PANAMJAS
Pan-American Journal of Aquatic Sciences

Morphological aspects and seasonal changes of some planktonic ciliates (Protozoa) from a temporary pond in Buenos Aires Province, Argentina

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Abstract. The morphology of some planktonic ciliates in a temporary freshwater pond located in Buenos Aires province, Argentina, is compared and the seasonal variation in their abundances over an annual cycle is described. Samples were taken from June 2004 to June 2005. Physical and chemical characteristics of the environment were also recorded. Taxonomic identifications were made *in vivo* and after employing the Protargol technique. Five planktonic species were recorded for the first time in South America.

Key words: Ciliophora, plankton, freshwater pond, morphology, abundances variation.

Resumo. Aspectos morfológicos e mudanças sazonais de alguns ciliados (Protozoa, Ciliophora) planctônicos de uma poça temporária na província de Buenos Aires, Argentina. Dados morfológicos de alguns ciliados planctônicos, coletados de uma poça temporária de água doce localizada na província de Buenos Aires, Argentina, são comparados, assim como também foram descritas as variações sazonais da densidade ao longo do ciclo anual. Amostras foram obtidas desde junho de 2004 até junho de 2005 em três locais de coleta. Características físicas e químicas do ambiente foram registradas. As identificações taxonômicas foram feitas *in vivo* e depois da utilização da técnica de Protargol. Cinco espécies planctônicas foram registradas pela primeira vez América do Sul.

Palavras Chave: Ciliophora, plâncton, poça de água doce, morfologia, variação das abundâncias.

Introduction

Taxonomic studies of freshwater ciliates have been scarcely conducted in Argentina, despite of their ubiquity in planktonic communities and their important role as carbon recyclers. Although ciliates taxonomy has been already investigated employing silver staining methods and electron microscopy in other countries, mainly in Europe, in South America the contribution to this field is from Paiva & da Silva-Neto (2003, 2004a, b, c, 2005) in Brazil and Pettigrosso *et al*. (1997), Pettigrosso (2001, 2003), Barría (2002), and Pettigrosso & Barría (2004) in Argentina. In this country, other researchers have studied the ciliate fauna of several temporary ponds in Buenos Aires province by live observation (Cela 1972, Vucetich 1972, Vucetich & Escalante 1979, Modenutti & Claps 1986). At global scale, ciliates in temporary waters are poorly known (Andrushchyshyn *et al*. 2003). These habitats, which are frequent in Buenos Aires province during humid periods, are populated by organisms with particular physiological and behavioral properties and function as microcosms to study their ecology (Williams 2001).

The aims of this work are to compare morphological aspects of planktonic ciliate species from a temporary pond (Buenos Aires province, Argentina) with earlier descriptions of corresponding species from other continents. We also analyze the variability in the abundance of those species along a year cycle and their relationship with physical and chemical changes.

Materials and Methods

The study was carried out in a freshwater temporary pond located near the city of La Plata in Buenos Aires province, Argentina (35° 05' S, 57° 48' W) (Fig. 1) that goes through drought periods, mainly in summer and the beginning of autumn. During rainy periods, the pond has an approximate length of 30 m and about 1 m maximum depth. It is located beneath a cattle field, bounded by *Eucalyptus* spp. (Myrtaceae) and the Route 36. The water supply comes mainly from rainfall. Following the summer drought, the macrophytes *Alternanthera philoxeroides* (Amaranthaceae) and *Ludwigia peploides* (Onagraceae) persist in the pond for a short period of time and after their decomposition, the planktonic community dominates the water body. Samples were taken monthly during the morning at three sampling stations, with 5 liter bottles from June 2004 to June 2005, except in October 2004, summer 2005, and May 2005, when the pond was dry. Two replicates were collected at the same time and at each sampling site, from which two 250 ml sub-samples were fixed using acid Lugol 2% and other live sub-samples were cultured in wheat infusions. Temperature, pH, and conductivity were recorded with a multiparameter sensor (®Horiba U21). Dissolved oxygen was estimated by the Winkler method (Clesceri *et al*. 1998). Observations and measurements were performed *in vivo* and after revealing the argentophilic structures by the Protargol technique (Wilbert 1975), at magnifications of 100, 400 and 1000×. Previous to the silver staining, the ciliates were fixed with Bouin's solution. The drawings of impregnated cells were performed by using a tracing device and the micrographs were taken with a Leica Wild MPS52. Cells were counted using an inverted microscope in 10 ml chambers (Utermöhl 1958), examining the entire chamber at a magnification of 150×. The classification proposed by Lynn & Small (2000) was followed.

Abbreviations used in morphometric tables are as follow: X, arithmetic mean; Min, minimum observation; Max, maximum observation; M, median; SD, standard deviation; N, number of observations.

Results

Observations on the species

The morphology and infraciliature of ten planktonic ciliates belonging to the orders Haptorida (one species), Cyclotrichida (two species), Prostomatida (one species), Choreotrichida (one species), Halteriida (one species), Strombidiida (three species), and Stichotrichida (one species) were considered. Five species were recorded for the first time in South America, another one in Argentina, and additionally one in Buenos Aires province. Morphology and infraciliature of *Askenasia volvox*, *Coleps hirtus hirtus*, and *Halteria grandinella,* which were previously studied *in vivo* and by supravital staining, were also considered. Abundances of *Teuthophrys trisulca africana*, *Rhabdoaskenasia minima*, and *Hypotrichidium conicum* were not estimated from field samples as these species were cultured in the laboratory.

Order Haptorida Corliss
Teuthophrys trisulca africana (Dragesco & Dragesco-Kernéis) Foissner, Berger & Schaumburg
(Table I; Figs. 2a and 3a)

Sack-like body shape with three anterior, spirally curved oral arms. Posterior contractile vacuole. Macronucleus vermiform and coiled. Cytoplasm colorless and without endosymbiotic algae. Oral arms lined by trychocysts. Somatic ciliature uniform. With rod-shaped somatic extrusomes (2.8-8 μm long) and dark granules over the body.

This species was recorded in autumn, when *Alternanthera philoxeroides* occurred, and in cultures of mud samples taken in October 2004, where the resting cysts developed.

Order Cyclotrichida Jankowski
Askenasia volvox (Eichwald) Kahl
(Table II; Figs. 2b and 3b, c)

Body ovoid to pyriform, widened posteriorly. Without endosymbiotic algae. Contractile vacuole sub-equatorial and with another posterior floating vacuole. Macronucleus globular to ellipsoidal, sometimes constricted. Micronucleus indented in the macronucleus. Somatic kineties arranged in a pre-equatorial girdle, each row of them with single kinetosomes with 7 groups of flame like cilia that extend anteriorly; an equatorial girdle with paired kinetosomes with posteriorly directed cilia; a sub-equatorial girdle with flexible bristles, each row with 3 kinetosomes. Oral region surrounded by a circumoral wreath of granules. Extrusomes were faintly impregnated.

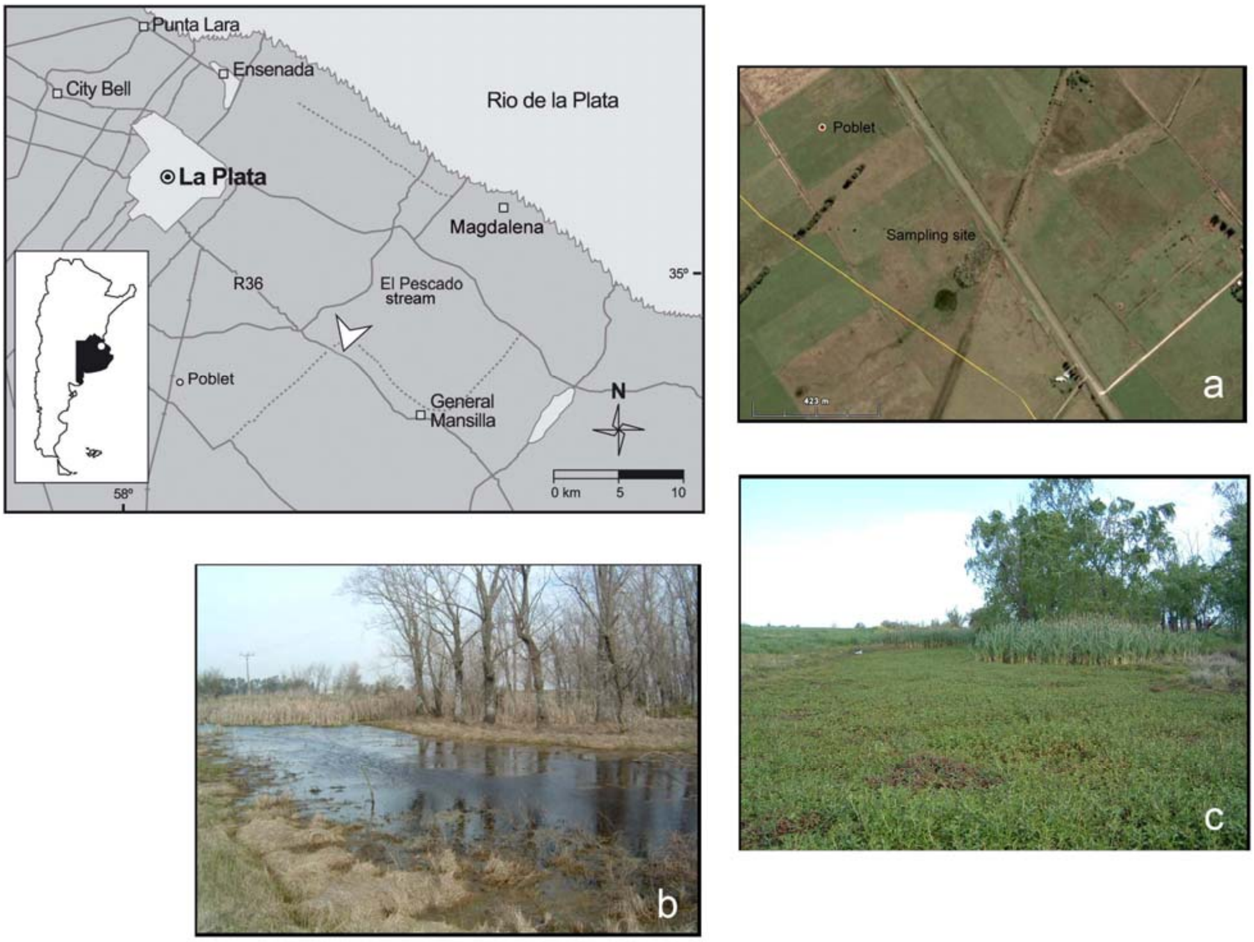

Figure 1. Location of the sampling site in Buenos Aires province, Argentina. **a.** Aerial view. **b, c.** The pond during a rainy period (b) and a dry phase (c).

This species occurred in the pond from late autumn to winter and early spring. It was not recorded at temperatures over 11 °C. The highest densities occurred at the lowest conductivity values, alkaline pH, and over 70 % of dissolved oxygen saturation (Fig. 4). *Cyclidium glaucoma* Müller and *Halteria grandinella* (Müller) Dujardin were observed inside the food vacuoles of *A. volvox* in Protargol stained preparations.

Rhabdoaskenasia minima Krainer & Foissner (Table III; Fig. 2c)

Body pyriform, with rounded posterior end. With a single contractile vacuole. Macronucleus reniform. Oral dome surrounded by a circumoral row of dikinetids that give rise to the rhabdos. Somatic kineties, arranged in a pre-equatorial kinety girdle with single kinetosomes in each row; an equatorial girdle also with single kinetosomes; a sub-equatorial girdle of bristles, with 2 kinetosomes in each row.

This species occurred in late autumn.

Order Prostomatida Schewiakoff *Coleps hirtus hirtus* (Müller) Foissner, Berger & Schaumburg (Table IV; Fig. 2d)

Body barrel-shaped. *In vivo* with pretzel-like cortical windows and three posterior cortical spines. Symbiotic algae are absent. Somatic kineties composed by dikinetids. With single caudal cilium. Dorsal brush in three groups with two longitudinal rows of basal bodies each. First group with four basal bodies in each row and the other groups with three basal bodies in each row. External pectinelles with two basal bodies and internal pectinelles with four basal bodies.

Coleps hirtus hirtus was only absent in autumn. The maximum abundance of this species was observed under the highest temperatures, intermediate conductivity values (183 $\mu S\ cm^{-1}$), low dissolved oxygen saturation (49 %) and slightly acid pH (Fig. 4).

Table I. Morphometric data on *Teutophrys trisulca africana*.

in vivo	X	Min	Max	M	SD	N
Body, length	261.3	238	280	266	21.4	3
Body, width	126	112	140	126	14	3

After Protargol	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	207.2	168	252	210	22.7	10
Body, width	98	84	112	98	8.4	8
Oral arms, length	128.7	112	154	126	10.1	13
Oral extrusomes, length	5.9	5	7	5.6	0.7	13
Somatic extrusomes, length	5.9	2.8	8	6	1.6	13
Somatic extrusomes, width	0.7	0.7	0.7	0.7	0	13
Pigmented granules, width	1.8	0.7	2.8	2.1	0.8	13

Table II. Morphometric data on *Askenasia volvox*.

in vivo	X	Min	Max	M	SD	N
Body, length	46.7	35	63	45.5	9.5	6
Body, width	38.5	35	42	38.5	3.8	6
Groups of anterior cilia, number	7	7	7	7	0	3

After Protargol	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	51.8	49	63	49	4.2	20
Body, width	46.5	42	56	49	4.7	20
Somatic kineties, number	49.9	46	53	50.5	2.7	20
Kinetosomes in pre-equatorial girdle, number	11	8	14	10	1.9	20
Paired kinetosomes in equatorial girdle, number	9.5	9	10	9.5	0.7	2
Kinetosomes in sub-equatorial girdle, number	3	3	3	3	0	20
Kinetosomes per circumoral lobe, number	4.5	3	5	5	0.6	20
Macronucleus, length	18	11.2	25.2	19.3	4.4	10
Macronucleus, width	15.1	10	26.6	14.7	5.2	10
Micronucleus, diameter	3.1	2.8	3.5	2.8	0.4	5

Order Choreotrichida Small & Lynn
Strobilidium caudatum (Fromentel) Foissner
(Table V; Figs. 2e and 3d, e)

Body pyriform, posteriorly pointed and truncated. Horse shoe-shaped macronucleus. Contractile vacuole at the posterior end of the body. Five somatic kineties, three of them form a caudal spiral and the other two are shorter. Oral apparatus composed by a closed ring of external membranelles, some of which enlarge into the oral cavity, one internal membranelle, and the endoral kinety. Some specimens had irregularly spaced extrusomes and pigmented granules in the posterior half of the body.

Table III. Morphometric data on *Rhabdoaskenasia minima*.

After Protargol	X	Min	Max	M	SD	N
Body, length	52.5	42	63	52.5	14.8	2
Body, width	45.5	42	49	45.5	4.9	2
Somatic kineties, number	77.5	75	80	77.5	3.5	2
Kinetosomes in pre-equatorial girdle, number	8.5	8	9	8.5	0.6	4
Kinetosomes in sub-equatorial girdle, number	2	2	2	2	0	4
Circumoral paired granules, number	32	32	32	32	0	1
Macronucleus, maximum length	29.4	29.4	29.4	29.4	0	1

Table IV. Morphometric data on *Coleps hirtus hirtus*.

in vivo	X	Min	Max	M	SD	N
Body, length	61.5	61.5	61.5	61.5	0	1
Body, width	24.6	24.6	24.6	24.6	0	1
After Protargol	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	40	35	49	38.8	4.9	12
Body, width	17.9	11.2	28	17.8	4.2	12
Cytopharynx, length	11.4	8.4	14.7	11.2	2.1	7
Somatic kineties, number	13	11	15	13	1.2	7
Paired kinetosomes per somatic kinety, number	13	12	14	13	0.5	8
External pectinelles, number	10	10	10	10	0	2
Kinetosomes per external pectinelle, number	2	2	2	2	0	3
Internal pectinelles, number	10	10	10	10	0	2
Kinetosomes per internal pectinelle, number	4.4	4	5	4	0.5	5
Paired kineties in dorsal brush, number	3	3	3	3	0	3
Paired kinetosomes in dorsal brush kinety 1, number	4	4	4	4	0	2
Paired kinetosomes in dorsal brush kinety 2, number	3	3	3	3	0	2
Paired kinetosomes in dorsal brush kinety 3, number	3	3	3	3	0	2
Macronucleus, length	10.1	7	16.8	9.1	2.8	10
Macronucleus, width	11.2	6.3	17.5	10.5	3.1	10
Micronucleus, diameter	1.4	1.4	1.4	1.4	0	2

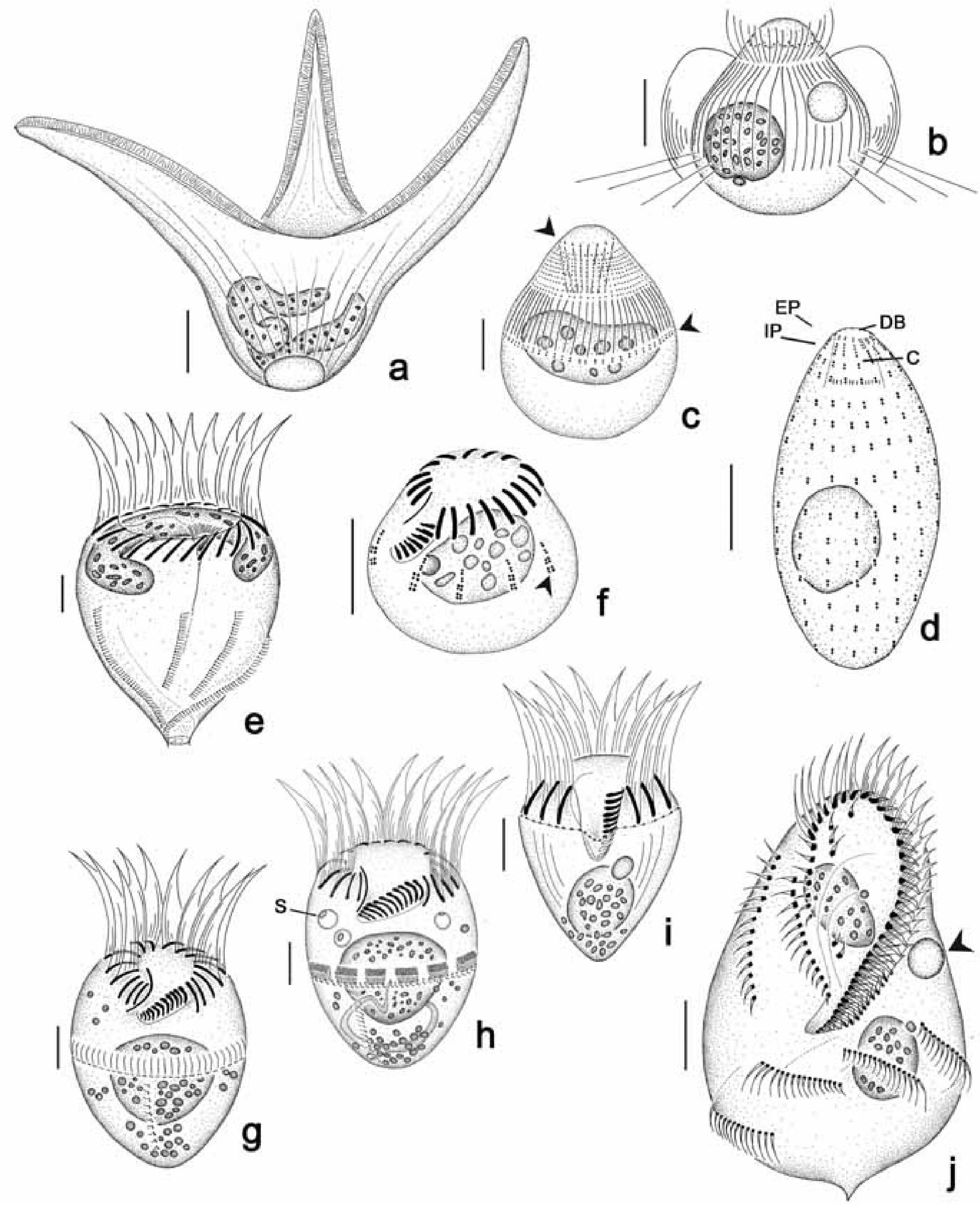

Figure 2. Morphology of the species recorded, composite from protargol impregnation and live observation (a, b, j) and protargol impregnation only (c-i). **a.** *Teuthophrys trisulca africana*. **b.** *Askenasia volvox*. **c.** *Rhabdoaskenasia minima*, circumoral wreath of granules (left arrowhead), two sub-equatorial kinetosomes (right arrowhead). **d.** *Coleps hirtus hirtus*, cytopharynx (C), dorsal brush (DB), external pectinelles (EP), internal pectinelles (IP). **e.** *Strobilidium caudatum*, ventral view. **f.** *Halteria grandinella*, equatorial somatic kinety (arrowhead). **g.** *Limnostrombidium pelagicum*, ventral view. **h.** *Limnostrombidium viride*, ventral view, symbiont (S). **i.** *Pelagostrombidium mirabile*, ventral view. **j.** *Hypotrichidium conicum*, ventral view, contractile vacuole (arrowhead). (a) scale bar = 50 µm; (b-f, i) scale bar = 10 µm; (g, h, j) scale bar = 20 µm.

Strobilidium caudatum was only absent in late winter and late spring. This non euplanktonic species reached the maximum densities in coincidence with high conductivity, low temperatures, and intermediate dissolved oxygen concentrations. This ciliate was recorded under acid as well as alkaline pH values (Fig. 4). It was also observed adhered to artificial substrates. It could be maintained in wheat cultures for a short time.

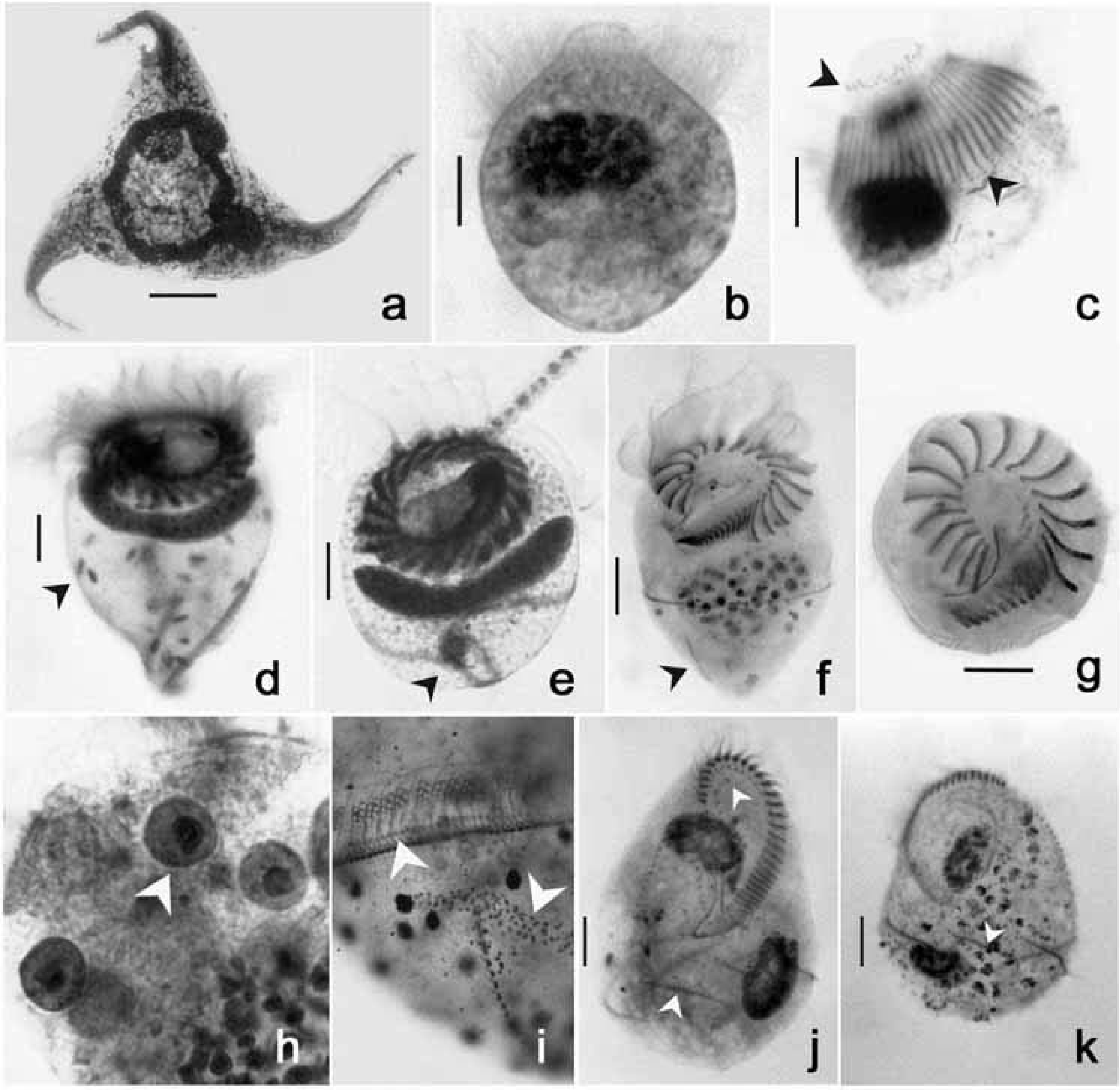

Figure 3. Morphology of the species recorded, after protargol impregnation. **a.** *Teuthophrys trisulca africana*, aboral view. **b.** *Askenasia volvox*. **c.** *A. volvox*, circumoral wreath of granules (left arrowhead) and three subequatorial kinetosomes (right arrowhead). **d.** *Strobilidium caudatum*, dorsal view, extrusomes (arrowhead). **e.** *S. caudatum*, oral view, caudal spiral (arrowhead). **f.** *Limnostrombidium pelagicum*, ventral view, ventral kinety (arrowhead). **g.** *L. pelagicum*, oral view. **h.** *L. viride*, symbionts near the oral region (arrowhead). **i.** *L. viride*, ventro-posterior view, clavate cilia in equatorial girdle (left arrowhead) and neoformation organelle (right arrowhead). **j.** *Hypotrichidium conicum*, ventral view, single frontal cirri (top arrowhead) and posterior rows of cirri (down arrowhead). **k.** *H. conicum*, dorsal view, posterior rows of cirri (arrowhead). (a, f, j, k) scale bar = 20 µm. (b-e, g) scale bar = 10 µm.

Order Halteriida Petz & Foissner
Halteria grandinella (Müller) Dujardin
(Table VI; Fig. 2f)

The most important features to separate this species from its congeners are the absence of symbiotic algae and the disposition of basal bodies in the equatorial somatic kineties in four groups, two of them with two kinetosomes each and the other two with four kinetosomes each.

Halteria grandinella was recorded throughout the studied period. The highest densities occurred at temperatures below 11°C but under a wide range of conductivity, pH and dissolved oxygen concentration (Fig. 4).

Order Strombidiida Petz & Foissner
Limnostrombidium pelagicum (Kahl) Krainer
(Table VII; Figs. 2g and 3f, g)

Body conical-shaped, narrowed posteriorly. With an equatorial girdle of extrusomes, lined by a ring of somatic dikinetids with clavate cilia. Ventral somatic kinety with paired kinetosomes. Oral apparatus composed by an open ring of collar and ventral membranelles, and the endoral kinety.

Without endosymbiotic algae. Macronucleus globular; micronuclei elliptical and indented in the posterior pole of the macronucleus. With numerous ovoid pigmented granules, mainly in the posterior half of the body and near equatorial extrusomes. This species was recorded from winter to late spring. It was maintained for a few days in wheat infusion cultures.

Table V. Morphometric data on *Strobilidium caudatum*.

in vivo	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	71.4	42	98	84	24.4	5
Body, width	50.1	28	68.6	56	17.7	5

After Protargol	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	72.2	56	84	70	6.6	16
Body, width	59.1	49	70	56	5.1	16
Peristome, diameter	45	35	56	42	5.6	17
Apex to end of cytopharyngeal fibers, distance	42	33.3	50	43.3	5.2	13
Macronucleus, length	7	5.6	8.4	7	1	10
Macronucleus, width	32.1	23.1	39.2	39.2	4.6	9
Micronucleus, length	2.7	2.1	3.2	2.8	0.3	6
Micronuclei, number	1	1	1	1	0	6
Somatic kineties, number	5	5	5	5	0	20
External polykineties, number	19	18	21	20	0.8	20
Enlarged external polykineties, number	6	4	7	6	0.9	18
Internal polykineties, number	1	1	1	1	0	11
Extrusomes, length	3.9	3.3	5	3.3	0.9	11
Extrusomes, width	1	0.7	1.4	1	0.3	11

Table VI. Morphometric data on *Halteria grandinella*.

After Protargol	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	24	21	28	23.8	2.8	13
Body, width	22.7	19.6	28	22.4	2	13
Equatorial somatic kineties, number	7	6	7	7	0.4	16
Adoral polykinetids, number	16	15	17	16	0.7	15
Ventral polykinetids, number	7	6	7	7	0.5	4
Macronucleus, length	9.5	8.4	11.2	9.1	1	10
Macronucleus, width	16	9.1	21	16.4	3.3	10
Micronucleus, length	2.5	2.1	2.8	2.8	0.4	5
Micronucleus, width	2.2	2.1	2.8	2.1	0.3	5

Table VII. Morphometric data on *Limnostrombidium pelagicum*.

After Protargol	X	Min	Max	M	SD	N
Body, length	61.8	48	80	60	9.2	30
Body, width	46.4	35	60	45	8.4	30
Adoral polykinetids, number	16	16	16	16	0	22
Ventral polykinetids, number	12	10	14	12	0.9	25
Ventral somatic kinety, number of basal body pairs	11	8	12	11	1	22
Macronucleus, length	17.3	14	22	17	2.6	25
Macronucleus, width	21	14	27	21	3.2	25
Micronucleus, diameter	2.7	2.1	3.5	2.8	0.4	15
Micronucleus, number	2	1	2	2	0.3	15
Pigmented granules, diameter	2.3	2.1	2.8	2.1	0.3	25

Table VIII. Morphometric data on *Limnostrombidium viride*.

After Protargol	X	Min	Max	M	SD	N
Body, length	56	40	70	55	8.2	30
Body, width	42.1	30	55	40	5.9	30
Adoral polykinetids, number	16	16	16	16	0	12
Ventral polykinetids, number	13	11	15	13	0.9	18
Ventral somatic kinety, number of basal body pairs	15	13	18	15	1.2	20
Macronucleus, length	19.9	13	25	21	3.6	10
Macronucleus, width	24.7	20	28	24	3	10
Micronucleus, diameter	2.9	2.1	3.5	2.8	0.4	9
Micronucleus, number	1.1	1	2	1	0.3	9
Pigmented granules, diameter	2.2	1.5	2.8	2.1	0.4	20
Equatorial extrusomes, number of groups	12	10	14	12	2	3
Equatorial extrusomes, diameter of groups	5.9	5.6	7	5.6	0.5	8
Symbionts, diameter	8.9	5.6	10	9.4	1.4	8

Limnostrombidium viride (Stein) Krainer (Table VIII; Figs. 2h and 3h, i)

This species is similar to *L. pelagicum* but it mainly differs in that it maintains functional plastids (cleptoplasts) from the algae it feeds on. The number of paired kinetosomes (13-18) in ventral kinety and the number of ventral membranelles (11-15) are also slightly different.

This species was recorded during autumn and winter, coexisting with *L. pelagicum*. Both species reached the maximum abundances at temperatures below 8 °C (Fig. 4).

Table IX. Morphometric data on *Pelagostrombidium mirabile*.

in vivo	X	Min	Max	M	SD	N
Body, length	40	40	40	40	0	3
Body, width	28.3	25	30	30	2.8	3
After Protargol	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	42.2	30	60	40	7	24
Body, width	32.5	25	50	30	5.7	24
Adoral polykinetids, number	15	13	16	15	1	11
Ventral polykinetids, number	12	10	14	12	1.1	17
Macronucleus, length	20.2	16.8	28	19.8	2.8	12
Macronucleus, width	18.7	12.6	28	16.8	5.1	11
Micronucleus, diameter	4.8	4.2	5.6	4.9	0.5	9
Extrusomes, length	19.6	15.4	25.2	18.2	5	3

Table X. Morphometric data on *Hypotrichidium conicum*.

in vivo	X	Min	Max	M	SD	N
Body, length	105	98	112	105	9.8	2
Body, width	70	56	84	70	19.7	2
Buccal cavity, depth	56	56	56	56	0	2
After Protargol	**X**	**Min**	**Max**	**M**	**SD**	**N**
Body, length	128.1	98	168	126	17.7	30
Body, width	88.2	63	112	87.5	14	30
Buccal cavity, depth	82.1	70	98	84	9.5	30
Frontal cirri, number	1	1	1	1	0	20
Frontal rows of cirri, number	4	4	4	4	0	30
Number of cirri,						
1st frontal row	6	4	7	6	0.7	20
2nd frontal row	6	5	7	6	0.5	20
3rd frontal row	11	10	13	12	1.1	20
4th frontal row	14	11	16	13	1.5	20
Posterior rows of cirri, number	6	6	6	6	0	20
Rows of dorsal bristles, number	3	3	3	3	0	11
Oral polykinetids, number	41	34	49	40	3.7	20
Macronucleus, length	28.7	21	63	28	9	20
Macronucleus, width	17.8	14	21	21	3.6	20
Micronucleus, length	3.2	2.8	4.2	3.5	0.4	20
Micronucleus, width	2.7	2.1	3.5	2.8	0.3	20
Micronucleus, number	2	2	2	2	0	20

Table XI. Compared physical and chemical variables (V) under which the species were found. T, temperature (°C); DO, dissolved oxygen (mg L^{-1}); C, conductivity (µS cm^{-1}).

Species	V	Our observations	Other authors	Locality	Citation
Teuthophrys trisulca africana	T	8.6	5.2 - 8.7	France, Germany	Foissner *et al.* (1999)
	pH	5.4	8.4		
	DO	6.3	6.7 - 10.2		
	C	220	—		
Askenasia volvox	T	2.4 - 10.8	2.0 - 21.0	Germany	Foissner *et al.* (1995)
	pH	4.5 - 8.4	5.0 - 9.5		
	DO	5.5 - 8.8	5.1 - 15.9		
	C	160 - 220	—		
Rhabdoaskenasia minima	T	2.39	—	—	—
	pH	4.97	—		
	DO	5.47	—		
	C	220	—		
Coleps hirtus hirtus	T	2.39-19.17	1-30	Austria, Bulgaria, Germany	Bick & Kunze (1971)
	pH	4.97-8.57	4.7-9.5		
	DO	4.53-9.65	0-38		
	C	145-276	—		
Strobilidium caudatum	T	2.4 - 20.8	5.3 - 29	Austria, Bulgaria, USA	Foissner *et al.* (1991)
	pH	4.9 - 7.5	4.9 - 9.0		
	DO	5.5 - 8.8	4.0 - 11.0		
	C	160 - 220	—		
Halteria grandinella	T	2.39-19.17	0.8-35	Austria, Bulgaria, Germany, Hungary, USA	Foissner *et al.* (1999)
	pH	4.97-8.57	4.2-9.8		
	DO	4.53-9.65	0-38		
	C	145-276	—		
Limnostrombidium pelagicum	T	9.4 - 24.1	10.6 - 21.4	USSR	Belova (1989)
	pH	6.3 - 6.8	—		
	DO	6.3 - 7.9	—		
	C	120 - 220	—		
L. viride	T	2.4 - 20.8	1.4 - 21	Germany, Hungary, USA	Foissner *et al.* (1991)
	pH	4.9 - 8.4	6.1 - 9.5		
	DO	5.5 - 8.8	0.2 - 15.9		
	C	145 - 220	—		
Pelagostrombidium mirabile	T	6.7 - 10.8	—	—	—
	pH	7.8 - 8.4	—		
	DO	6.6 - 8.0	—		
	C	145 - 189	—		
Hypotrichidium conicum	T	24.7	3.0 - 27.5	Slovakia	Foissner *et al.* (1999)
	pH	6.82	6.4 - 7.2		
	DO	—	1.5 - 5.8		
	C	190	—		

Pelagostrombidium mirabile (Penard) Krainer (Table IX; Fig. 2i)

Body ellipsoidal, posteriorly narrower than anteriorly, mostly covered by polygonal cortical platelets. Cytoplasm yellowish-green due to the presence of cleptoplasts. Girdle of somatic extrusomes lined by a non-ciliated ring of kinetosomes, continuous at the buccal vertex. Adoral zone of membranelles as an opened ring, composed of collar and ventral membranelles that end below mid-body. Endoral kinety at the right margin of the buccal cavity.

This species was recorded in late winter and early spring. The density peaks occurred under alkaline pH, low temperature (11 °C) and low conductivity values, while the dissolved oxygen concentration was high (72 % of saturation) (Fig. 4).

Order Stichotrichida Fauré-Fremiet *Hypotrichidium conicum* Ilowaisky (Table X; Figs. 2j and 3j, k)

Body pyriform, posteriorly widened and with a cytoplasmic process. Two macronuclear nodules, with one indented micronucleus each. Contractile vacuole on the left, lateral to the peristome and in the superior third of the body. Single frontal cirrus in front of the paroral membrane and four rows of frontal cirri to the right of the peristome. Six oblique rows of posterior cirri and 3 dorsal rows of dikinetids. Buccal field relatively long, extending up to ¾ of body length. Paroral and endoral kineties cross at the right margin of the buccal cavity.

This species was recorded in spring and it also grew from mud samples in summer. It was maintained in wheat cultures for a short time.

Table XI shows the ranges of the physical and chemical variables under which this species, as well as the other ones, were recorded.

Species abundances and variation along an annual cycle

The most abundant species were *Halteria grandinella*, *Coleps hirtus hirtus*, and *Pelagostrombidium mirabile*. *Halteria grandinella* was present in the pond along the whole studied period, reaching the highest abundances in July 2004 (18916 ind L^{-1}). The greatest densities of *C. h. hirtus* were recorded during December 2004 (11366 ind L^{-1}), being relatively scarce in the other months (less than 600 ind L^{-1}) and was not found during June 2005. *Pelagostrombidium mirabile* appeared for the first time in July 2004 (2917 ind L^{-1}) and was present in the pond only until September, when it reached the highest numbers (8066 ind L^{-1}). *Askenasia volvox* was present from June to September 2004 and in June 2005, mostly in low numbers (less than 400 ind L^{-1}) except during September 2004 (1233 ind L^{-1}). *Strobilidium caudatum* was not found in the pond only in August and December 2004, and attained the highest densities during June 2004 (1000 ind L^{-1}) and April 2005 (2283 ind L^{-1}), when it was the most abundant species. *Limnostrombidium* spp. could not be identified to species level in Lugol preserved samples and the highest number of individuals was recorded during June 2004 (2783 ind L^{-1}). *Limnostrombidium* spp. were not recorded during December 2004 and June 2005.

Rhabdoaskenasia minima, *Teuthophrys trisulca africana*, and *Hypotrichidium conicum* were not detected in Lugol fixed samples.

Discussion

Teuthophrys trisulca africana is recorded for the first time in South America. Our specimens match better with the African specimens observed by Dragesco & Dragesco-Kernéis (1986), since it is apochlorotic, although the macronucleus is not dumb bell-shaped but vermiform and coiled. Foissner *et al.* (1999) also found apochlorotic specimens from mud samples in Australia. It is considered a rare species, which prefers the spring (Foissner *et al.* 1999), although we found it for the first time in autumn and late spring.

Askenasia volvox was previously cited in a water quality paper (Zaleski & Claps 2000) for a eutrophic shallow lake from Buenos Aires province but no description is available. The species was recorded in South America by Pinto (1925) in Brazil and by Wölfl (1996) in Chile, also without description. The number of paired kinetosomes in the equatorial kinety girdle is lower (9-10) than that found by Packroff & Wilbert (1991) (18-20).

Rhabdoaskenasia minima is a new record for South America. Morphometric data are coincident with those of Krainer & Foissner (1990), although the extrusomes of our specimens were not well impregnated and this is a key character according to Foissner *et al.* (1999). In this study, it was identified as *R. minima* due to the presence of a very conspicuous rhabdos, single kinetosomes in the equatorial kinety girdle, two basal bodies in the sub-equatorial kinety girdle, and a single contractile vacuole. The previously cited authors recorded this species along the whole year, peaking in autumn

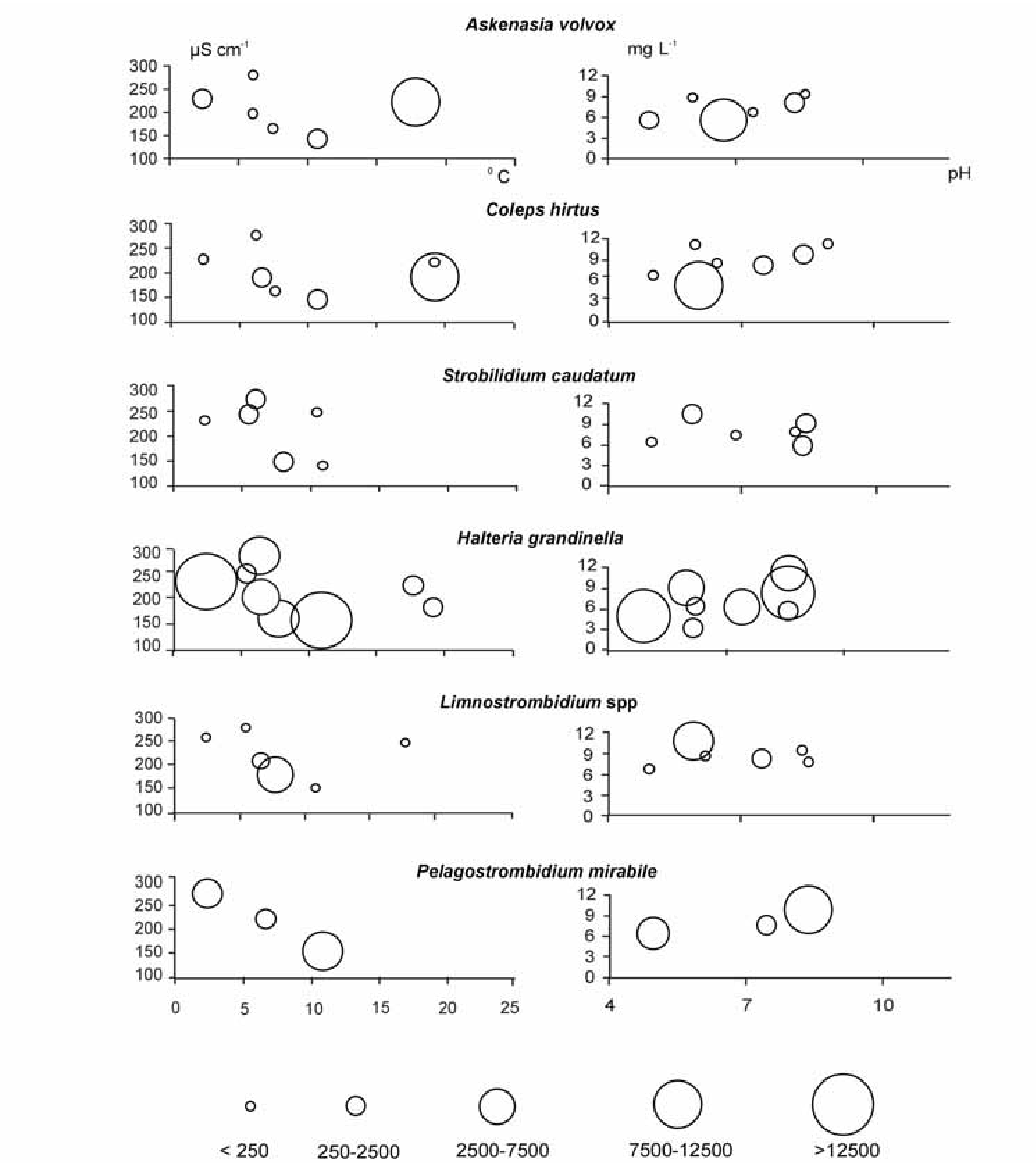

Figure 4. Ranges of species densities (ind L^{-1}) related to conductivity and temperature (left column) and to dissolved oxygen and pH (right column).

(2670 ind L^{-1} and 1720 ind L^{-1}) and feeding on *Urotricha* sp. On the contrary, we only found it once in winter and coexisting with *A. volvox*.

Coleps hirtus hirtus was previously cited in Argentina and South America by other authors (de la Rua 1911, Cela 1972, Guillén-Aguirre 2002), although it was only observed *in vivo* and after supravital staining. Morphometry is coincident with the observation of other authors (Foissner *et al*. 1994, 1999).

Strobilidium caudatum is a new record for Argentina. It was previously observed in South America by Bürger (1909) in Chile, and by Guillén-Aguirre (2002) in Peru. Most morphometric data are coincident with those observed by other authors (Foissner *et al*. 1991, Petz & Foissner 1992). The number of external membranelles coincides with the observations of Petz & Foissner (1992), although

Foissner *et al*. (1991) mentioned a wider range (18-21 vs 22-30, respectively). On the other hand, we observed cortical extrusomes and pigmented granules in some individuals, which was not cited by other authors and would need further investigation.

Halteria grandinella is a cosmopolitan species, which was previously cited in Argentina and South America (de la Rua 1911, Cela 1972, Guillén-Aguirre 2002), although it was only studied *in vivo* or by supravital staining. Morphometric characters are coincident with the observations of other authors (Fauré-Fremiet 1951, Dragesco 1970, Foissner *et al.* 1999) but Song & Wilbert (1989) observed a higher number of equatorial somatic kineties (9-10 groups).

Limnostrombidium pelagicum is a new record for South America. It could have been mistaken by other Argentinean researchers with *L. viride* as was also pointed by Foissner *et al*. (1999) for other localities. Morphometric characters coincide with those stated in Foissner *et al*. (1999), although we observed a slightly higher number of basal body pairs in the ventral kinety (7-10 vs 8-12, respectively) and numerous ovoid pigmented extrusomes, mainly in the posterior half of the body and near the equatorial extrusomes. *Limnostrombidium pelagicum* became very similar to *L. viride* after a few days in culture, when it lost the plastids and presumably began to feed on bacteria.

Limnostrombidium viride is a new record for Buenos Aires province. It has been previously found in Argentina by Seckt (1924), in Córdoba province, who mentioned it in a checklist, without taxonomic description, and by Modenutti & Pérez (2001), in an Andean lake. Morphometric characters are coincident with those described by other authors (Kahl 1932, Foissner *et al*. 1991, 1999), although in the present study the specimens possessed few symbionts and of larger size than those described in Foissner *et al*. (1999), which were 6×3.2 μm and possibly belonging to genus *Kirchneriella*.

Pelagostrombidium mirabile is a new record for South America, while other authors only found it in Eurasia (Foissner *et al*. 1999). The morphometric characters of this species match with the descriptions of Penard (1922), Krainer (1991), and Foissner *et al*. (1999), although the range of ventral membranelles in our observations is lower than that stated in Foissner *et al*. (1999) (10-14 vs 12-17, respectively).

Hypotrichidium conicum is a new record for the ciliate fauna from South America. This cosmopolitan and typical euplanktonic species has been found in other ephemeral and eutrophic environments (Foissner *et al*. 1991, 1999). As the species developed from mud samples when the pond went through a drought period, we assume it is able to form resting cysts, although they were not observed. The contractile vacuole was located on the left side, lateral to the peristome on the superior third of the body as in *H. tisiae*, and not near the cytostome, as stated in Foissner *et al*. (1991, 1999). It is different from the previously mentioned species by having six posterior rows of cirri, and, for this reason, it was identified in this study as *H. conicum*.

Concerning the seasonal variation of the species found, the highest density of *Askenasia vovlox* was recorded in early spring, while other authors found low numbers during the cold half of the year (Wang 1928, Wilbert 1969, Foissner *et al*. 1999). *Coleps hirtus hirtus* was recorded throughout the year, as found in previous studies, along a maximum in spring (Foissner *et al*. 1999). The highest numbers of *Strobilidium caudatum* were observed during autumn, when macrophytes were present in the pond, while Wilbert (1969) found 60000 ind L^{-1} during summer in a eutrophic stream from Germany. *Halteria grandinella* occurred in more than 1000 ind L^{-1}, which indicates eutrophic or highly eutrophic conditions (Foissner *et al*. 1999). *Limnostrombidium pelagicum* could not be distinguished from *L. viride* in Lugol fixed samples but, in coincidence with the findings of Krainer (1991, 1995) in Austria, we observed higher numbers of both species in spring and summer. *Limnostrombidium viride* was very abundant in autumn after the summer drought, while other authors found higher numbers in summer (Foissner *et al*. 1999) and summer and autumn (Modenutti & Pérez 2001). Mixotrophic ciliates are known to be dominant in oligotrophic environments due to the accessibility to scarce nutrients (Fenchel 1987), which along with the bacterivorous feeding regime allow *L. viride* to inhabit very different habitats, such as ultraoligotrophic lakes in Patagonia (Modenutti & Pérez 2001) and, as in the present study, a eutrophic shallow pond, being tolerant to a wide range of environmental characteristics. *Pelagostrombidium mirabile* appeared only during winter and spring, while Krainer (1991) found it abundantly throughout the year in eutrophic groundwater ponds in Austria, peaking in autumn.

Most of the ecological characteristics recorded coincide with other findings (Table XI). In addition, the physical and chemical variables under which *Rhabdoaskenasia minima* and *Pelagostrombidium mirabile* were found, were not mentioned by other authors. *Teuthophrys trisulca africana* was recorded under lower pH conditions than those stated in its ecological summary by Foissner *et al*. (1999).

The presence of the species dealt within this study in an unpredictable environment such as this temporary pond is related to their bacterivorous regime (Fenchel 1987) as a primary or secondary option, their tolerance to a wide range of environmental conditions, when the pond was filled, and their ability to produce resting cysts (Foissner 1987) to survive during dry periods.

Acknowledgments

Norbert Wilbert from Zoologisches Institut der Universität Bonn, Germany, is greatly acknowledged for his unconditional help. Thanks go also to C. Ituarte and L. Lunaschi from the División Zoología Invertebrados, Museo de La Plata, S. Kleinman for improving the English, and M. Meléndez for his help with the Portuguese. Support of the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina, to which the authors belong, is gratefully acknowledged.

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Received July 2006
Accepted August 2006
Published online September 2006