo c.* 4 μm long. Caudal cirri conspicuous, *in vivo* about 20 μm long, 1 cirrus on each dorsal kinety.

COMPARISON WITH RELATED SPECIES. The body shape, the ventral infraciliature, the extrusomes, and the habitat of our population agree very well with the original description of Lepsi (1951), which is, however, based on living observations only. *Wallackia bujoreani* differs from the limnetic species *W. schiffmanni* Foissner, 1976 by the lower number of cirri in the frontoventral rows 2 and 3 and the lower number of dorsal kineties as well as in the shape and size of the extrusomes.

Wallackia Foissner, 1976 is probably closely related to the genus *Kahliella* Corliss, 1960, which has a very similiar arrangement of the 5 frontoventral rows but no caudal cirri (Berger & Foissner 1987, 1988*c*). A close relationship to *K. acrobates* (Horváth, 1932) Corliss, 1960 was already mentioned by Lepsi (1951). *Wallackia* differs from



Figs 23, 24 *Laurentiella strenua*. Infraciliature in ventral and dorsal view after protargol impregnation.

Figs 25–30 *Paraurostyla granulifera* from life (Figs 25–28), after methylgreen-pyronin staining (Fig. 29), and after protargol impregnation (Fig. 30). **25–27** Ventral, dorsal, and lateral view. The right side of Figure 26 shows the arrangement of the colourless subpellicular granules. **28, 29** Extrusomes. **30** Infraciliature in ventral view.

Table 7 Biometrical characterization of *Paraurostyla granulifera*

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	211.9	204.0	17.4	6.592	8.2	195.0	240.0	7
Body, width	92.7	92.0	12.7	4.804	13.7	70.0	112.0	7
Adoral membranelles, number	59.9	60.0	3.2	1.223	5.4	55.0	65.0	7
Adoral zone of membranelles, length	84.0	84.0	5.4	2.035	6.4	73.0	90.0	7
Macronuclear segments, number	2.0	2.0	0	0	0	2.0	2.0	7
Macronuclear segments, distance between	35.0	35.0	4.4	3.651	12.5	27.0	39.0	7
Posterior macronuclear segment, length	26.1	24.0	4.0	1.519	15.4	22.0	34.0	7
Posterior macronuclear segment, width	13.9	14.0	0.9	0.340	6.5	13.0	15.0	7
Micronuclei, number	4.1	4.0	1.1	0.404	25.8	3.0	6.0	7
Posterior micronucleus, length	5.8	6.0	0.9	0.341	15.5	4.0	7.0	7
Posterior micronucleus, width	3.4	3.0	0.5	0.202	15.6	3.0	4.0	7
Left marginal row, number of cirri	48.0	47.0	5.3	1.988	11.0	40.0	56.0	7
Right marginal row, number of cirri	40.0	40.0	1.8	0.690	4.6	38.0	43.0	7
Frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	7
Buccal cirri, number	1.0	1.0	0	0	0	1.0	1.0	7
Cirri behind the right frontal cirrus, number	1.0	1.0	0	0	0	1.0	1.0	7
Frontoventral rows, number	3.0	3.0	0	0	0	3.0	3.0	7
Left frontoventral row, number of cirri	18.3	19.0	2.4	0.918	13.3	15.0	22.0	7
Middle frontoventral row, number of cirri	14.0	13.0	2.0	0.756	14.3	12.0	18.0	7
Right frontoventral row, number of cirri	31.1	30.0	1.7	0.634	5.4	30.0	34.0	7
Postoral ventral cirri, number	1.4	1.0	0.5	0.202	37.4	1.0	2.0	7
Ventral cirri near the transverse cirri, number	2.0	2.0	0	0	0	2.0	2.0	7
Transverse cirri, number	7.0	7.0	0.6	0.218	8.2	6.0	8.0	7
Distance 1[1]	30.0	28.0	6.7	2.562	22.3	21.0	39.0	7
Caudal cirri, number	3.0	3.0	0	0	0	3.0	3.0	7

[1]Distance 1, distance between the posterior transverse cirrus and the posterior end of the cell.

Trachelochaeta Šrámek-Hušek, 1954 by the lack of distinct transverse cirri.

Laurentiella strenua (Dingfelder, 1962) nov. comb. (basionym: ***Paruroleptus strenuus*** Dingfelder, 1962)

DISCUSSION AND ADDITIONAL OBSERVATIONS (Figs 23, 24, Tables 1, 6). Neither Fedriani *et al.* (1976) nor Martin *et al.* (1983) compared *L. acuminata* (Fedriani, Martin & Perez-Silva, 1976) with *Paruroleptus strenua* described by Dingfelder (1962) and redescribed by Czapik & Jordan (1976). There are some differences between the descriptions of *L. acuminata* and *L. strenua*, as in the number of macronuclear segments and frontoventral rows. However, both characters show a high variability (see Table 6), which suggests that they should not be used to separate species. Thus, in our opinion *L. acuminata* is a junior synonym of *L. strenua*.

The generic classification of this conspicuous species is still uncertain and can probably be discussed successfully only after the description of the type-species of the closely related genus *Onychodromus* Stein, 1859, *O. grandis* Stein, 1859 (Stein 1859*a,b*; Foissner *et al.*, 1987; Foissner, unpublished).

Here we give a biometrical characterization and line drawings of the ventral and dorsal infraciliature of the type-population of *L. acuminata*, kindly supplied by Dr J. Martin (University of Cordoba, Spain).

Paraurostyla granulifera nov. spec.

DIAGNOSIS. *In vivo* 170–230 × 70–100 µm. Perpendicular to the pellicle very many *c.* 2 × 1 µm large, colourless subpellicular granules (extrusomes). 60 adoral membranelles and 7 considerably anteriad displaced transverse cirri on average. 3 frontoventral rows, 1–2 postoral ventral cirri.

TYPE LOCATION. Soil of a deciduous forest. Mt Ryu-Ga-Take, Amakusa, Kumamoto Prefecture, Japan.

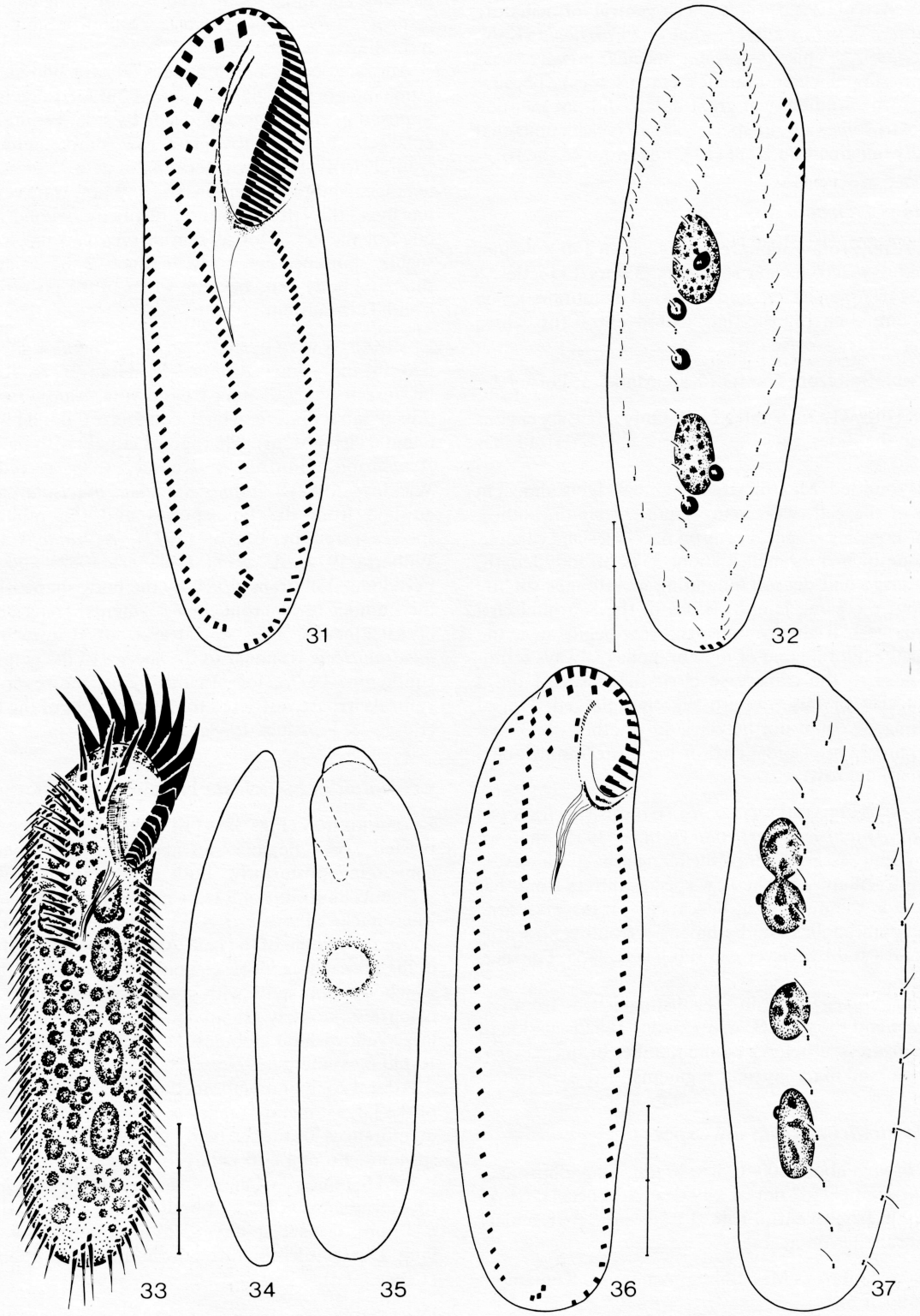
DESCRIPTION (Figs 25–30, Tables 1, 7). Right margin straight, left one convex, in the anterior part markedly indented. Anterior and posterior end rounded. About 2:1 flattened, body flexible. Macronuclear segments lying distinctly left of the median of the cell. Micronuclei *in vivo c.* 7 × 5 µm. Contractile vacuole in about the middle of the cell, during diastole with channels. Single extrusomes are difficult to discern, because they are very closely spaced, forming a distinct lucident seam, which gives the organism a brownish colour at low magnification. Extrusomes ejected after the addition of methylgreen-pyronin, stain red, u- or horseshoe-shaped; between this type of extrusomes there are many thin structures which are probably fully exploded extrusomes. Cytoplasm colourless, with many cytoplasmatic crystals and food vacuoles with fungal spores, flagellates, cysts of amoebae, and testaceans (*Trinema enchelys*). Rapid movement.

Adoral zone of membranelles about 40% of body length, bases of the largest membranelles *in vivo c.* 8 µm wide. Undulating membranes slightly bent, nearly of the same length, paroral membrane consists of short oblique kineties, at least in the middle part. Buccal cirrus near the anterior end of the paroral membrane. Bases of the buccal cirrus, the cirrus behind the right frontal cirrus, and the *in vivo c.* 25 µm long frontal cirri distinctly enlarged. Left and right frontoventral row begin at the level of the cirrus behind the right frontal cirrus, the left one terminates in about the middle of the cell, the right one at the transverse cirri like the middle row, which begins at about the level of the cytostome. Transverse cirri *in vivo c.* 30 µm long, terminate at the posterior edge of the cell. Marginal rows nearly confluent posteriorly, cirri *in vivo c.* 20 µm long. 3 caudal cirri at the

Table 8 Biometrical characterization of *Amphisiella polycirrata* (upper line), *Amphisiella quadrinucleata* (middle line), and *Uroleptoides binucleata* (lower line)

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	150.0	150.0	10.0	5.774	6.7	140.0	160.0	3
	86.3	84.0	10.1	2.607	11.7	70.0	105.0	15
	140.6	140.0	12.7	4.014	9.0	126.0	168.0	10
Body, width	46.7	46.0	5.0	2.906	10.8	42.0	52.0	3
	25.2	25.0	3.1	0.812	12.5	21.0	32.0	15
	40.9	41.0	6.0	1.900	14.7	35.0	50.0	10
Adoral membranelles, number	36.7	37.0	1.5	0.882	4.2	35.0	38.0	3
	16.6	17.0	1.6	0.412	9.6	14.0	19.0	15
	24.5	24.0	1.8	0.627	7.2	22.0	28.0	8
Adoral zone of membranelles, length	52.7	56.0	5.8	3.333	11.0	46.0	56.0	3
	18.3	19.0	2.5	0.645	13.6	14.0	22.0	15
	29.4	30.0	1.3	0.400	4.3	28.0	31.0	10
Macronuclear segments, number	2.0	2.0	0	0	0	2.0	2.0	3
	4.0	4.0	0	0	0	4.0	4.0	15
	2.0	2.0	0	0	0	2.0	2.0	9
Posterior macronuclear segment, length	19.3	21.0	3.8	2.186	19.6	15.0	22.0	3
	8.1	8.0	1.0	0.256	12.2	7.0	10.0	15
	25.2	25.0	3.8	1.209	15.2	20.0	31.0	10
Posterior macronuclear segment, width	10.7	11.0	0.6	0.333	5.4	10.0	11.0	3
	5.5	6.0	0.6	0.165	11.7	4.0	6.0	15
	8.0	8.0	0.9	0.298	11.8	7.0	10.0	10
Macronuclear segments, distance between[1]	25.7	25.0	2.1	1.202	8.1	24.0	28.0	3
	7.5	7.0	2.5	0.646	33.5	4.0	14.0	15
	–	–	–	–	–	–	–	0
Distance 1[2]	–	–	–	–	–	–	–	– 0
	3.7	3.0	1.9	0.494	52.2	0	7.0	15
	–	–	–	–	–	–	–	0
Micronuclei, number	3.7	3.0	1.2	0.667	31.5	3.0	5.0	3
	2.3	2.0	0.5	0.125	20.5	2.0	3.0	14
	2.0	2.0	0	0	0	2.0	2.0	9
Posterior micronucleus, length	4.0	4.0	0.5	0.289	12.5	3.5	4.5	3
	1.8	1.6	0.6	0.168	34.4	1.4	3.5	14
	5.6	6.0	1.1	0.340	19.2	4.0	7.0	10
Posterior micronucleus, width	3.4	3.5	0.6	0.348	17.6	2.8	4.0	3
	1.7	1.5	0.6	0.151	33.9	1.4	3.0	14
	2.8	3.0	0.5	0.167	18.6	2.0	4.0	10
Left marginal row, number of cirri	41.0	44.0	9.9	5.686	24.0	30.0	49.0	3
	36.6	35.0	6.1	1.579	16.7	29.0	49.0	15
	46.0	45.0	5.1	1.793	11.0	42.0	58.0	8
Right marginal row, number of cirri	43.0	44.0	6.7	3.786	15.2	36.0	49.0	3
	36.1	36.0	2.8	0.714	7.7	32.0	41.0	15
	42.3	42.5	3.3	1.652	7.8	38.0	46.0	4
Frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	3
	3.0	3.0	0	0	0	3.0	3.0	15
	3.0	3.0	0	0	0	3.0	3.0	5
Buccal cirri, number	5.3	6.0	1.2	0.667	21.7	4.0	6.0	3
	2.7	3.0	0.5	0.118	16.7	2.0	3.0	15
	1.0	1.0	0	0	0	1.0	1.0	7
Left frontoventral row, number of cirri	3.0	3.0	0	0	0	3.0	3.0	3
	3.2	3.0	0.4	0.107	12.9	3.0	4.0	15
	2.8	3.0	0.8	0.375	29.9	2.0	4.0	5
Right frontoventral row, number of cirri	32.5	32.5	6.4	4.500	19.6	28.0	37.0	2
	14.6	15.0	1.6	0.423	11.2	12.0	18.0	15
	22.3	23.0	1.5	0.615	6.7	20.0	24.0	6
Distance 2[2]	–	–	–	–	–	–	–	0
	11.7	11.0	2.3	0.599	19.9	7.0	15.0	15
	–	–	–	–	–	–	–	0
Distance 3[2]	–	–	–	–	–	–	–	0
	32.5	32.0	3.9	1.018	12.1	25.0	39.0	15
	83.7	82.0	8.2	3.353	9.8	75.0	98.0	6
Transverse cirri, number	4.0	4.0	0	0	0	4.0	4.0	2
	3.0	3.0	0.4	0.098	12.6	2.0	4.0	15
	4.0	4.0	0	0	0	4.0	4.0	7
Dorsal kineties, number	3.0	3.0	0	0	0	3.0	3.0	3
	2.0	2.0	0	0	0	2.0	2.0	15
	3.0	–	–	–	–	–	–	1

[1]In *A. quadrinucleata* the distance between the second and the third macronuclear segment is listed.
[2]Distance 1, distance between the first and the second macronuclear segment. Distance 2, distance 3, distance between the anterior end of the cell and the posterior end of the left and right frontoventral row, respectively.



Figs 31, 32 *Amphisiella polycirrata*. Infraciliature in ventral and dorsal view after protargol impregnation.

Figs 33–37 *Amphisiella quadrinucleata* from life (Figs 33–35) and after protargol impregnation (Figs 36, 37). **33–35** Ventral, lateral, and dorsal view. **36, 37** Infraciliature in ventral and dorsal view.

posterior end of the cell. The dorsal infraciliature was hidden by the extrusomes which often stain with protargol.

COMPARISON WITH RELATED SPECIES. The ventral infraciliature of *P. granulifera* is very similar to that of *P. fossicola* (Kahl, 1932) Borror, 1972. This fresh-water species, however, has obviously no subpellicular granules (extrusomes), because Kahl (1932), who studied it in great detail, did not mention them. The extrusomes of our species are so conspicuous that we can hardly imagine that Kahl (1932) overlooked them.

Amphisiella polycirrata nov. spec.

DIAGNOSIS. After protargol impregnation about 150 × 46 µm, long ellipsoid. 2 macronuclear segments, 3 dorsal kineties. 6 buccal cirri, 4 transverse cirri, and 37 adoral membranelles on average. About 33 cirri in the right frontoventral row which terminates at the transverse cirri.

TYPE LOCATION. Soil from Garajan Kap, Madeira, Portugal.

DESCRIPTION (Figs 31, 32, Tables 1, 8). Only a few specimens were found in the slides, thus the biometric characterization is incomplete.

Both ends rounded. Macronuclear segments lying almost in the median of the cell, with many small chromatin bodies. Subpellicular granules absent. Feeds on flagellates and ciliates.

Adoral zone of membranelles about 35% of body length. Buccal area large and deep. Undulating membranes slightly bent, of about the same length. Bases of the 3 frontal cirri distinctly enlarged. Right frontoventral row begins near the distal end of the adoral zone of membranelles, always terminates very near to the transverse cirri; the bases of the 3 anteriormost cirri of this row are slightly enlarged. Dorsal cilia 3 µm long. It could not be clarified whether the 3 cirri shown in Figure 32 are caudal cirri or the posteriormost cirri of the left marginal row.

COMPARISON WITH RELATED SPECIES. *In vivo* this species looks so similar to *Amphisiella terricola* Gellért, 1955, that we considered it unnecessary to draw the living aspect. However, the ventral infraciliature of the new species differs from that of *A. terricola* in the number of buccal cirri, transverse cirri, and adoral membranelles and by having a frontoventral row which terminates at the transverse cirri (Gellért, 1955; Foissner, 1984).

Amphisiella polycirrata can be distinguished from *A. quadrinucleata* and the species mentioned in the discussion of *A. quadrinucleata* (see below) by the number of buccal cirri, dorsal kineties, and macronuclear segments.

Amphisiella quadrinucleata nov. spec.

DIAGNOSIS. *In vivo* about 100–125 × 30 µm, long ellipsoid. 4 macronuclear segments, 2 dorsal kineties, 2–3 buccal cirri. 15 cirri in the right frontoventral row, 3 transverse cirri, and 17 adoral membranelles on average.

TYPE LOCATION. Soil from Mae-Shima, Amakusa, Kumamoto Prefecture, Japan.

DESCRIPTION (Figs 33–37, Tables 1, 8). Body margins parallel, anterior part of the cell usually bent to the left. Both ends rounded. About 2:1 flattened, flexible. Macronuclear segments *in vivo* *c.* 10 × 6 µm, with large chromatin bodies, lying slightly left of the median. Contractile vacuole slightly above the middle of the cell, distinctly displaced inwards, during diastole without channels. Subpellicular granules absent. Cytoplasm colourless, with numerous 1–7 µm large, fat globules and some food vacuoles containing ciliates (*Colpoda fastigata, Pseudoplatyophrya nana*). Slow movement, trembling.

Adoral zone of membranelles 20% of body length. Undulating membranes slightly bent, about the same length, superimposed or closely arranged side by side. Frontal cirri slightly enlarged. Left frontoventral row short, behind the right frontal cirrus. Right row terminates at 38% of body length on average. Marginal cirri *in vivo* *c.* 10 µm, transverse cirri *c.* 14 µm long, the latter protrude distinctly beyond the posterior edge of the cell. Dorsal cilia *in vivo* *c.* 3 µm long, kinety 1 slightly shortened anteriorly, in kinety 2 the distances between the basal body pairs become wider in the posterior direction. Caudal cirri absent.

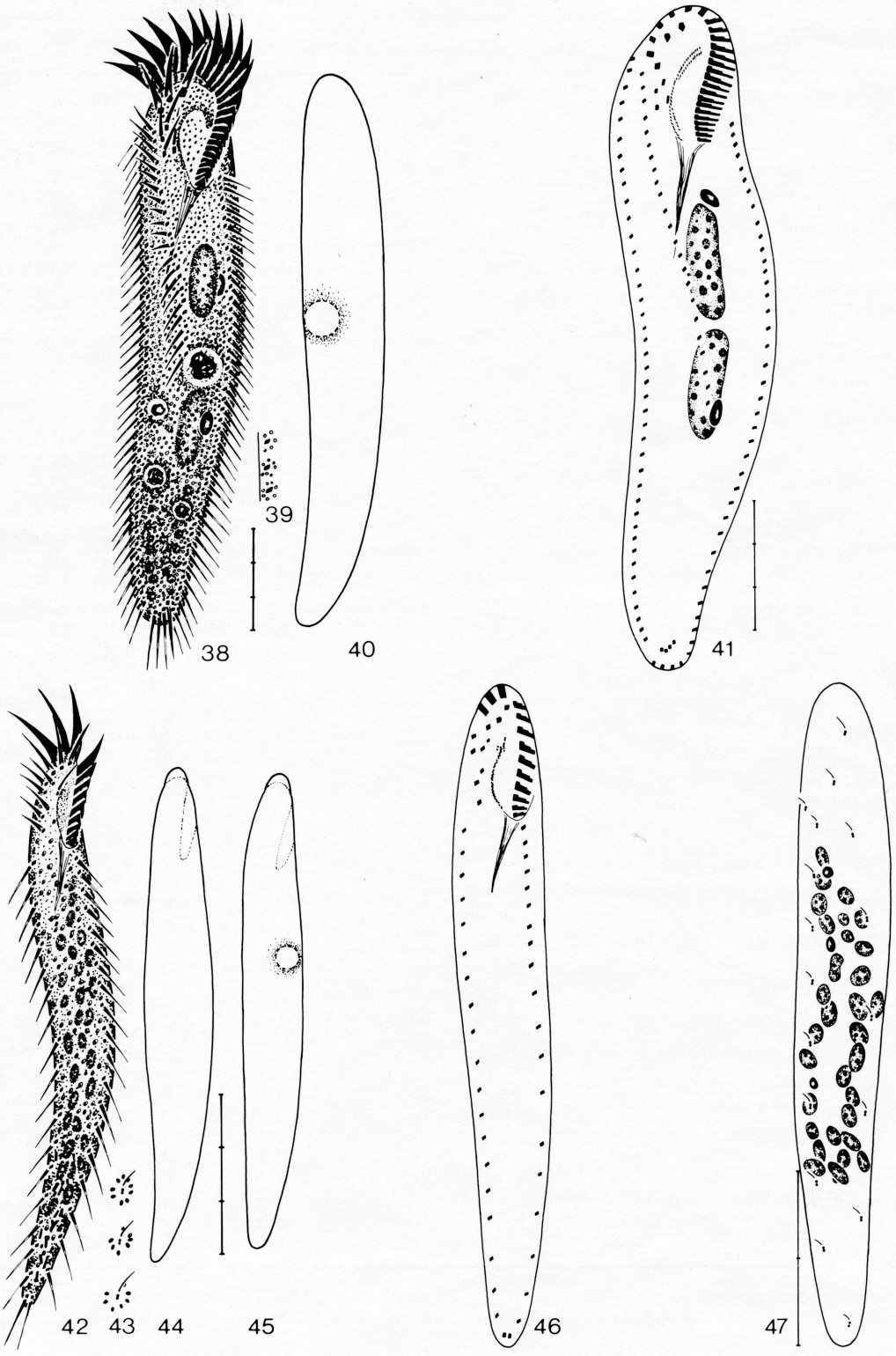
COMPARISON WITH RELATED SPECIES. The new species is classified in the genus *Amphisiella* Gourret & Roeser, 1888, because it has a distinct frontal row, transverse cirri, and a dorsal infraciliature which consists of dorsal kineties only (caudal cirri absent). This agrees largely with the type-species *A. marioni* Gourret & Roeser, 1888 as redescribed by Wicklow (1982). *Amphisiella quadrinucleata* can be distinguished from the type-species and the other congeneric species listed by Borror (1972), *A. raptans* Buitkamp & Wilbert, 1974; *A. acuta* Foissner, 1982; and *A. oscensis* Fernandez-Leborans, 1984, by the body shape, the body size, the number of macronuclear segments, transverse cirri, and dorsal kineties. The ventral and dorsal infraciliature of *A. quadrinucleata* is similar to the species of the genus *Lamtostyla* Buitkamp, 1977*a*, too. In this genus, however, the frontoventral cirri are restricted to the area right of the buccal cavity (Berger & Foissner, 1988*a*).

Uroleptoides binucleata Hemberger, 1985

REDESCRIPTION (Figs 38–41, Tables 1, 8). Body often slightly twisted, very flexible, inconspicuously flattened, margins converging posteriorly, both ends rounded. Macronuclear segments long ellipsoid, lying almost in the median of the cell. Micronuclei *in vivo* c. 7 × 4 µm. Contractile vacuole slightly above the middle of the cell. Around the bases of the cirri and in the buccal area inconspicuous (< 1 µm) colourless granules, which do not stain with methylgreen-pyronin. Cytoplasm colourless, densely granulated, posteriorly many about 3 µm large yellowish fat globules. Probably feeds on zooflagellates. Rapid movement.

Adoral zone of membranelles *c.* 20% of body length, bases of the largest membranelles *in vivo* *c.* 6 µm wide. Undulating membrances distinctly bent, pharyngeal fibres *in vivo* conspicuous. Frontal cirri enlarged. Buccal cirrus inserted slightly behind the middle of the undulating membranes. Frontoventral row terminates at 60% of body length. Marginal cirri *in vivo* *c.* 12 µm, transverse cirri *c.* 20 µm, and dorsal cilia *c.* 3 µm long. Dorsal infraciliature poorly stained, probably 3 kineties (1 specimen).

DISCUSSION The body shape, the nuclear apparatus, the ventral cirral pattern, and the number of adoral membranelles of our population from Berlin, FRG, agree very well with the type-material which was found in a mull-rendsina soil near Bonn, FRG. Differences exist in the body size (type-material 200–260 × 50 µm; our population 160–180 × 30 µm) and consequently in the number of right (60; 38–46) and left



Figs 38–41 *Uroleptoides binucleata* from life (Figs 38–40) and after protargol impregnation (Fig. 41). **38** Ventral view. **39** Small (< 1 μm), colourless subpellicular granules around the bases of the cirri. **40** Dorsal view. **41** Infraciliature in ventral view.

Figs 42–47 *Hemisincirra inquieta* from life (Figs 42–45) and after protargol impregnation (Figs 46, 47). **42** Ventral view. **43** Ellipsoid, about 1 μm large, orange-yellow subpellicular granules around the bases of the dorsal cilia. **44, 45** Ventral views. **46, 47** Infraciliature in ventral and dorsal view.

Table 9 Biometrical characterization of *Hemisincirra inquieta* (upper line), *Hemisinicirra vettersi* (middle line), and *Terricirra matsusakai* (lower line)

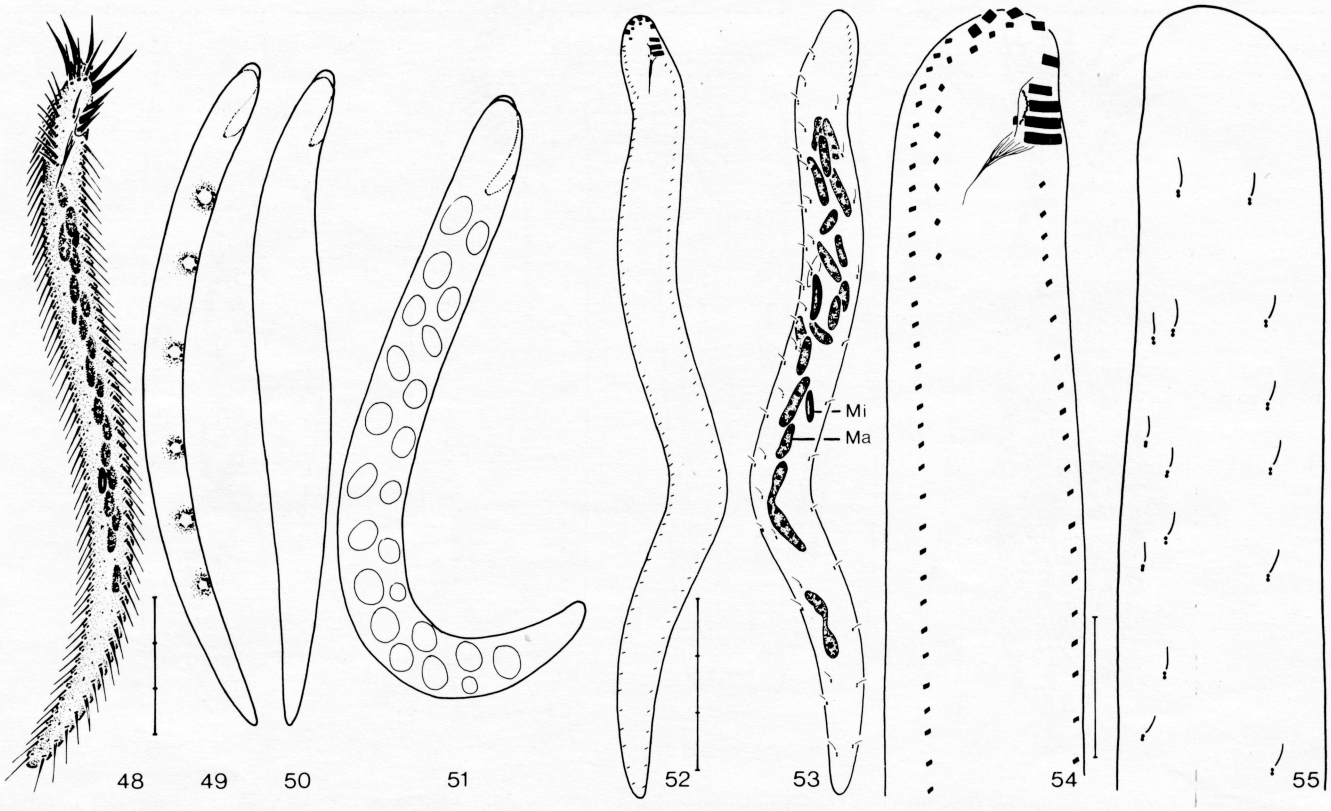
Character	$\bar{x}$	M	SD	SE	CV	Min	Max	n
Body, length	84.6	90.0	11.4	4.298	13.4	70.0	98.0	7
	143.6	145.0	18.6	5.162	13.0	112.0	180.0	13
	93.2	95.0	11.2	3.379	12.0	78.0	112.0	11
Body, width	12.6	13.0	1.3	0.481	10.1	11.0	14.0	7
	12.0	11.0	1.5	0.424	12.7	10.0	15.0	13
	23.9	23.0	5.3	1.592	22.1	18.0	35.0	11
Adoral membranelles, number	13.1	13.0	0.7	0.261	5.3	12.0	14.0	7
	8.3	8.0	0.6	0.175	7.6	7.0	9.0	13
	18.2	18.0	1.3	0.377	6.9	16.0	20.0	11
Adoral zone of membranelles, length	15.1	15.0	1.4	0.508	8.9	13.0	17.0	7
	8.5	8.0	0.9	0.243	10.4	7.0	10.0	13
	17.5	17.0	1.2	0.366	6.9	15.0	20.0	11
Macronuclear segments, number	31.7	32.0	2.1	0.808	6.7	30.0	36.0	7
	27.5	27.0	7.5	2.074	27.2	20.0	50.0	13
	4.0	4.0	0	0	0	4.0	4.0	11
Posterior macronuclear segment, length	4.4	4.0	1.3	0.481	28.7	3.0	7.0	7
	9.2	7.0	4.9	1.372	54.0	3.0	22.0	13
	12.0	13.0	2.1	0.647	17.9	8.0	14.0	11
Posterior macronuclear segment, width	1.9	2.0	0.4	0.139	19.2	1.4	2.5	7
	1.8	1.7	0.4	0.102	21.0	1.2	2.5	13
	5.7	6.0	1.0	0.304	17.6	4.0	7.0	11
Micronuclei, number	2.1	2.0	0.7	0.261	32.2	1.0	3.0	7
	1.9	2.0	0.5	0.137	25.7	1.0	3.0	13
	1.9	2.0	0.8	0.251	43.5	1.0	3.0	11
Posterior micronucleus, length	2.3	2.5	0.5	0.187	21.8	1.6	2.8	7
	8.2	8.0	1.3	0.355	15.7	7.0	11.0	13
	1.6	1.6	0.0	0.012	2.6	1.5	1.6	11
Posterior micronucleus, width	1.6	1.5	0.1	0.052	8.8	1.4	1.8	7
	2.0	2.0	0.5	0.137	24.4	1.4	2.8	13
	1.6	1.6	0.0	0.012	2.6	1.5	1.6	11
Left marginal row, number of cirri	19.9	20.0	2.0	0.769	10.3	17.0	23.0	7
	52.1	53.0	4.7	1.313	9.1	43.0	60.0	13
	30.3	29.0	3.7	1.104	12.1	23.0	36.0	11
Right marginal row, number	21.4	21.0	2.3	0.869	10.7	18.0	2.0	7
of cirri	68.8	70.0	6.2	1.725	9.0	58.0	78.0	13
	32.2	32.0	4.4	1.327	13.7	26.0	41.0	11
Frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	7
	3.0	3.0	0	0	0	3.0	3.0	13
	3.0	3.0	0	0	0	3.0	3.0	11
Buccal cirri, number	1.3	1.0	0.8	0.333	61.2	1.0	3.0	7
	1.0	1.0	0	0	0	1.0	1.0	13
	1.0	1.0	0	0	0	1.0	1.0	11
Frontoventral row, number of cirri	–	–	–	–	–	–	–	0
	8.2	8.0	1.4	0.390	17.2	6.0	11.0	13
	4.0	4.0	0.5	0.135	11.2	3.0	5.0	11
Cirri left of the frontoventral row, number	–	–	–	–	–	–	–	0
	–	–	–	–	–	–	–	0
	1.1	1.0	0.3	0.091	27.6	1.0	2.0	11
Transverse cirri, number	2.0	2.0	0	0	0	2.0	2.0	6
	–	–	–	–	–	–	–	0
	3.2	3.0	0.6	0.180	19.0	3.0	5.0	11
Dorsal kineties, number[1]	3.0	3.0	0	0	0	3.0	3.0	7
	3.0	3.0	0	0	0	3.0	3.0	13
	4.0	4.0	0	0	0	4.0	4.0	11
Distance 1[2]	16.5	16.0	1.7	0.462	10.1	14.0	20.0	13

[1]In *H. inquieta* the single basal body pair (dorsal kinety 1, see Figure 47) is included.
[2]Distance 1, distance between the anterior end of the cell and the posterior end of the frontoventral row. These values are valid for *H. vettersi* only.

marginal cirri (55; 42–58) and cirri in the right frontoventral row (33–40; 20–24). Hemberger (1985) observed 3 terminal cirri (transverse cirri ?), whereas in the population from Berlin 4 distinct transverse cirri are recognizable. The granules around the cirri are not mentioned by Hemberger (1985). They are, in fact, rather difficult to discern and thus he may have overlooked them.

Hemisincirra inquieta Hemberger, 1985

DISCUSSION AND ADDITIONAL OBSERVATIONS (Figs 42–47, Tables 1, 9). The population from Iceland has a more tapered body shape than that from Ulm, FRG (Berger & Foissner 1987). However, the ventral and dorsal infraciliature and the



Figs 48–55 *Hemisincirra vettersi* from life (Figs 48–51) and after protargol impregnation (Figs 52–55). **48, 49** Theronts in ventral view. **50, 51** Trophonts in ventral view. **52–55** Infraciliature in ventral and dorsal view. Ma, macronuclear segment; Mi, micronucleus.

bio-metrical data agree very well with the type-material and the German population (Hemberger, 1985; Berger & Foissner, 1987).

In vivo about 115 × 15 µm, not flattened, very flexible. Subpellicular granules ellipsoid, about 1 µm long, orange-yellow, arranged around the cirri and dorsal cilia only. Cytoplasm with many *c.* 1 µm large, colourless fat granules. Vivacious movement.

Hemisincirra vettersi nov. spec.

DIAGNOSIS. Theront *in vivo* about 150 × 9 µm, extremely vermiform. Trophont *in vivo* about 125–160 × 14–25 µm. About 6 contractile vacuoles near the left body margin. 27 macronuclear segments and 8 adoral membranelles on average. 3 dorsal kineties of body length.

TYPE LOCATION. Soil under a tuft of *Alchemilla alpina* near Dettifoss, Neisland, Iceland.

DEDICATION. This species is named in honour of Dr Wolfgang Vetters, University of Salzburg, who collected the soil samples from Iceland.

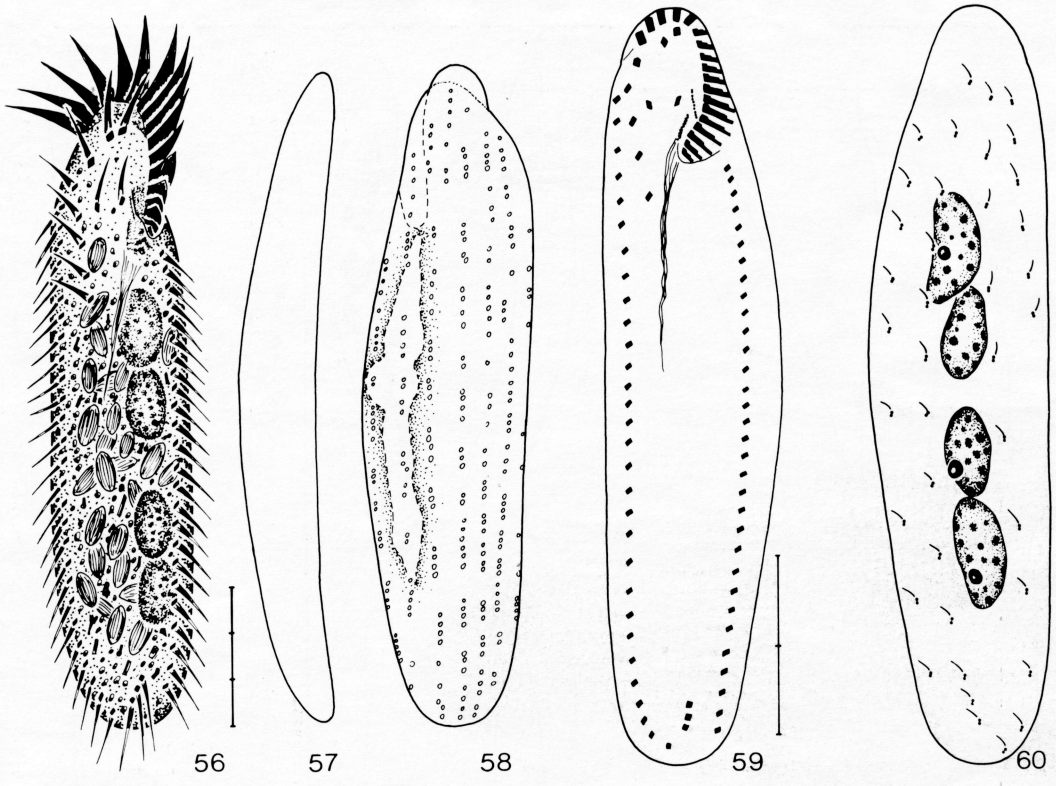
DESCRIPTION (Figs 48–55, Tables 1, 9). Theront usually s-shaped, posteriorly tapered. Trophont distinctly twisted, nematode-like. Frontal area very thin, remaining body not flattened, very fragile. Macronuclear segments and micronuclei usually elongated and of similar size. Subpellicular granules absent. Cytoplasm colourless, in trophonts with many about 10 µm large, fat globules. Theronts with worm-like movements, trophonts nearly motionless.

Adoral zone of membranelles about 6% of body length only! Distal adoral membranelles loosely arranged. Very probably the adoral membranelles consist of 2 rows of basal bodies only. Buccal area very small. Buccal cirrus inserted near the posterior end of the very small undulating membranes whose structures, thus, could not be seen clearly in the light microscope. All cirri very thin. Conspicuously more right than left marginal cirri. Transverse and caudal cirri very probably absent. Distance between dorsal kinety 1 and 2 distinctly smaller than between kineties 2 and 3.

COMPARISON WITH RELATED SPECIES. *Hemisincirra vettersi* differs from the other vermiform congeneric species viz. *H. vermiculare* Hemberger, 1985; *H. interrrupta* (Foissner, 1982) Foissner, 1984; *H. filiformis* (Foissner, 1982) Foissner, 1984; *H. polynucleata* Foissner, 1984; and *H. muelleri* Foissner, 1986, in the number of dorsal kineties, adoral membranelles, macronuclear segments, and contractile vacuoles.

TERRICIRRA nov. gen.

DIAGNOSIS. Vermiform to long ellipsoid Oxytrichidae with green to blue subpellicular granules and spindle-shaped food vacuoles containing parallel arranged bacteria. Undulating membranes short, forming an acute angle. 1 short frontoventral row.



Figs 56–60 *Terricirri matsusakai* from life (Figs 56–58) and after protargol impregnation (Figs 59, 60). **56–58** Ventral, lateral, and dorsal view. Figure 58 shows the arrangement of the dark-green, spherical subpellicular granules. **59, 60** Infraciliature in ventral and dorsal view.

TYPE-SPECIES .*Terricirra viridis* (Foissner, 1982) nov. comb. (basionym: *Perisincirra viridis* Foissner, 1982).

COMPARISON WITH RELATED GENERA. The conspicuous combination of the characters—green to blue subpellicular granules, spindle-shaped food vacuoles, and the markedly differently orientated short undulating membranes—is unique within the hypotrichs. It separates *Terricirra* distinctly from the genera *Hemisincirra* Hemberger, 1985 and *Lamtostyla* Buitkamp, 1977*a* which have a very similar infraciliature (Berger & Foissner, 1988*a*). The same type of food vacuoles occurs in the colpodid ciliate *Parabryophrya penardi* (Kahl, 1931) Foissner, 1985.

The other two species which have to be included in the new genus are *Terricirra matsusakai* (see below) and *T. livida* (Berger & Foissner, 1987) nov. comb. (basionym: *Hemisincirra livida* Berger & Foissner, 1987). Recently, two further species of this genus were found in soils of Denmark and Australia (Foissner, unpublished). This supports the establishment of *Terricirra* which is very probably restricted to soil (Foissner, 1987*c*).

Terricirra matsusakai nov. spec.

DIAGNOSIS. *In vivo c.* 125–135 × 27–30 μm. Subpellicular granules dark green, spherical, *c.* 1 μm in diameter. 18 adoral membranelles on average, 4 macronuclear segments, 4 dorsal kineties.

TYPE LOCATION. Soil of a rice field of Kyokushi, Kumamoto Prefecture, Japan.

DEDICATION. This species is named in honour of Dr Tadao Matsusaka, University of Kumamoto, who collected the soil samples from Japan.

DESCRIPTION (Figs 56–60, Tables 1, 9). Body margins parallel, in the area of the adoral zone of membranelles distinctly converging, both ends rounded. Very flexible, slightly contractile, 1.5–2 : 1 flattened. Macronuclear segments *in vivo c.* 15 × 11 μm, arranged in the median of the cell or slightly left of it. Contractile vacuole in the middle of the cell, during diastole with distinct channels. About 6 loose rows of subpellicular granules on the ventral and dorsal surface, respectively. Cytoplasm colourless, with many *c.* 7–9 μm long food vacuoles, 1–2 μm large fat globules, and cytoplasmatic crystals.

Adoral zone of membranelles c. 19% of body length. Buccal area flat and narrow, the posterior part of the buccal area covered by a hyaline cytoplasmatic roof. Marginal and transverse cirri *in vivo c.* 10 μm and 15 μm long, respectively. The latter one arranged in a short, rather oblique row. Dorsal kinety 1 slightly shortened at both ends, kineties 2 and 3 of body length, and kinety 4 terminates in about the middle of the cell. Dorsal cilia *in vivo c.* 2 μm long. Caudal cirri absent.

The morphogenesis commences with the apokinetal formation of the oral primordium in about the middle of the cell.

COMPARISON WITH RELATED SPECIES. *Terricirra matsusakai* differs from the rather similar *Hemisincirra quadrinucleata* Hemberger, 1985, which also has the same type of undulating membranes, in that it has more dorsal kineties, no interruption in the adoral zone of membranelles, and a more posteriorly located contractile vacuole. Since Hemberger (1985) gives no

Table 10 Biometrical characterization of *Oxytricha islandica* (upper line), *Oxytricha lanceolata* (middle line), and *Oxytricha longigranulosa* (lower line)

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	93.3	96.5	12.1	3.839	13.0	72.0	115.0	10
	94.5	96.0	12.2	3.842	12.9	70.0	108.0	10
	87.6	91.0	8.5	2.344	9.6	72.0	98.0	13
Body, width	30.7	31.0	3.6	1.146	11.8	25.0	35.0	10
	34.2	34.5	3.4	1.083	10.0	29.0	42.0	10
	31.9	32.0	3.1	0.866	9.8	27.0	38.0	13
Adoral membranelles, number	26.7	27.0	2.3	0.715	8.5	21.0	29.0	10
	27.6	28.0	0.8	0.267	3.1	26.0	29.0	10
	26.5	27.0	1.1	0.291	4.0	24.0	28.0	13
Adoral zone of membranelles, length	29.1	30.0	2.7	0.849	9.2	22.0	31.0	10
	30.1	31.5	3.5	1.100	11.6	24.0	34.0	10
	28.1	28.0	1.3	0.366	4.7	25.0	30.0	13
Macronuclear segments, number	4.2	4.0	0.6	0.200	15.1	4.0	6.0	10
	2.0	2.0	0	0	0	2.0	2.0	10
	2.0	2.0	0	0	0	2.0	2.0	13
Macronuclear segments, distance between	–	–	–	–	–	–	–	0
	8.5	10.0	2.7	0.860	32.0	3.0	11.0	10
	11.7	12.0	2.8	0.763	23.5	7.0	16.0	13
Posterior macronuclear segment, length	13.1	13.0	2.1	0.657	15.9	9.0	17.0	10
	13.9	14.5	1.6	0.504	11.5	10.0	15.0	10
	14.8	14.0	1.8	0.496	12.1	12.0	17.0	13
Posterior macronuclear segment, width	7.4	7.0	0.2	0.163	7.0	7.0	8.0	10
	6.9	7.0	0.9	0.277	12.7	5.0	8.0	10
	7.6	7.0	0.8	0.213	10.1	7.0	9.0	13
Micronuclei, number	1.8	2.0	0.4	0.133	23.4	1.0	2.0	10
	1.8	2.0	0.6	0.200	35.1	1.0	3.0	10
	1.2	1.0	0.4	0.104	32.5	1.0	2.0	13
Posterior micronucleus, length	3.1	3.0	0.2	0.066	6.8	3.0	3.5	10
	2.8	2.8	0.1	0.020	2.2	2.8	3.0	10
	2.7	2.8	0.4	0.123	16.2	2.0	3.5	13
Posterior micronucleus, width	3.1	3.0	0.2	0.066	6.8	3.0	3.5	10
	2.6	2.6	0.2	0.050	6.0	2.4	2.8	10
	2.4	2.5	0.4	0.104	15.7	2.0	3.0	13
Left marginal row, number of cirri	26.2	26.0	2.9	0.928	11.2	22.0	32.0	10
	31.7	32.0	3.6	1.136	11.3	25.0	36.0	10
	22.9	23.0	1.4	0.390	6.2	21.0	25.0	13
Right marginal row, number of cirri	25.6	26.5	2.2	0.686	8.5	21.0	28.0	10
	28.5	28.0	1.9	0.601	6.7	26.0	32.0	10
	25.9	26.0	1.6	0.436	6.1	23.0	28.0	13
Frontal cirri, number[1]	3.0	3.0	0	0	0	3.0	3.0	10
Buccal cirri, number[1]	1.0	1.0	0	0	0	1.0	1.0	10
Frontoventral cirri, number[1]	4.0	4.0	0	0	0	4.0	4.0	10
Postoral ventral cirri, number[1]	3.0	3.0	0	0	0	3.0	3.0	10
Ventral cirri near the transverse cirri, number[1]	2.0	2.0	0	0	0	2.0	2.0	10
Transverse cirri, number[1]	5.0	5.0	0	0	0	5.0	5.0	10
Caudal cirri, number[1]	3.0	3.0	0	0	0	3.0	3.0	10
Dorsal kineties, number	4.1	4.0	0.3	0.100	7.7	4.0	5.0	10
	4.0	4.0	0	0	0	4.0	4.0	10
	6.0	6.0	0	0	0	6.0	6.0	13

[1] These values are valid for *O. lanceolata* (n = 10) and *O. longigranulosa* (n = 13) too.

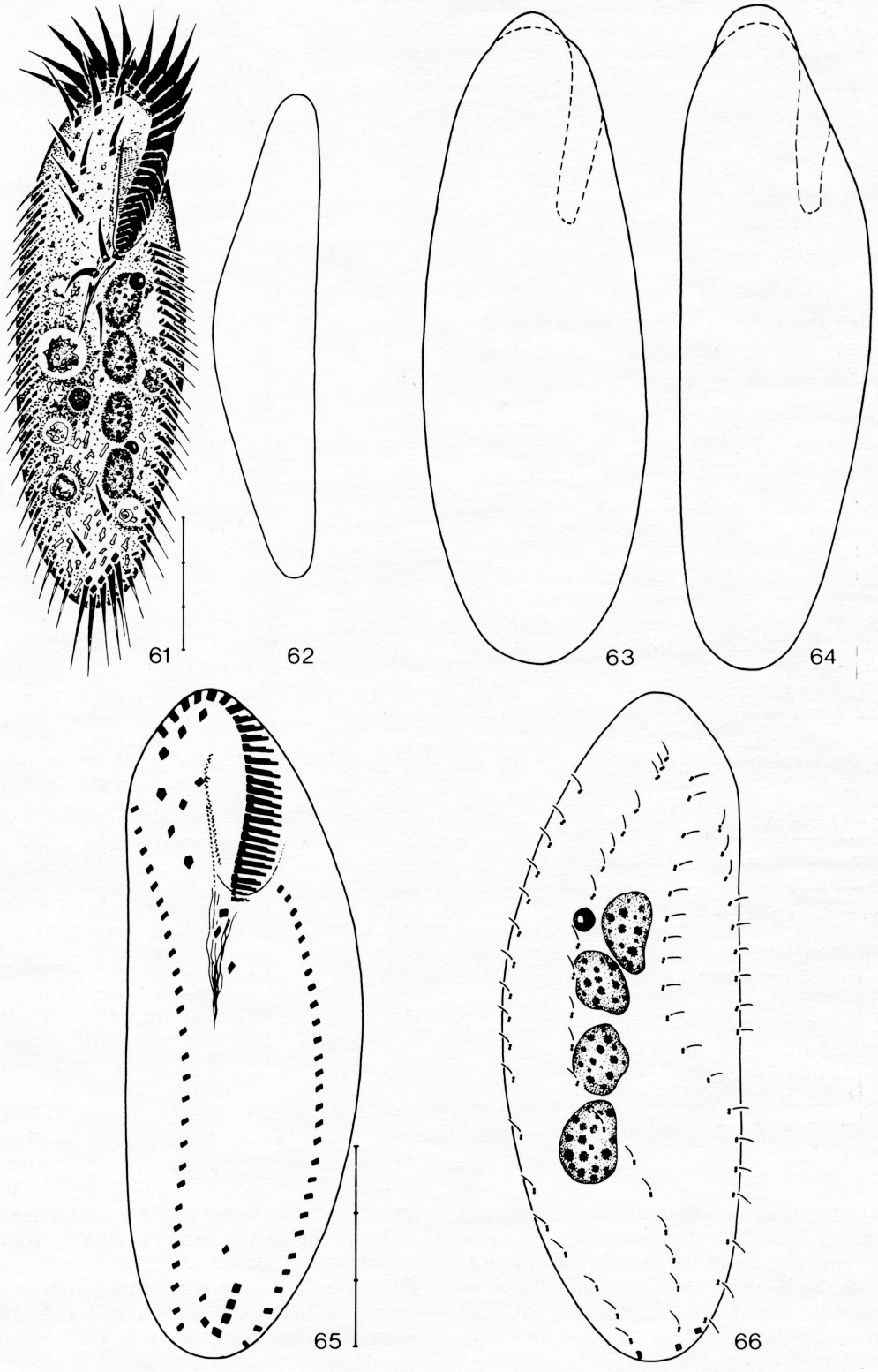
information about the food vacuoles and the subpellicular granules, *H. quadrinucleata* is not transferred to the new genus. *Terricirra matsusakai* can be distinguished from *T. viridis* and *T. livida* by the body shape and the number of macronuclear segments, dorsal kineties, transverse cirri, and cirri in the frontoventral row.

Oxytricha islandica nov. spec.

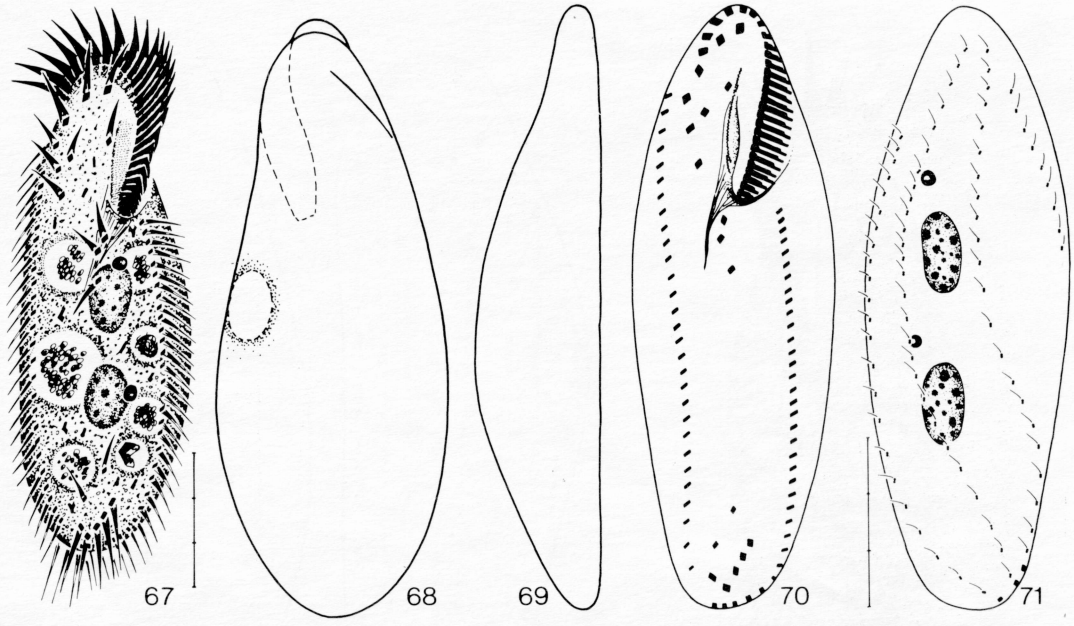
DIAGNOSIS. *In vivo* 100–140 × 35–45 µm. Usually 4 macronuclear segments. About 27 adoral membranelles, *c.* 26 left and 26 right marginal cirri. 4 dorsal kineties.

TYPE LOCATION. Pasture with moss and *Deschámpsia caespitósa* on the peninsula Vatnsney 'Hvitserkur', Iceland.

DESCRIPTION (Figs 61–66, Tables 1, 10). Body ellipsoid, left margin sometimes straight, right one distinctly convex, posteriorly distinctly converging. Both ends rounded. About 2 : 1 flattened. Very flexible, slightly contractile. Macronuclear segments *in vivo c.* 13 × 10 µm, arranged in a line almost in the median of the cell or slightly left of it. Micronuclei *in vivo* about 4 µm in diameter. Contractile vacuole somewhat above the middle of the cell, during diastole without distinct channels. Subpellicular granules absent. Cytoplasm colourless, posteriorly



Figs 61–66 *Oxytricha islandica* from life (Figs 61–64) and after protargol impregnation (Figs 65, 66). **61–64** Ventral and lateral views. **65, 66** Infraciliature in ventral and dorsal view.



Figs 67–71 *Oxytricha lanceolata* from life (Figs 67–69) and after protargol impregnation (Figs 70, 71). **67–69** Ventral, dorsal, and lateral view. **70, 71** Infraciliature in ventral and dorsal view.

filled with many cytoplasmic crystals and numerous food vacuoles (*c.* 10 μm in diameter) containing cysts of amoebae and unidentified material. Rapid movement.

Adoral zone of membranelles about 31% of body length. Bases of the largest membranelles *in vivo c.* 7 μm wide. Buccal area flat, undulating membranes nearly straight. Buccal cirrus inserted at about the level of the posterior end of the endoral membrane. Typical *Oxytricha* cirral pattern. Frontal, marginal, and transverse cirri *in vivo c.* 15 μm, 14 μm, and 22 μm long, respectively. Dorsal kineties 1–3 distinctly bent, kinety 1 slightly shortened anteriorly, kinety 4 terminates roughly in the middle of the cell. Dorsal cilia *in vivo c.* 3 μm long. Caudal cirri on kineties 1–3.

COMPARISON WITH RELATED SPECIES. *Oxytricha islandica* differs from the other *Oxytricha* species in that it has 4 macronuclear segments (compare Kahl, 1932; Stiller, 1974). It can be distinguished from other quadrinucleate members of the family by the habitat, the body shape, the body size, and the ventral and dorsal infraciliature (Quennerstedt, 1987; Kahl, 1932, 1935; Gelei & Szabados, 1950; Dragesco, 1966; Dragesco & Njine, 1971; Foissner, 1980, 1982, 1984; Berger & Foissner, 1987).

Oxytricha lanceolata Shibuya, 1930

DISCUSSION AND ADDITIONAL OBSERVATIONS (Figs 67–71, Tables 1, 10). It is widely assumed that oxytrichids are rather variable. This is not in accordance with our experience. To document this once more, we shortly describe here a further population of *O. lanceolata* from Madeira. This *in vivo* about 110 × 50 μm large population agrees very well in all characters (e.g. absence of subpellicular granules, number of adoral membranelles) with the Austrian population described by Berger & Foissner (1987).

Cytoplasm made opaque by small (< 1 μm), fat globules. Food vacuoles *c.* 8–16 μm, with globular green algae, zooflagellates, and crystaline content. Distinct dorsal furrow right anteriorly. Undulating membranes only inconspicuously bent, nearly superimposed. Caudal cirri motile.

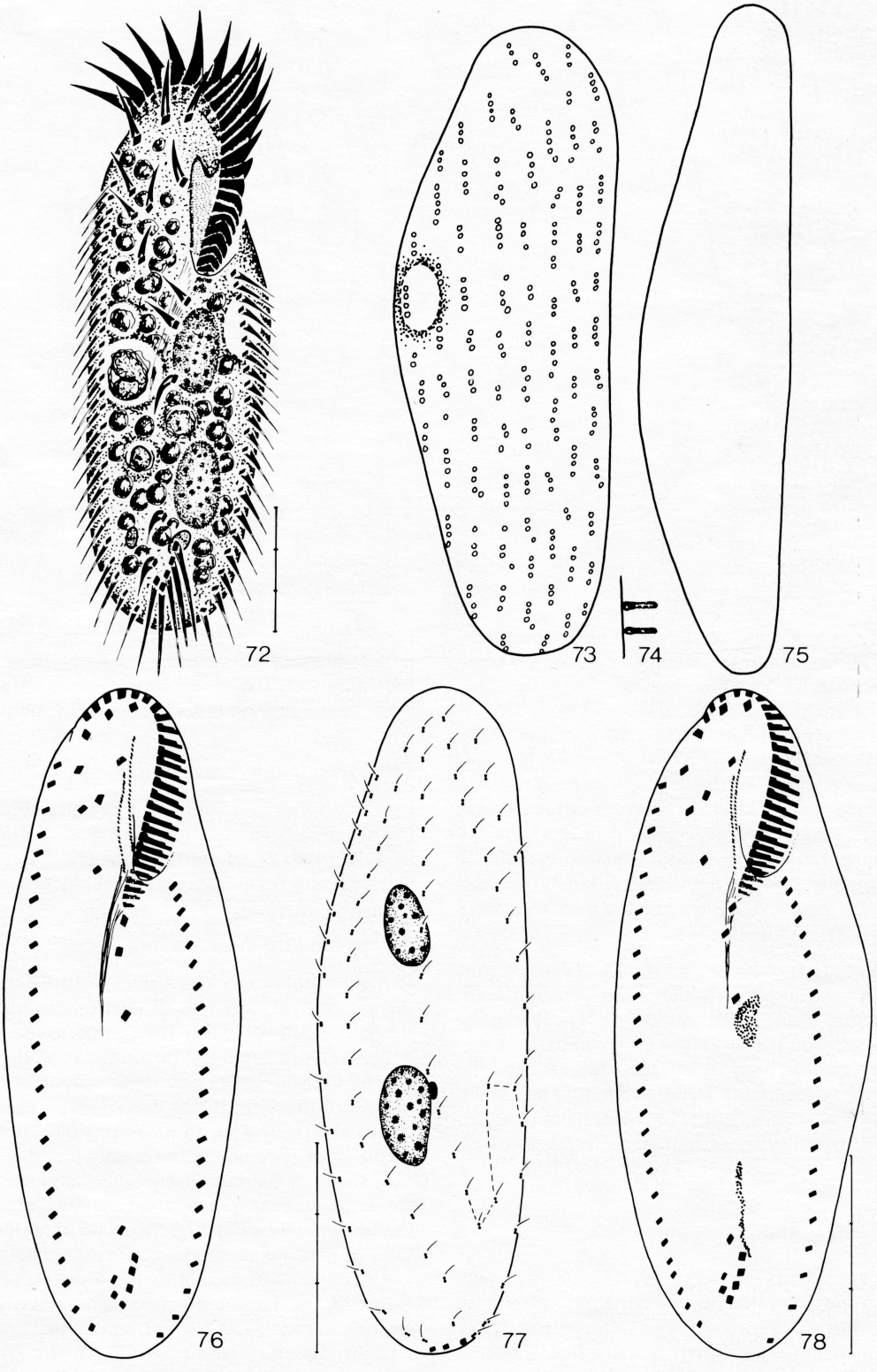
Oxytricha longigranulosa nov. spec.

DIAGNOSIS. *In vivo* about 135 × 55 μm. Subpellicular granules (extrusomes) colourless, rod-shaped, c. 2–3 μm long, arranged in short rows. 26 adoral membranelles, 25 right, and 23 left marginal cirri on average. 6 dorsal kineties.

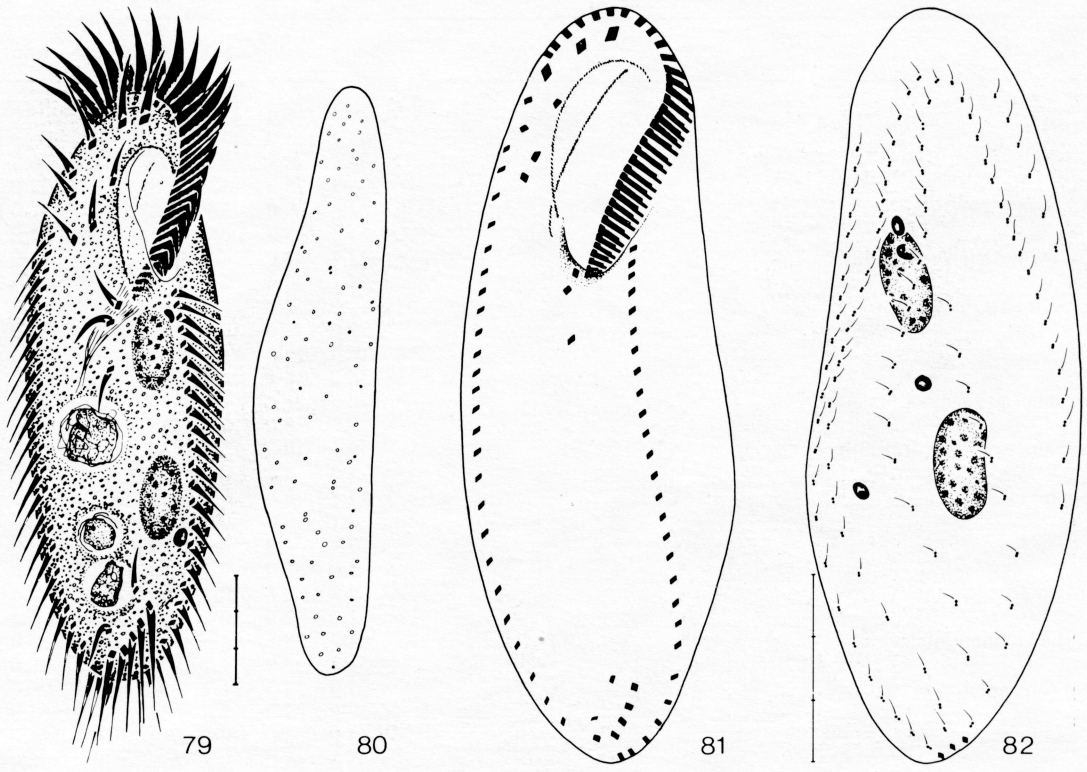
TYPE LOCATION. Soil from Mt Kura-Take, Amakusa, Kumamoto Prefecture, Japan.

DESCRIPTION (Figs 72–78, Tables 1, 10). Body ellipsoid, right margin straight, left one distinctly bent out at the level of the contractile vacuole. Both ends rounded. About 2 : 1 flattened, very flexible. Macronuclear segments lying slightly left of the median. Contractile vacuole slightly above the middle of the cell, during diastole without channels. Extrusomes anteriorly with an inconspicuous knob, stain red with methylgreen-pyronin, but were not ejected. Cytoplasm colourless, with *c.* 5 μm large fat globules and many food vacuoles containing fungal spores, zooflagellates, and ciliates. Hence, the specimens appear slightly brownish at low magnification. Gliding movement, sometimes nearly jumping.

Adoral zone of membranelles about 32% of body length. Bases of the largest membranelles in vivo *c.* 7 μm wide. Buccal area flat and narrow, undulating membranes nearly straight. Bases of all cirri nearly of the same size. Typical *Oxytricha* cirral pattern. Marginal and transverse cirri *in vivo c.* 15 μm and 20 μm long, respectively. Dorsal kineties 1 and 2 nearly of body length, kinety 3 with a bend at the posterior end and kinety 4 distinctly bent to the left anteriorly so that the connexion of these 2 kineties is still recognizable. Kinety 5 half of body length, kinety 6 consists of about 4 basal body



Figs 72–78 *Oxytricha longigranulosa* from life (Figs 72–75) and after protargol impregnation (Figs 76–78). **72, 73** Ventral and dorsal view. Figure 73 shows the arrangement of the 2–3 μm long, colourless extrusomes. **74** Extrusomes in lateral view. **75** Lateral view. **76, 77** Infraciliature in ventral and dorsal view. In Figure 77 the posterior end of dorsal kinety 3 and the anterior end of dorsal kinety 4 are connected by a dotted line. **78** Early morphogenetic stage in ventral view.



Figs 79–82 *Steinia muscorum* from life (Figs 79, 80) and after protargol impregnation (Figs 81, 82). **79** Ventral view. **80** Lateral view. Red granules (c. 1 μm) close beneath the pellicle and in the ctyoplasm. **81, 82** Infraciliature in ventral and dorsal view.

pairs only. Dorsal cilia *in vivo c.* 3 μm long. Caudal cirri on kineties 1, 2, and 4.

COMPARISON WITH RELATED SPECIES. So far only 2 *Oxytricha* species with subpellicular granules have been described: *O. granulifera* Foissner & Adam, 1983 and *O. rubripuncta* Berger & Foissner, 1987. *Oxytricha longigranulosa* differs from these species in the shape, size, colour, and arrangement of the subpellicular granules and the number of dorsal kineties and adoral membranelles. The beginning of the morphogenesis is rather similar to that of *O. granulifera* (Foissner & Adam, 1983).

Steinia muscorum Kahl, 1932

DISCUSSION AND ADDITIONAL OBSERVATIONS (Figs 79–82, Tables 1, 11). Since 1982 we have observed many populations of this species and found them to be usually a little wider than that figured in Foissner (1982). Thus, we show the morphology of such a population. The biometrical data agree well with that of Buitkamp (1977*b*) and Foissner (1982).

In vivo 140–160 × 55–60 μm, about 2 : 1 flattened. Buccal area large, partly covered by a hyaline projection. Feeds on fungal spores, zooflagellates, testaceans (*Schoenbornia* sp.), and ciliates (*Odontochlamys* sp., *Opercularia* sp., *Gonostomum* sp.). Very rarely a seventh dorsal kinety, which consists of 2–4 basal body pairs only.

Urosoma octonucleata nov. spec.

DIAGNOSIS. *In vivo* about 140–180 × 25–40 μm, vermiform. 8 macronuclear segments and 25 adoral membranelles on average. 3–4 transverse cirri (including the ventral cirri nearby).

TYPE LOCATION: Soil in Garajan Kap, Madeira, Portugal.

DESCRIPTION (Figs 83–88, Tables 1, 11). Anterior end rounded, posterior one tapered and usually bent to the right. About 2 : 1 flattened, very flexible. Macronuclear segments *in vivo* 7 × 5 μm, arranged in a line slightly left of the median. Micronuclei in *vivo c.* 4 μm in diameter. Contractile vacuole distinctly above the middle of the cell, during diastole with 2 channels. Close beneath the pellicle numerous colourless, 2 μm large ellipsoid structures (mitochondria ?). Subpellicular granules absent. Cytoplasm colourless, with numerous 1 μm large, colourless granules and some *c.* 7 μm large food vacuoles containing bacteria. In the posterior part many cytoplasmatic crystals.

Adoral zone of membranelles about 23% of body length, the distal 4 membranelles slightly separated from the proximal, nearly perpendicular arranged part. Bases of the largest membranelles *in vivo c.* 5 μm wide. Buccal area very flat, undulating membranes nearly straight. Buccal cirrus inserted at the anterior end of the paroral membrane. Frontal cirri only slightly enlarged, *in vivo c.* 14 μm long. Cirrus behind the right frontal cirrus slightly enlarged, situated anteriorly to the remaining frontoventral cirri of the frontal area. Postoral ventral cirri arranged in a line. 2 transverse cirri slightly enlarged. Marginal cirri *in vivo c.* 10 μm long, posteriorly the distance among the cirri is distinctly wider than anteriorly. Dorsal cilia about 3 μm long. Dorsal kinety 1 and 4 anteriorly and posteriorly shortened, respectively. Caudal cirri on kineties 1–3.

Table 11 Biometrical characterization of *Steinia muscorum* (upper line) and *Ursoma octonucleata* (lower line)

Character	x̄	M	SD	SE	CV	Min	Max	n
Body, length	129.4	126.0	14.7	3.123	11.3	105.0	155.0	22
	141.2	145.0	13.5	4.072	9.6	105.0	155.0	11
Body, width	47.7	48.5	5.3	1.135	11.2	36.0	56.0	22
	25.8	25.0	1.9	0.585	7.5	22.0	28.0	11
Adoral membranelles, number	34.8	36.0	3.9	0.823	11.1	24.0	40.0	22
	25.1	25.0	0.7	0.211	2.8	24.0	26.0	11
Adoral zone of membranelles, length	42.1	42.0	4.9	1.043	11.6	32.0	52.0	22
	33.2	34.0	2.0	0.600	6.0	29.0	36.0	11
Macronuclear segments, number	2.0	2.0	0	0	0	2.0	2.0	22
	7.6	8.0	0.8	0.247	10.9	6.0	8.0	11
Distance 1[1]	16.0	15.5	4.0	0.846	24.8	11.0	24.0	22
	56.0	56.0	4.4	1.335	7.9	48.0	65.0	11
Posterior macronuclear segment, length	20.5	21.0	2.8	0.606	13.9	14.0	25.0	22
	7.6	8.0	0.5	0.157	6.9	7.0	8.0	11
Posterior macronuclear segment, width	9.5	10.0	1.7	0.371	18.4	6.0	14.0	22
	5.0	5.0	0.9	0.270	17.9	4.0	6.0	11
Micronuclei, number	2.5	2.0	0.6	0.127	23.9	2.0	4.0	22
	2.1	2.0	0.3	0.091	14.4	2.0	3.0	11
Posterior micronucleus, length	3.9	4.0	0.4	0.091	11.1	3.0	4.0	22
	3.0	3.0	0.2	0.055	6.0	2.8	3.5	11
Posterior micronucleus, width	2.8	2.8	0.2	0.035	5.8	2.5	3.0	22
	2.0	2.0	0.2	0.059	10.1	1.5	2.2	11
Left marginal row, number of cirri	24.7	25.5	2.6	0.552	10.5	20.0	29.0	22
	31.1	32.0	1.7	0.513	5.5	28.0	34.0	11
Right marginal row, number of cirri	23.0	23.5	1.7	0.369	7.5	20.0	25.0	22
	37.3	38.0	1.8	0.541	4.8	35.0	40.0	11
Frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	22
	3.0	3.0	0	0	0	3.0	3.0	11
Buccal cirri, number	1.0	1.0	0	0	0	1.0	1.0	22
	1.0	1.0	0	0	0	1.0	1.0	11
Frontoventral cirri, number	4.0	4.0	0	0	0	4.0	4.0	22
	4.0	4.0	0	0	0	4.0	4.0	11
Postoral ventral cirri, number	3.0	3.0	0	0	0	3.0	3.0	22
	2.9	3.0	0.3	0.091	10.4	2.0	3.0	11
Ventral cirri near the transverse cirri, number	2.0	2.0	0	0	0	2.0	2.0	22
	–	–	–	–	–	–	–	0
Transverse cirri, number[2]	5.0	5.0	0	0	0	5.0	5.0	22
	3.5	3.0	0.5	0.157	15.1	3.0	4.0	11
Caudal cirri, number	3.0	3.0	0	0	0	3.0	3.0	22
	3.1	3.0	0.3	0.091	9.6	3.0	4.0	11
Dorsal kineties, number	6.1	6.0	0.3	0.063	4.8	6.0	7.0	22
	4.0	4.0	0	0	0	4.0	4.0	11
Distance 2[1]	4.1	4.0	1.1	0.227	26.0	3.0	7.0	22
	14.2	15.0	2.4	0.711	16.6	10.0	18.0	11

[1]Distance 1, distance between the macronuclear segments (*S. muscorum*) and length of the macronucleus figure (*U. octonucleata*), respectively. Distance 2, distance between the posterior transverse cirrus and the posterior end of the cell.
[2]In *U. octonucleata* adjacent ventral cirri are included.

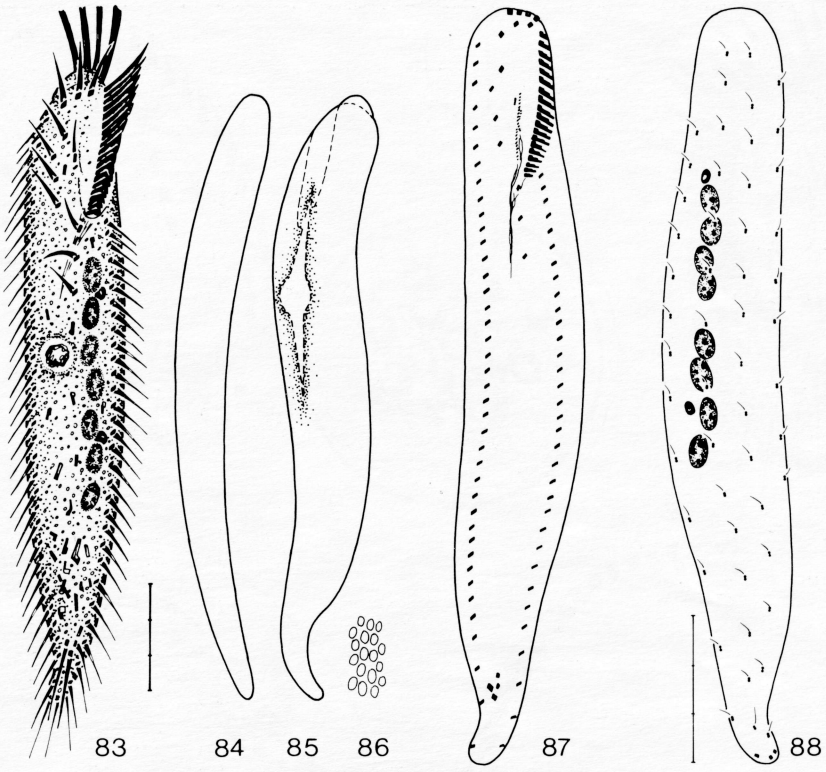
COMPARISON WITH RELATED SPECIES. The arrangement of the frontoventral cirri in the frontal area, the slightly enlargement of the cirrus III/2, and the body shape require the classification in the genus *Urosoma* Kowalewski, 1882 (Foissner, 1987*a*; Berger & Foissner, 1988*c*).

Urosoma octonucleata can be distinguished from the other congeneric species by the higher number of macronuclear segments and the lower number of transverse cirri (Kahl, 1932; Dragesco, 1972; Foissner, 1982, 1984, 1987*a*; Dragesco & Dragesco-Kerneis, 1986; Berger & Foissner, 1987). *In vivo, U. octonucleata* can be easily confused with *Hemisincirra polynucleata* Foissner, 1984, because the body shape, the nuclear apparatus, and the arrangement of the mitochondria close beneath the pellicle are very similar (Foissner, 1984, Abb. 63). Additionally, the infraciliature of the frontal area and the dorsal surface and many biometrical characters are largely identical. However, the species can be clearly separated by the number of postoral ventral cirri (*U. octonucleata* 3; *H. polynucleata* 1) and the number and the position of the transverse cirri including the adjacent ventral cirri (3–4, distinctly subterminal; 2, terminal).

Euplotes corsica nov. spec.

DIAGNOSIS. *In vivo* about 40 × 20 µm, oval, about hemispherical in cross-section. 10 frontoventral, 5 transverse, and 3–4 caudal cirri, 7–8 dorsolateral kineties. 22 adoral membranelles on average. Dorsal argyrome of double-eurystomus type.

TYPE LOCATION. Soil of a saline pool at the Etang d'Urbino, Corsica, France.

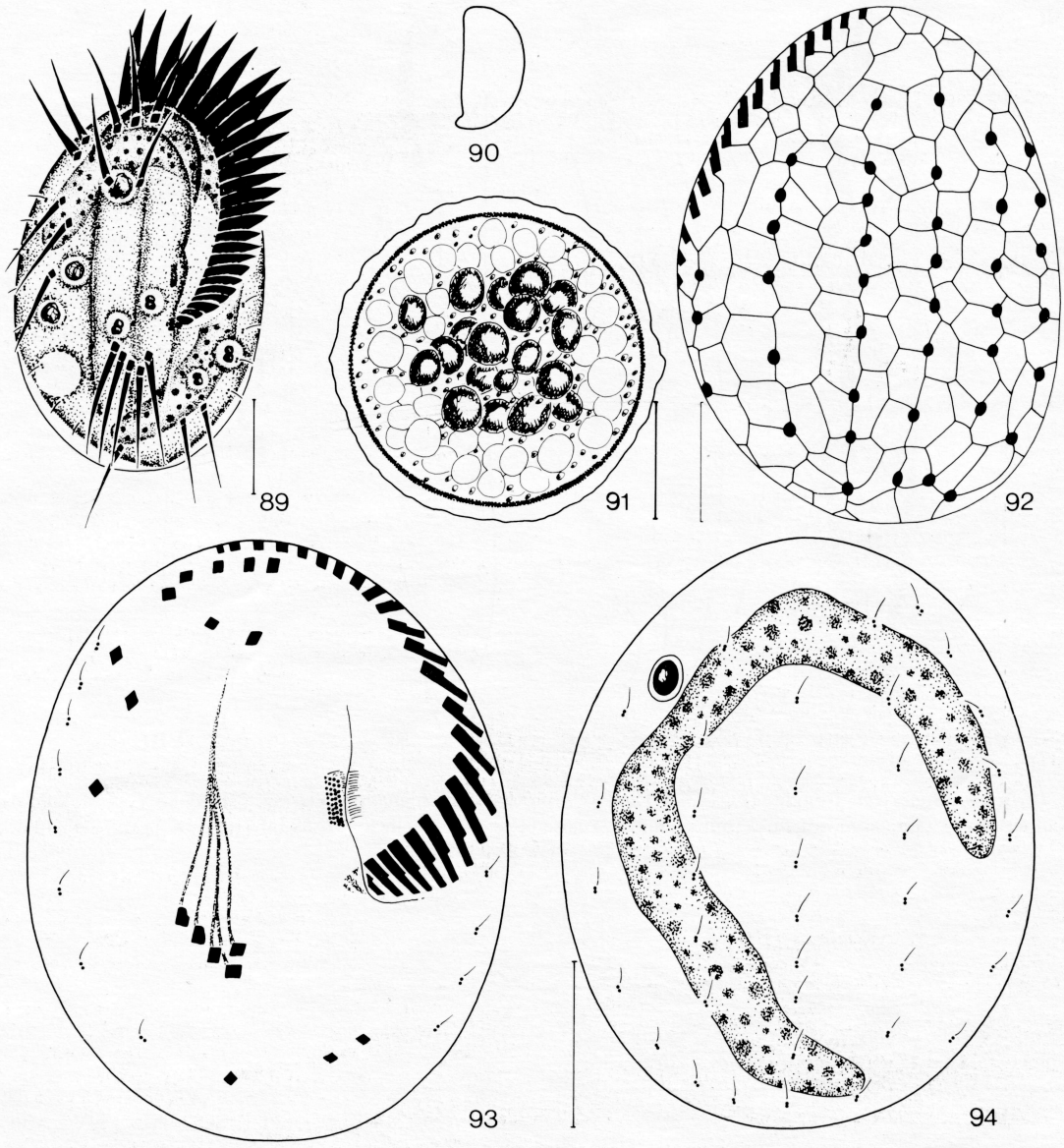


Figs 83–88 *Urosoma octonucleata* from life (Figs 83–86) and after protargol impregnation (Figs 87, 88). **83–85** Ventral, lateral, and dorsal view. **86** Colourless, c. 2 µm large structures (mitochondria?) close beneath the pellicle. **87, 88** Infraciliature in ventral and dorsal view.

Table 12 Biometrical characterization of *Euplotes corsica*

Character	$\bar{x}$	M	SD	SE	CV	Min	Max	n
Body, length	35.5	35.0	3.8	0.833	10.8	29.0	42.0	21
Body, width	27.6	28.0	2.6	0.567	9.4	22.0	32.0	21
Adoral membranelles, number	22.2	22.0	1.2	0.264	5.4	20.0	25.0	21
Adoral zone of membranelles, length	22.0	21.0	2.1	0.447	9.3	17.0	25.0	21
Paroral membrane, length	3.1	3.0	0.4	0.076	11.5	2.0	4.0	21
Macronucleus, length[1]	29.9	31.0	3.9	0.840	12.9	20.0	36.0	21
Macronucleus, width	4.7	4.0	0.9	0.197	19.2	4.0	6.0	21
Micronucleus, length	3.0	3.0	0.1	0.024	3.6	3.0	3.5	21
Micronucleus, width	2.2	2.0	0.3	0.055	11.7	1.8	2.5	21
Distance 1[2]	8.6	8.0	2.2	0.471	25.2	6.0	12.0	21
Frontal cirri, number	3.0	3.0	0	0	0	3.0	3.0	21
Distance 2[3]	4.0	4.0	0	0	0	4.0	4.0	21
Ventral cirri, number	7.0	7.0	0	0	0	7.0	7.0	21
Transverse cirri, number	5.0	5.0	0	0	0	5.0	5.0	21
Caudal cirri, number	3.2	3.0	0.4	0.087	12.6	3.0	4.0	21
Dorsolateral kineties, number	7.5	7.0	0.5	0.112	6.8	7.0	8.0	21
Dorolateral kinety 5, number of basal body pairs	7.5	8.0	0.9	0.203	12.3	6.0	9.0	21
Cyst, large diameter[4]	26.7	27.5	2.5	0.710	9.2	22.0	31.0	12
Cyst, small diameter[4]	25.1	25.0	2.4	0.679	9.4	21.0	28.0	12

[1]Distance between the anteriormost and posteriormost point of the macronucleus.
[2]Distance between the anterior end of the cell and the anterior end of the micronucleus.
[3]Distance between the right edge of the right and the left edge of the left frontal cirrus.
[4]From life culture material.



Figs 89–94 *Euplotes corsica* from life (Figs 89–91), after wet silver impregnation (Fig. 92), and after protargol impregnation (Figs 93, 94). **89, 90** Ventral and lateral view. **91** Cyst. **92** Dorsal argyrome. **93, 94** Infraciliature in ventral and dorsal view.

DESCRIPTION (Figs 89–94, Tables 1, 12). Posterior third of the cell with a hyaline edge, especially on the right side. Ventral surface with 3 median ridges. Dorsal surface only slightly ridged, protrudes beyond the ventral surface posteriorly. About 2 : 1 flattened. Contractile vacuole at about the level of the transverse cirri, conspicuously near the body margin. Cytoplasm colourless, filled with many *c.* 5 µm large food vacuoles and some vacuoles containing 4 µm large, dumbbell-shaped crystals. Rapid movement.

Adoral zone of membranelles about 62% of body length. Cirri fine, transverse cirri *in vivo c.* 20 µm long, do not protrude beyond the posterior margin.

Cyst slightly elliptical, wall about 1.4 µm thick. Outer layer yellowish, fine irregularly wrinkled. Cytoplasm densely filled with bright vacuoles (3–4 µm in diameter) and 3–5 µm large clod-like inclusions.

COMPARISON WITH RELATED SPECIES. *Euplotes corsica* is very probably conspecific with the *E. alatus* Kahl, 1932 of Borror (1968) from a tidal marsh pond. It differs from the original description of *E. alatus* and the population of Gelei (1938) in the shape and size of the body and the number of dorsolateral kineties, respectively. It can be distinguished from the other species of the 'double-eurystomus' type listed in Curds (1975) in the body size and the nearly hemispherical body shape to name but two characters. The rather similar limnetic species *E. palustris* Ten Hagen, 1980, which is 45–55 µm long, has a dorsal argyrome of the 'double-patella' type.

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