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Deviata estevesi sp. n. (Ciliophora: Spirotrichea), a new ciliate protist from a restinga lagoon in Rio de Janeiro, Brazil

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Summary. In samples collected from the Cabiúnas Lagoon, located in the north region of Rio de Janeiro, Brazil, we found *Deviata estevesi* sp. n., a spirotrich ciliate protist characterized as: *Deviata* measuring 80-110 × 25-50 µm *in vivo*, body flexible and contractile; narrowed at the anterior end and broad at the posterior end; cortical granules absent; dark coloration under dissection microscope. Cirri arranged in seven rows right of adoral zone of membranelles and four rows left of it. Contractile vacuole located in the left mid-body, away from the margins. Buccal cirrus lacking. Macronucleus usually composed of two small ovoid or elliptical nodules. Two dorsal kineties, with right kinety posterior shortened. Stomatogenesis begins with oral primordium of the opisthe developing from very close to the terminal cirrus of row R3.

Key words: *Deviata estevesi* sp. n., Kahliellidae, lagoon, Macaé, restinga, Rio de Janeiro, South America.

INTRODUCTION

Eigner (1995) has redefined the family Kahliellidae Tuffrau, 1979, as "Euhypotrichina with more than one longitudinal cirral row on right side of body. Neokinetal anlagen develop during morphogenesis". In the same paper, he erected the genus *Deviata* to include the new species *Deviata abbrevescens*, placed within the Kahliellidae, and *D. bacilliformis*, as new combination for *Kahliella bacilliformis* (Gelei, 1954) sensu Gelei (1954) and Berger and Foissner (1987). Eigner also mentioned that the French population of *Kahliella bacilliformis*, presented by Fleury and Fryd-Versavel (1984) could actually be a third species of *Deviata*, because of its ciliary configuration. In subsequent papers, Eigner (1997, 1999) transferred the genus *Deviata* to the family Oxytrichidae (Ehrenberg, 1838), based on morphogenetic studies. Such discussion is not in focus here.

In this paper, we present a morphological study of *Deviata estevesi*, a new species discovered in samples of brackish water with bottom sediment from a coastal lagoon located in Rio de Janeiro (Brazil) and compare it with the remaining congeners. This species is also the first occurrence of *Deviata* reported for Brazilian locations.

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MATERIALS AND METHODS

Study area: the Cabiúnas Lagoon (Figs 1, 2) is a restinga lagoon located in the city of Macaé (Rio de Janeiro), and is part of a complex of coastal lakes in the Parque Nacional da Restinga de Jurubatiba. This is a federal area of ecological preservation, which extends over 44 km along the northwest coast of the Rio de Janeiro State, between the cities of Macaé and Quissamã. Limnological studies on this and the other lagoons in this region were conducted by Esteves *et al*. (1983) and Petrucio (1998).

Methodology: *Deviata estevesi* was discovered in samples of brackish water and sediment from the bottom of the lagoon (1.2 m depth), in July of 2003. The water was dark colored due to the heavy concentration of detritus in suspension and the presence of humic substances. Samples were stored in hermetic flasks and brought to the laboratory the same day they were obtained. Raw cultures in Petri dishes were established by adding crushed rice and wheat grains to aliquots of the samples. After two days, the ciliates were highly abundant and were isolated by means of micropipettes under the dissecting microscope. Morphological studies included *in vivo* observations, protargol-impregnation following the protocol proposed by Dieckmann (1995), and scanning electronic microscopy (SEM) according to Silva-Neto (1994).

Measurements of living specimens and observations on the body outline shape in various angles were made at a magnification of 100-200× on coverless slides. Magnification of 630-1000× with differential interference contrast (DIC) was used to check for the presence of cortical granules. The approximate measures of cirri and adoral membranelles were made at 400-1000× with phase contrast. The biometric data presented in Table 1 was made from observations at a magnification of 1000×, using bright field microscopy. The values were obtained from protargol impregnated interphasic specimens selected according to the criteria proposed by Berger and Hatzidimitriou (1978).

Continuous biometric characters were obtained as following: (i) body length and width are the measurement of the major longitudinal body axis and its central orthogonal line; (ii) length and width of the macronuclear nodules were obtained by measuring each nodule along its major orthogonal axes in respect to their orientation; (iii) the distance between macronuclear nodules corresponds to the distance measured from the internal opposing end of each nodule, parallel to the body length; (iv) the length of adoral zone of membranelles (AZM), corresponds to the distance between the anterior end of the body to the basis of the first proximal membranelle. The statistic procedures were conducted according to Sokal and Rohlf (1981) and calculated with a 99% confidence interval.

The drawings of living specimens are reconstructions based on sketches and notes taken from observations of organisms *in vivo.* Drawings of protargol-impregnated specimens were made with a camera lucida, at 1000× magnification, using bright field microscopy. They are based on the most representative specimens present in the slides. All drawings are shown with the anterior end of the organisms pointing to the top of the page.

RESULTS

Deviata estevesi sp. n.

Diagnosis: Size *in vivo* about: 100 × 40 µm (n=15). Dark, or almost black coloration under dissection microscope. Cortical granules lacking. Cytoplasm filled with

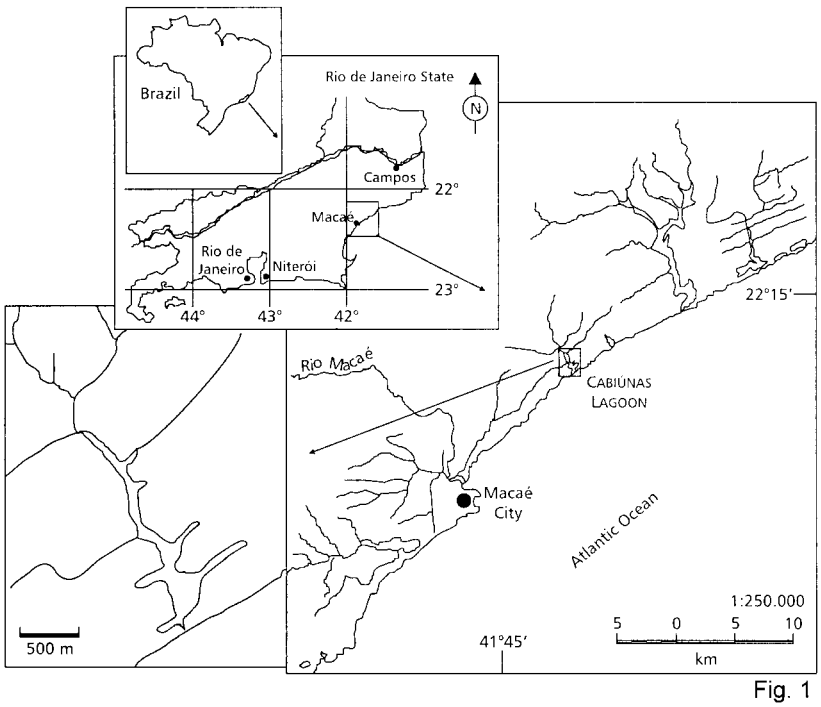
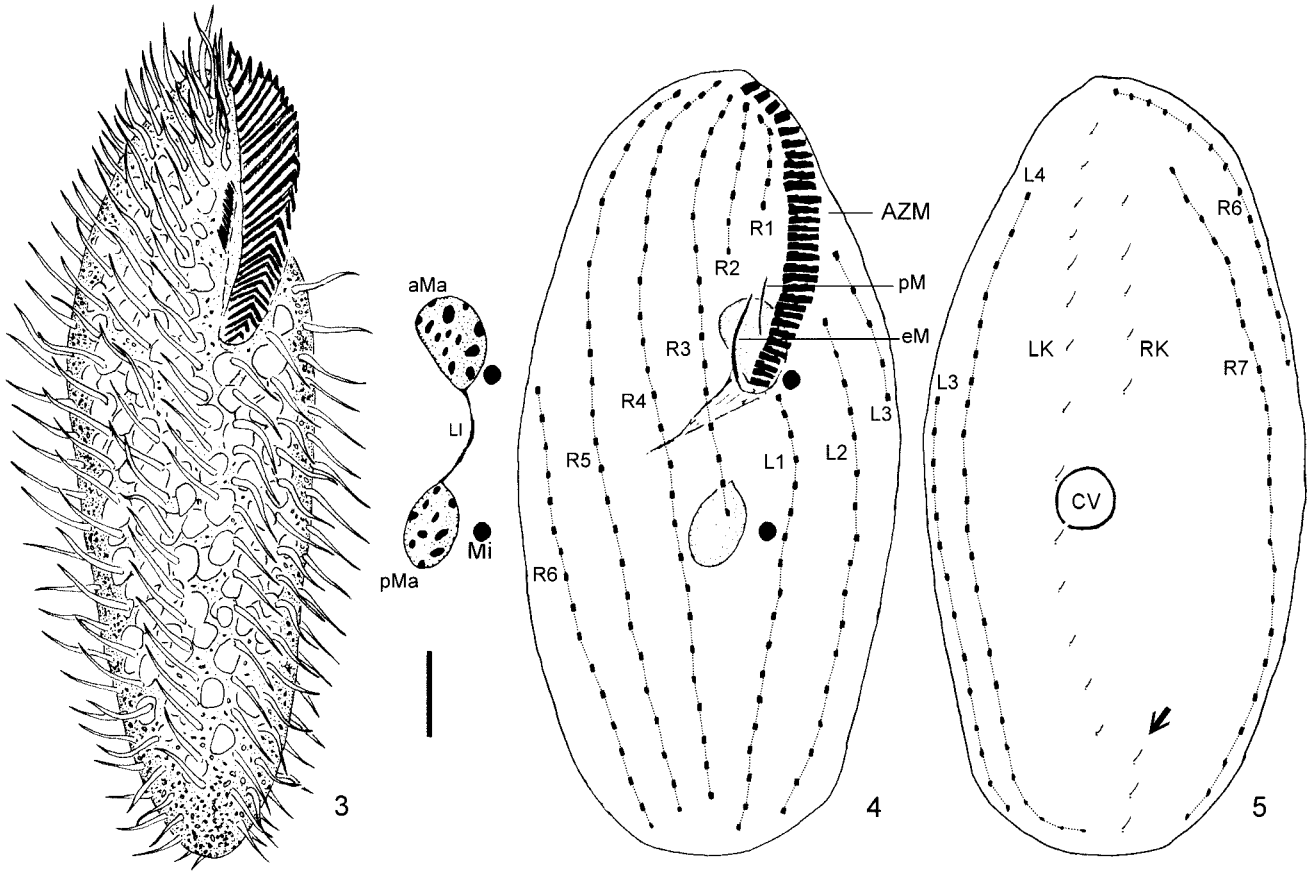


Fig. 1

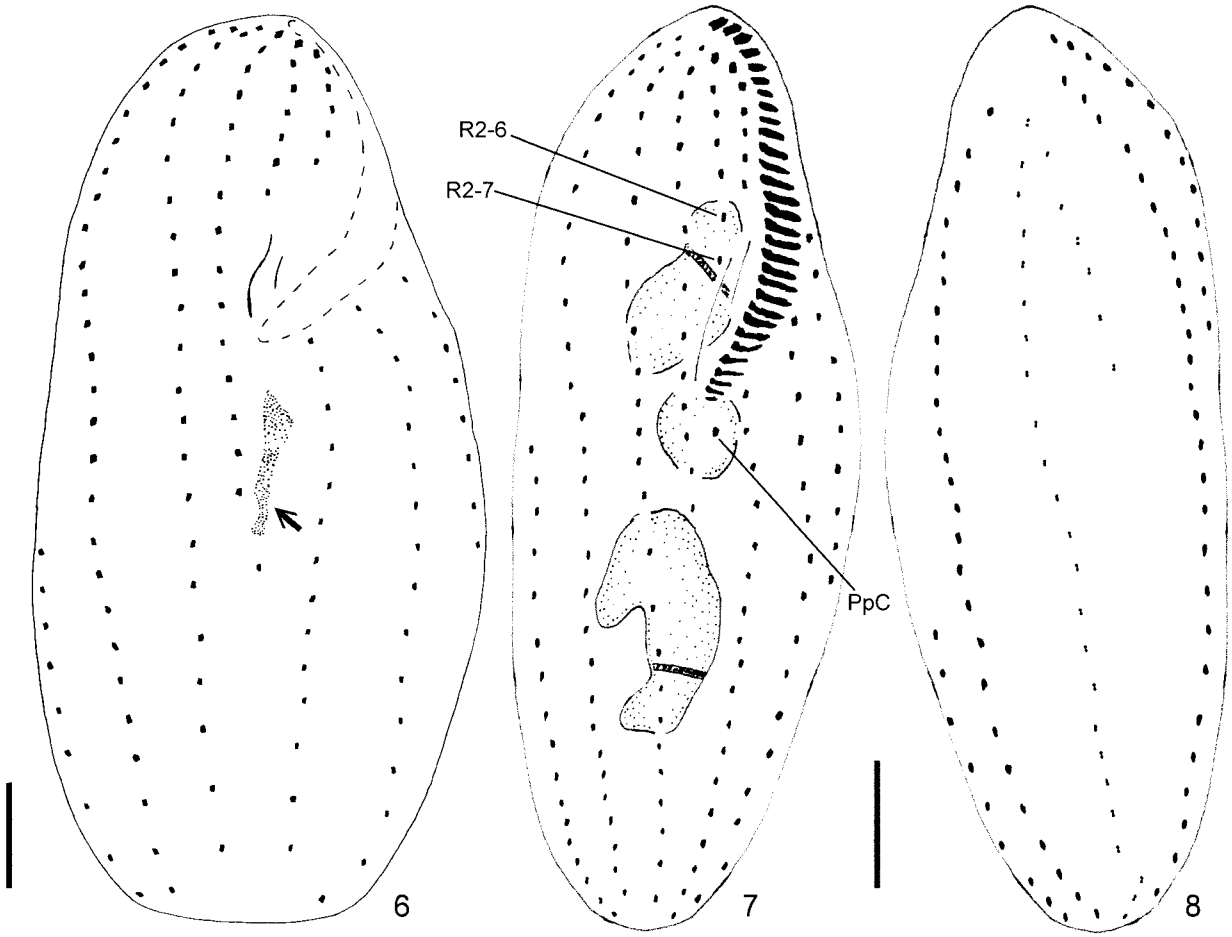
Figs 1, 2. The Cabiúnas Lagoon; **1** - map showing the location of the lagoon along the Brazilian coast (from Branco 1998); **2** - picture showing the location from where the samples containing *Deviata estevesi* sp. n. were collected.



Figs 3-5. *Deviata estevesi* sp. n. **3** - ventral side of living *specimen*; **4** - drawing of protargol impregnated specimen, showing ventral cirral pattern, morphology and relative position of nuclear apparatus; **5** - drawing of protargol impregnated specimen, showing dorsal cirral pattern and dorsal kineties (the cilia on dorsal kineties were reconstructed based on scanning electron micrographs). Arrow points to the short file of cilia located close to the posterior end of body. aMa - anterior macronuclear nodule, AZM - adoral zone of membranelles, eM - endoral membrane, L(x) - cirral rows located left of adoral zone of membranelles, LI - linking isthmus between the two macronuclear nodules, LK - left dorsal kinety, Mi - micronucleus, pM - paroral membrane, pMa - posterior macronuclear nodule, R(x) - cirral rows located right of adoral zone of membranelles, RK - right dorsal kinety. Scale bar 10 µm.

compact crystals measuring about 3-5 µm. Body flexible and contractile, with outline variable, but usually narrowed at the anterior end and broad at the posterior end. Dorsoventral flattened in the anterior region and ellipsoid in cross section below the cell equator (Figs 3, 10, 11). With small, round contractile vacuole located at the mid-body, away from its margins. Cirri arranged in 7 rows right of adoral zone of membranelles and 4 rows left of it. Row R1 with 5-7 cirri; R2 with 6-9 cirri; R3 always ending in equatorial region of body. Buccal cirrus absent. Nuclear apparatus composed of usually two macronuclear nodules and two micronuclei. Two dorsal kineties, right kinety posterior shortened. A short file of dorsal cilia, possibly an extension of the right kinety, is present at the posterior region of body.

Morphological characterization: The cytoplasm is filled with numerous compact, 3-5 µm big, transparent light-greenish crystals that often cause cell rupture during fixation and do not stain with protargol, but remain visible in slides (Figs 3, 13-18, 22). Such crystals tend to be less numerous in specimens of old cultures, possibly due to starvation. The crystals are located about 3 µm distant from the body wall, separated by a "layer" containing a smaller, irregular shaped kind of cytoplasmic granulations (Fig. 18). The contractile vacuole is round and lacks lacunar collector ducts. It is inconspicuously located at the mid-body of the organism, close to its inner dorsal margin, and below the level of the back side of the adoral zone of membranelles (AZM) (Figs 5, 9, 17). Full diastole occurs at intervals of approximately



Figs 6-8. *Deviata estevesi* sp. n. **6** - ventral side of protargol impregnated specimen showing development of oral primordium, pointed by a short arrow; **7** - ventral side of protargol impregnated specimen which shows a postperistomial cirrus and very irregular shaped macronuclear nodules; **8** - same specimen, in dorsal view. PpC - postperistomial cirrus, R2-6 - 6th cirrus of 2nd cirral row right of adoral zone of membranelles, R2-7 - 7th cirrus of 2nd cirral row right of adoral zone of membranelles. Scale bars 10 µm.

10 seconds, followed by a brief systole lasting about 1 second.

The adoral zone of membranelles shows a conspicuous shape for this genus, and is composed of 29-33 membranelles. It occupies about 38% of body length. In addition, as observed in similar species, it terminates at the apex of body, not extending much into the right margin. The membranelles located in the middle region of AZM measure about 5 µm. Paroral membrane anterior to endoral, never intersecting it (Figs 3, 4, 14-16, 29, 30).

All studied specimens show seven cirral rows right of the AZM and four rows left of it. All cirral rows are comprised of very thin cirri, which in the equatorial region, are about 8-12 µm long and formed by four cilia (Fig. 31). Rows R1 and R2 end anterior to the infundibulum. Row R3 ends in the equatorial region of the cell. Row R4 begins anterior to the first cirrus of row R3, extending along the ventral surface to the posterior end of the cell. Row R5 begins to the right of R4, and usually at the level of the first cirrus in R3. The rows R6 and R7 begin in the dorsal region, but R6 twists to the ventral side in the posterior region of the cell (Figs 4, 5).

The first row left of the AZM, L1, begins close to the infundibulum border, posterior to the proximal adoral membranelles and extends to the posterior end of the cell. Row L2 begins to the left of L1, starting from the middle part of the AZM, extending to the posterior region of the cell. Row L3 begins close to L2, and twists to the dorsal surface in the equatorial region. It ends close to the posterior end of the cell, curving inwards to the opposite body margin. Row L4 begins on the dorsal

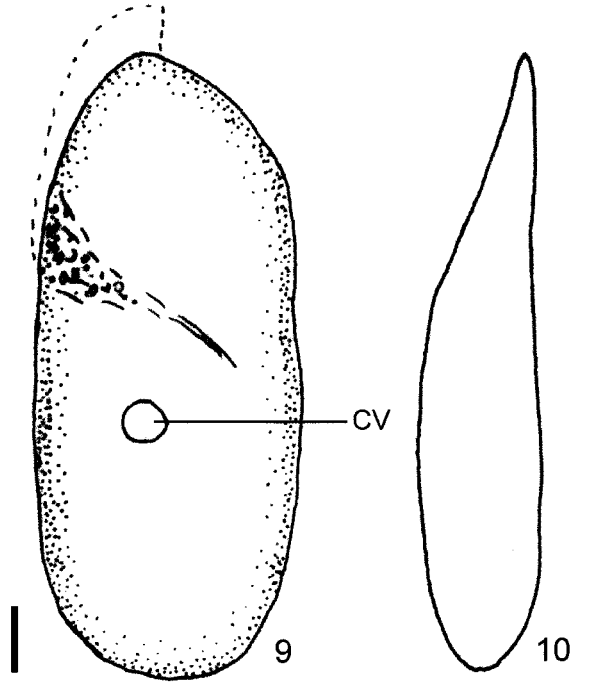
Table 1. Biometric characterization of *Deviata estevesi* sp. n. All measurements are in µm. $\bar{x}$ - arithmetic mean, M - median, SD - standard deviation of the arithmetic mean, SE - standard error of the arithmetic mean, CV - coefficient of variance (in %), Min - minimum value observed within the sample, Max - maximum value observed within the sample, n - sample size.

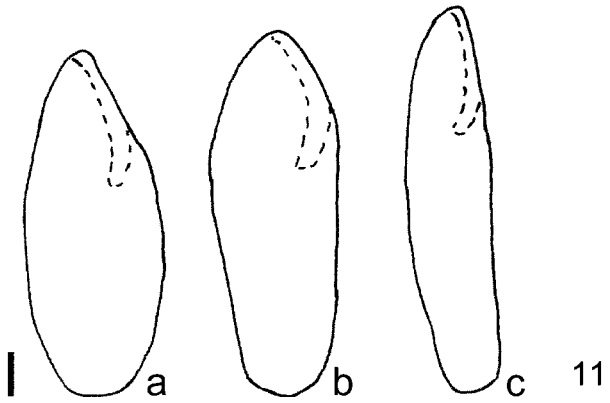
Character	$\bar{x}$	M	SD	SE	CV	Min	Max	n
Body length	86.20	84	7.42	1.49	8.61	75.00	100.00	25
Body width	42.72	44	8.73	1.75	20.42	27.00	60.00	25
Length of AZM	32.50	32.50	2.86	0.61	8.78	28.00	40.00	22
Number of adoral membranelles	30.32	30.00	1.52	0.33	5.03	28	33	22
Number of cirri rows left of AZM	4.00	4.00	0	0	0	4	4	20
Number of cirri in L1	17.90	19.00	1.77	0.46	9.90	14	20	15
Number of cirri in L2	18.20	18.00	2.24	0.58	12.32	14	20	15
Number of cirri in L3	21.88	22.00	1.76	0.43	8.06	19	25	17
Number of cirri in L4	24.47	24.00	3.20	0.78	13.09	20	32	17
Number of cirri rows right of AZM	7.00	7.00	0	0	0	7	7	25
Number of cirri in R1	5.95	6.00	0.50	0.11	8.36	5	7	21
Number of cirri in R2	7.38	7.00	0.86	0.19	11.71	6	9	21
Number of cirri in R3	16.00	16.00	1.92	0.43	12.00	13	20	20
Number of cirri in R4	24.72	24.00	2.52	0.59	10.18	22	32	18
Number of cirri in R5	27.94	28.00	2.14	0.52	7.64	24	32	17
Number of cirri in R6	31.38	31.50	2.22	0.55	7.07	25	35	16
Number of cirri in R7	27.75	27.00	1.96	0.57	7.06	25	32	12
Number of dorsal kineties	2.00	2.00	0	0	0	2	2	20
Number of macronuclear nodules*	2.10	2.00	0.45	0.10	21.30	2	4	20
Length of anterior macronclear nodule*	13.32	13.00	2.10	0.45	15.78	10.00	19.00	22
Width of anterior macronuclear nodule*	8.23	7.5	2.22	0.47	27.03	5.00	12.00	22
Length of posterior macronuclear nodule*	12.41	12.00	1.99	0.41	15.46	9.00	16.00	22
Width of posterior macronuclear nodule*	8.09	8.5	2.22	0.47	27.48	5.00	14.00	22
Distance between macronucelar nodules*	14.09	14.00	3.32	0.71	23.58	9.00	20.00	22
Number of micronuclei	2.16	2.00	0.37	0.07	17.32	2	3	25
Diameter of micronuclei	2.86	3.00	0.31	0.06	10.73	2.00	3.00	25

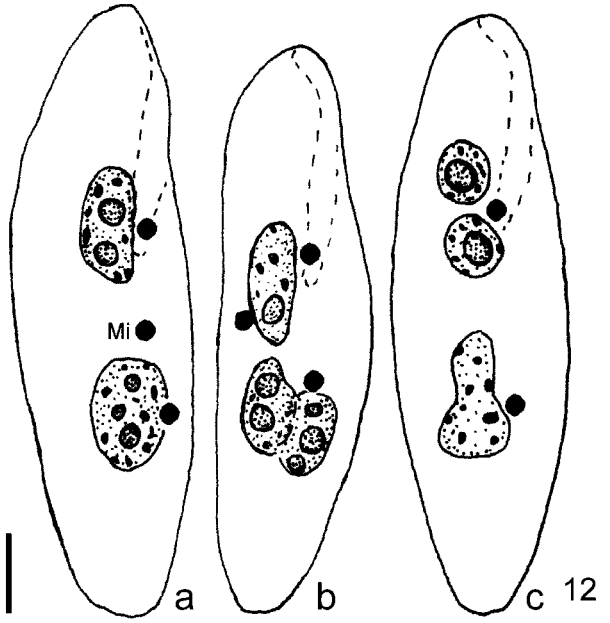
* Measured only in specimens with two not bisected macronuclear nodules.

surface, not twisting to the ventral side. It ends close to the end of L3, curving inwards even more to the opposite margin (Figs 3-5, 21, 23, 24, 29-31). One specimen in a sample of 25 showed a postperistomial cirrus immediately posterior to the infundibulum vertex (Figs 7, 8). This specimen, which has a rather irregular macronucleus, also has the terminal cirrus of row R2 placed close to the anterior right of the endoral membrane. Such cirrus and the one anterior to it are relatively more spaced than the other cirri in this row. On the dorsal side, there are two ciliary rows (kineties) composed of dikinetids (Figs 5, 8, 21, 28, 32). The left kinety begins anterior to the first dikinetid of the right kinety, extending to the posterior region of the organism. The right kinety usually begins close to the anterior region of kinety R7, and is interrupted in the equatorial region of the organism. In the posterior end of body, there is a small file of 3-5 (n=5; $\bar{x}$ =3.40; SD=0.89) dikinetids. Its anteriormost dikinetid is always aligned to the terminal dikinetid of the right kinety. Therefore, this file is possibly the continuation of the right dorsal kinety.

The nuclear apparatus is usually composed of two small, ovoid macronuclear nodules and 2-3 micronuclei. On average, the anterior macronuclear nodule measures 13 × 8.5 µm and the posterior nodule measures 12.5 × 8 µm (n=20). In the specimens with fewer cytoplasmic crystals, the nodules tend to be elliptical, sometimes irregular shaped, and show increased size in relation to the body overall measurements. In some specimens, we noticed that the macronuclear nodules are narrowed in their equatorial region or bisected (Figs 12, 23-26). The macronucleus contains internal bodies that measure 1-5 µm, and the larger of these stain in lighter tonality than the smaller ones (Figs 24, 26). The micronuclei measure about 3 µm in cross section, and are in number of two or three, often adjacent to a macronuclear nodule. The entire nuclear apparatus is located in the middle-left region of body, away from both lateral margins (Figs 4,







20). The anterior macronuclear nodule is usually placed posterior to the proximal region of the AZM. The nodules are linked by a very thin isthmus, as reported by Eigner (1995) for *D. abbrevescens* and by Walker and Goode (1976) for other spirotrich ciliates. This structure could only be seen in a few interphasic specimens, possibly because it stains poorly with protargol.

In a sample of 25 specimens, some other variations of the nuclear apparatus morphology were observed in cells with fewer cytoplasmic crystals: (i) four specimens with three micronuclei; (ii) two specimens with macronuclear nodules narrowed in their equatorial region or bisected; (iii) one specimen with four macronuclear nodules; and (iv) one specimen with a very irregular shaped macronucleus (Figs 23-26). Discoid macronuclear DNA replication bands, characteristic in spirotrich ciliates (Olins and Olins 1994), appear at the anterior half of the anterior nodule and posterior half of the posterior nodule (Figs 23, 26).

Stomatogenesis begins with oral primordium of the opisthe developing from very close to the terminal cirrus of row R3 (Figs 6, 22). The biometric characterization of *Deviata estevesi* is shown in Table 1.

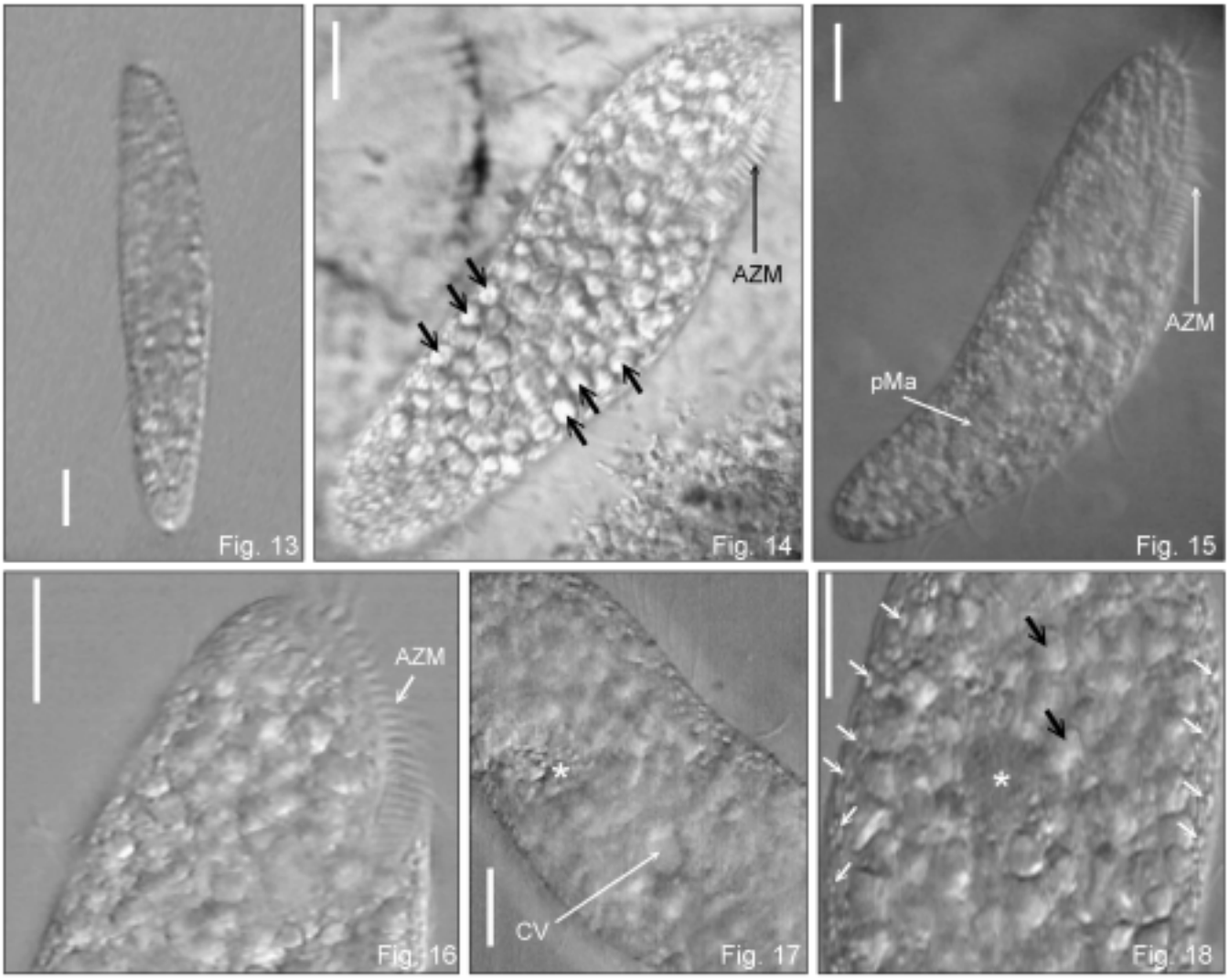
Type specimens: slides containing the holotype (IBZ-UFRJ 0008-6-1 slide) and paratypes (IBZ-UFRJ 0008-7-1 slide) of *Deviata estevesi* were deposited in the collection of Laboratório de Protistologia, Dept. de Zoologia, Inst. de Biologia - CCS, Universidade Federal do Rio de Janeiro (UFRJ).

Etymology: species name in dedication to Prof. Dr. Francisco de Assis Esteves, coordinator of Núcleo de Pesquisas Ecológicas de Macaé - NUPEM.

Type locality: Cabiúnas Lagoon, Macaé - RJ, Brazil. Geographic coordinates of sampling site: S 22° 17'46.7" W 41° 41' 32.3". Water characteristics: pH 7.24; dissolved [O_2] 3.29 mg/dm^3; temperature 22.9°C; conductivity 1875 µS; salinity 1.0‰.

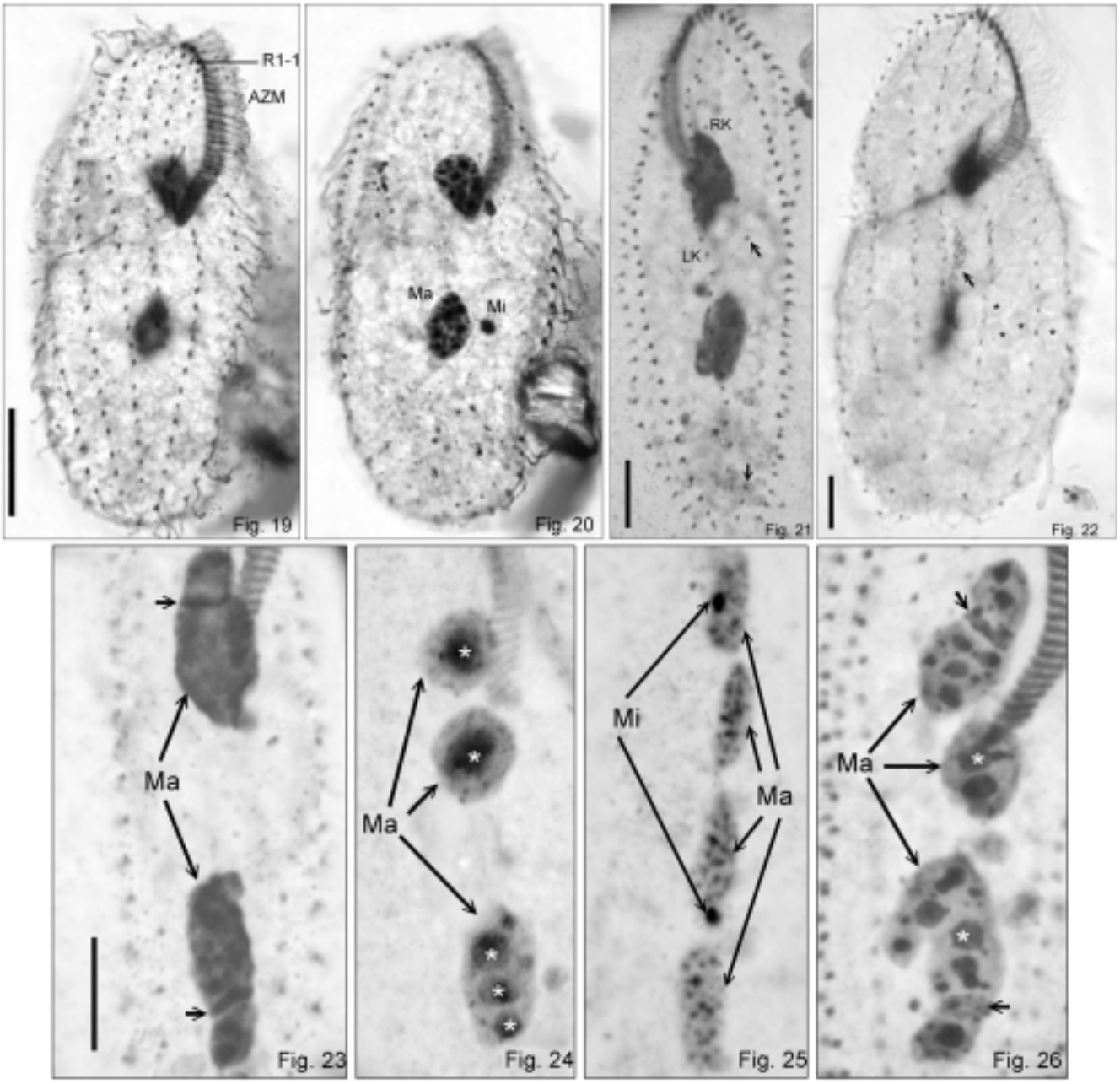
Ecological remarks: *Deviata estevesi* is bacterivorous and occurred simultaneously with *Coleps*

Figs 9-12. *Deviata estevesi* sp. n. **9** - dorsal surface of living specimen squeezed under a coverslip, showing contractile vacuole position; **10** - scheme of specimen in lateral view, from life; **11 a-c** - schematic drawings showing shape variations observed from living specimens under stereoscopic microscope. CV - contractile vacuole. **12a-c** - schematic drawings of anomalous nuclear apparatus present in protargol impregnation slides. **a** - with elliptical, enlarged macronuclear nodules and 3 micronuclei, **b** - specimen showing elliptical anterior and irregular shaped macronuclear nodule and posterior macronuclear nodule, with 3 micronuclei, **c** - macronucleus with bisected anterior nodule and narrowed posterior nodule, 2 micronuclei. Scale bars 10 µm.

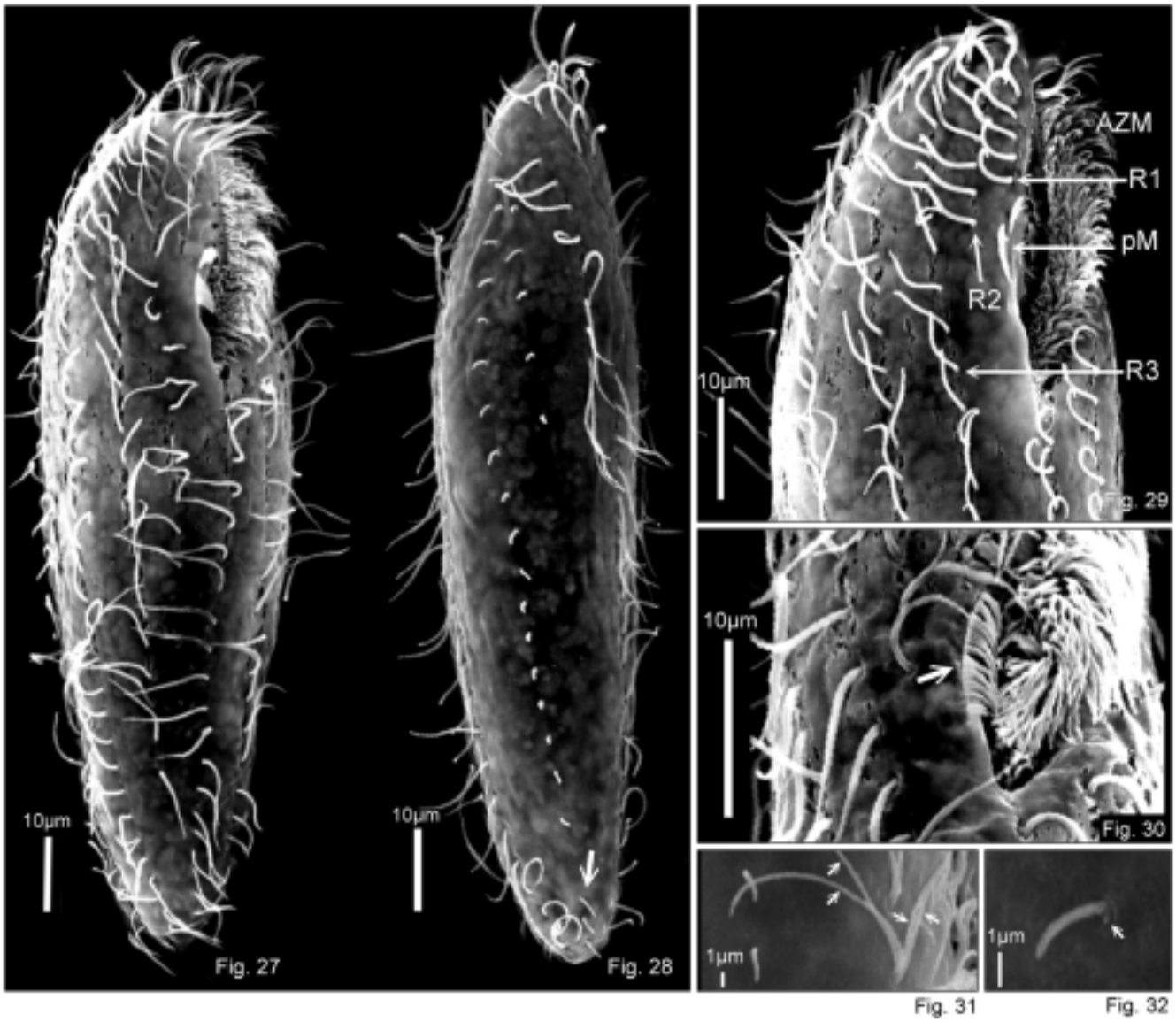


Figs 13-18. Light micrographs of living *Deviata estevesi* sp. n. **13 -** free motile specimen seen in dorsal view; **14 -** specimen seen under a coverslip, showing ventral surface and cytoplasmic crystals, marked by short black arrows; **15 -** specimen with very few cytoplasmic crystals; **16 -** anterior region of ventral surface, showing detail of the adoral zone of membranelles; **17 -** dorsal view of specimen heavily squeezed under a coverslip, showing contractile vacuole, located right below the infundibular region. Asterisk marks the back side of the oral region; **18 -** specimen showing macronuclear nodule (asterisk), cytoplasmic crystals (short black arrows) and layer with cytoplasmic granulations (short white arrows). AZM - adoral zone of membranelles, CV - contractile vacuole, pMa - posterior macronuclear nodule. Scale bars 10 µm.

elongatus Ehrenberg, 1830, *Cristigera* sp., and some scarce specimens of *Brachonella spiralis* (Smith, 1897) and *Saprodinium dentatum* Lauterborn, 1901. In enrichment cultures, *D. estevesi* was the only species left after 6-8 days, with the exception of few specimens of *Cristigera* sp. and numerous specimens of *Chilodonella uncinata* Ehrenberg, 1838, which had excysted. An important observation about *D. estevesi* is that it does not show highly thigmotactic behavior. It sometimes used to glide in the bottom of Petri dishes, but very rarely attached to sediment particles and crawled over them, as seen in other interstitial or bottom-dwelling spirotrichs (Kattar 1970). Eigner (1995) reported that *D. abbrevescens* sometimes stays anchored in the bottom of Petri dishes by its anterior end. Such behavior was not observed in *D. estevesi*, which kept swimming among sediment particles most of the time, rotating around its major body axis. It was not observed to occur in the water column high above the sediment, neither was present in the samples of sediment with water



Figs 19-26. *Deviata estevesi* sp. n. protargol impregnated specimens. **19** - ventral side, showing cirral pattern and adoral zone of membranelles; **20** - nuclear apparatus; **21, 22.** *Deviata estevesi* sp. n. protargol impregnated specimens; **21** - dorsal side, showing dorsal cirral pattern and dorsal kineties. Short arrows indicate the gap between the terminal region of the right dorsal kinety and the small file of cilia located close to the posterior border of cell; **22** - specimen showing oral primordium formation (short arrow). Asterisks mark some of the cytoplasmic crystals, which do not stain with protargol, however, remain visible after the process; **23-26 -** variations of *Deviata estevesi* sp. n. nuclear apparatus found in silver impregnated slides; **23 -** irregular, elongated nodules. Short arrows pointing to the discoid replication bands; **24 -** anterior nodule bisected; **25 -** with four macronuclear nodules; **26** - very irregular- shaped nodules. Asterisks on Figs 24 and 26 mark some large internal bodies which stain in different tonality (see text). AZM - adoral zone of membranelles, Ma - macronucleus, Mi - micronucleus, LK - left dorsal kinety, RK - right dorsal kinety. R1-1 - first cirrus of first cirral row right of adoral zone of membranelles. Ma - macronuclear nodules, Mi - micronuclei. Scale bars 10 µm (21, 23-26); 20 µm (19, 20, 22).



Figs 27-32. *Deviata estevesi* sp. n. scanning electron micrographs. **27** - ventral side; **28** - dorsal side. Short arrow marks the small file of cilia located close to the cell posterior border; **29** - ventral side, close view of anterior region, showing its cirral pattern; **30** - detail of the paroral membrane, marked by short arrow; **31** - detail of cirrus located in the equatorial region, formed by four cilia, which are indicated by short arrows; **32** - dorsal dikinetid, showing cilia and posterior aciliferous kinetosome, marked by a short arrow. AZM - adoral zone of membranelles, pM - paroral membrane, R1, R2, R3 - first, second and third cirral rows right of adoral zone of membranelles, respectively.

collected along the year of 2001, from the margin adjacent to the sand cord that separates the lagoon from the sea (Paiva and Silva-Neto 2004).

DISCUSSION

This species was included in genus *Deviata* because it matches most of the features mentioned in the original diagnosis by Eigner (1995), that is: it shows at least one cirral row right of AZM which ends in the equatorial region of body; parental rows are not preserved after division, which can be noticed by the constant number of cirral rows.

The most obvious difference from the other two congeners is the ventral cirral pattern in the anterior end of body (Figs 3, 4, 19, 21, 29, 30), which is highly constant in the studied population. In *Deviata abbrevescens* and

Table 2. Comparison among *Deviata abbrevescens*, *D. bacilliformis* and *D. estevesi* sp. n.

Character[1]	*Deviata abbrevescens*[2]	*Deviata bacilliformis*[3]	*Deviata estevesi*
Morphology of contractile vacuole	Small, round shaped vacuole, located left-midbody margin.	Slighty elongated vacuole, with lacunar collector ducts, located close to the left margin of body, extending from behind AZM to the proximity of the posterior end of body	Small, round shaped vacule, located at mid-body, away from the margins. (Figs 5, 9, 17)
Body size	90-300 × 16-40 µm ($\bar{x}$ = 172.4 × 27.1 µm; n = 25)	112-145 × 17-25 µm ($\bar{x}$ = 124.1 × 19.3 µm; n = 15)	75-100 ($\bar{x}$ = 86.2 µm) × 27-60 µm ($\bar{x}$ = 42.7 µm); n = 25
Length of AZM	23-32 µm ($\bar{x}$ = 27.7 µm; n = 20)	21-27 µm ($\bar{x}$ = 23.7µm; n = 15)	28-40 µm ($\bar{x}$ = 32.5 µm; n = 22)
Number of adoral membranelles	19-26 (M = 21; n = 20)	18-21 (M = 20; n = 15)	28-33 (M = 30; n = 22)
Number of dorsal kineties	2 (n = 20)	1 (n = 15)	2 (n = 25)
Morphology of macronuclear nodules[4]	2 elongated nodules, measuring about 2/3 of body length. Posterior nodule measures 20-100 ($\bar{x}$ = 50 µm; n = 25) × 4-8 µm ($\bar{x}$ = 5.2 µm; n = 20)	2–4 small, ellipsoid nodules (M = 2; n = 15). Posterior macronuclear nodule measuring 11-34 ($\bar{x}$ = 20 µm) × 4-7 µm ($\bar{x}$ = 5.8 µm); n = 15. Nodules sometimes bisect.	2 (rarely 4) small, variable shaped[5] nodules (n = 20). Posterior nodule measuring 9-16 ($\bar{x}$ = 12.4 µm) × 5-14 µm ($\bar{x}$ = 8.1); n = 22. Nodules sometimes bisect.

[1] Arithmetic mean $\bar{x}$ is shown for continuous characters. For discrete characters, median (M) shown; [2] Data from Eigner (1995); [3] Data from Berger and Foissner (1987); [4] Only the posterior nodule was used for comparison, because biometric data from the anterior nodule of *D. abbrevescens* and *D. bacilliformis* was not provided by the referred authors. Sometimes, *D. estevesi* may present 4 macronuclear nodules. See text; [5] The shape of macronuclear nodules has shown to be highly variable in this species, tending to be elliptical or irregular in specimens from old cultures. See text.

D. bacilliformis, the cirri in the first and second rows right of AZM are organized in sets of distinct, isolated frontal cirri and buccal cirrus. In *D. estevesi*, these rows, named in this paper as R1 and R2, are composed of 5-7 cirri and 6-9 cirri respectively, not forming distinct isolated frontal cirri, but comprising of short rows of that terminate anterior to the paroral membrane distal end. In addition, the buccal cirrus is lacking, except for one paratype, which shows the last cirri of row R2 more widely spaced than the remaining cirri in this row (Fig. 7). The contractile vacuole in *D. estevesi* is located in the mid-body (Figs 5, 9, 17) whereas in the other two congeners, it is located close to the left margin of the cell. Its inconspicuous location observed in *D. estevesi* makes the position of the contractile vacuole another suitable feature for species differentiation. Nevertheless, it does not show lacunar collector ducts, which are also absent in *D. abbrevescens*, but present in *D. bacilliformis*. Another feature of *D. estevesi* that distinguishes it from the remaining congeners is the right dorsal kinety, which is interrupted posteriorly. The short dorsal file composed of closely grouped cilia, present in the posterior end of body is also unique among the three species. Berger and Foissner (1987) studied a population of *D. bacilliformis* from Israel that presents spherical or elliptical colorless granules measuring 2 µm, and 2-5 µm large globules in the cytoplasm. From the drawings present in their paper, we think that these inclusions may be related to the cytoplasmic crystals that we observed in *D. estevesi*. Yet, those are reported as colorless. Table 2 shows a summary with main differences which we consider to be useful for discerning among the three species.

The French population of *Kahliella bacilliformis*, characterized by Fleury and Fryd-Versavel (1984), is also morphologically different from the species we

describe in the present paper due to the arrangement of cirri in its anterior region, rather similar to *D. bacilliformis*, and the presence of 3 dorsal kineties, as well as overall body size. Some morphological variations observed by Fleury and Fryd-Versavel (1984) in *K. bacilliformis* under different physiological conditions seem to match the ones observed in specimens of *D. estevesi* from old cultures, like cell elongation and the increase of the macronuclear nodules number. However, Fleury and Fryd-Versavel (1984) did not mention the occurrence of specimens with irregular shaped macronuclear nodules, such as observed in *D. estevesi* (Fig. 26).

Another kahliellid that must be compared with *D. estevesi* is *Kahliella microstoma* (Dragesco, 1970) Dragesco and Dragesco-Kernéis, 1986, from Yaoundé, Cameroon, which was originally presented by Dragesco (1970) as *Uroleptopsis multiseta* Dragesco, 1970. One strain of this species has the nuclear apparatus, shape of AZM and its proportion relative to the body size somewhat similar to *D. estevesi*. This organism shows one ventral cirral row right of AZM which ends at the equatorial level of the body (Dragesco 1970; p. 98, Fig. 71), thus indicating that it might also belong to *Deviata*, but differently from the other known species, the equatorially shortened cirral row is the second right of the adoral zone of membranelles. The other strain *K. microstoma* from Cameroon, which was also described by Dragesco (1970; p. 99, Fig. 72), lacks an equatorially shortened cirral row right of adoral zone of membranelles and has a distinctly different ventral cirral organization in the anterior region of body. However, Dragesco (1970) considered both as conspecific.

Based on our results, we regard the presented population of *Deviata* as a novel species. A complete study of the morphogenesis is necessary to verify if multiple within anlagen develop. According to Eigner (1995), this trait occurs during the divisional morphogenesis of *D. abbrevescens*, being considered by him as one of the diagnostic features for this genus. Such study will also clarify the precise classification of the first cirrus in row R1, which is always a little displaced to the right of the row itself (Figs 4, 19). It may be possible that this cirrus originates from a different anlage than the one from where row R1 originates. If this is confirmed, this cirrus may be homologous to the second frontal cirrus, right of AZM in *D. abbrevescens*. Another point is the origin of the short file of 3-5 cilia at the posterior region of dorsal surface, which at the present state and due to its position, we believe to be part of the right kinety.

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REFERENCES

Berger H., Foissner W. (1987) Morphology and biometry of some soil hypotrichs (Protozoa: Ciliophora). *Zool. Jb. Syst*. **114:** 193-239

Berger J., Hatzidimitriou G. (1978) Multivariate morphometric analyses of demic variation in *Ancistrum mytili* (Ciliophora: Scuticociliatida) commensal in two mytilid Pelecypods. *Protistologica* **2:**133-153

Branco C. W. C. (1998) Comunidades zooplanctônicas e aspectos limnológicos de três lagoas costeiras da Região Fluminense (Macaé, RJ). Tese de doutorado, CCS, Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro, Rio de Janeiro

Dieckmann J. (1995) An improved protargol impregnation for ciliates yielding reproducible results. *Europ. J. Protistol*. **31:** 372-382

Dragesco J. (1970) Ciliés libres du Cameroun. *Ann. Fac. Sci. Yaoundé* (Hors série) 1-141

Dragesco J., Dragesco-Kernéis A. (1986) Ciliés libres de l'Afrique intertropicale. Introduction à la connaissance et à l'étude des ciliés. Collection Faune Tropicale No. XXVI, ORSTOM, Paris

Ehrenberg, C. G. (1830) Beiträge zur Kenntniss der Organisation der Infusorien und ihrer geographischen Verbreitung, besonders in Siberien. *Abh. Akad. Wiss. Berlin*

Ehrenberg C. G. (1838) Die Infusionsthierchen als vollkommene Organismen. Ein Blick in das tiefere organische Leben der Natur. L. Voss, Leipzig

Eigner P. (1995) Divisional morphogenesis in *Deviata abbrevescens* nov. gen., nov. spec., *Neogeneia hortualis* nov. gen., nov. spec., and *Kahliella simplex* (Horváth) Corliss and redefinition of the Kahliellidae (Ciliophora, Hypotrichida). *Europ. J. Protistol*. **31:** 341-366

Eigner P. (1997) Evolution of morphogenetic processes in the Orthoamphisiellidae N. Fam., Oxytrichidae, and Parakahliellidae N. Fam., and their depiction using a computer method (Ciliophora, Hypotrichida). *J. Euk. Microbiol*. **44:** 553-573

Eigner P. (1999) Comparison of divisional morphogenesis in four morphologically different clones of the genus *Gonostomum* and update of the natural hypotrich system (Ciliophora, Hypotrichida). *Europ. J. Protistol*. **35:** 34-48

Esteves F. de A., Barbieri R., Ishii I. H., Camargo A. F. M. (1983) Estudos limnológicos em algumas lagoas costeiras do Estado do Rio de Janeiro. *An. Sem. Reg. Ecol. S. Carlos SP*. **3:** 22-38

Fleury A., Fryd-Versavel G. (1984) Unité et diversité chez les hypotriches (Protozoaires Ciliés) I. - Approche morphogénétique par l'étude de quelques formes peu différenciées. *Protistologica* **20:** 525-546

Gelei J. (1954) Über die Lebensgemeinschaft einiger temporärer Tümpel auf einer Bergwiese im Börzsönygebirge (Oberungarn) III. Ciliaten. *Acta Biol. Hung*. **5:** 259-343

Kattar M. R. (1970) Estudo dos protozoários ciliados psamófilos do litoral Brasileiro. *Bol. Zool. Biol. Mar.* **1:** 123-206

Lauterborn R. (1901) Die „sapropelische" Lebewelt: *Zoo. Anz*. **24:** 50-55

Olins D. E., Olins A. L. (1994) The replication band of ciliated protozoa. *Int. Rev. Cytol.* **153:** 137-170

Paiva T. S., Silva-Neto I. D. (2004) Ciliate protists from Cabiúnas Lagoon (Restinga de Jurubatiba, Macaé - Rio de Janeiro) with

emphasis on water quality indicator species and description of *Oxytricha marcili* sp. n. *Braz. J. Biol*. **64:** 465-478

Petrucio M. M. (1998) Caracterização das Lagoas Imboassica, Cabiúnas, Comprida e Carapebus a partir da temperatura, salinidade, condutividade, alcalinidade, O_2 dissolvido, pH, transparência e material em suspensão. In: Ecologia das Lagoas Costeiras do Parque Nacional da Restinga de Jurubatiba e do Município de Macaé (RJ) (Ed. F. de A.Esteves) Núcleo de Pesquisas Ecológicas de Macaé (NUPEM) - Universidade Federal do Rio de Janeiro, 109-122

Silva-Neto I. D. (1994) Observations sur é ultrastructure du cilié heterotriche *Licnophora auerbachi* Cohn, 1866, epibionte de l'etoile de mer. *Ann. Sci. Nat. Zool*. **2:** 49-62

Smith J. C. (1897) Notices of some undescribed Infusoria from the industrial fauna of Louisiana. *Trans. Amer. Microsc. Soc*. **19:** 55-68

Sokal R. R., Rohlf F. J. (1981) Biometry. 2nd. ed. Freeman, San Francisco

Tuffrau M. (1979) Une nouvelle famille d'hypotriches, Kahliellidae n. fam., et ses consequences dans la repartition des Stichotrichina. *Trans. Am. Microsc. Soc*. **98:** 521-528

Walker G. K., Goode D. (1976) The role of microtubules in macronuclear division of the hypotrich ciliates *Gastrostyla steinii* and *Stylonychia mytilus*. *Cytobiologie* **14:** 18-37

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