TÜBİTAK

Turkish Journal of Zoology

http://journals.tubitak.gov.tr/zoology/

Research Article

Turk J Zool
(2016) 40: 663-674
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doi:10.3906/zoo-1508-57

Freshwater ciliates from Beytepe Pond in Ankara with new records for Turkey

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Received: 31.08.2015 • **Accepted/Published Online:** 22.02.2016 • **Final Version:** 24.10.2016

Abstract: In this study, the ciliate biota from four sites within a pond in Central Anatolia has been examined. A total of 57 species have been identified, 4 of which are newly recorded within the Turkish ciliate fauna, including *Oxytricha similis*, *Pleuronema crassum*, *Astylozoon pyriforme*, and *Pseudovorticella monilata*. Turkish populations of these newly recorded species have been morphologically described. Furthermore, 17 species have been newly recorded in Central Anatolia. An overwhelming majority of the ciliates found belonged to 3 systematic groups: 1) Oligohymenophorea (44%, 25 species), 2) Spirotrichea (21%, 12 species), and 3) Litostomatea (21%, 12 species). All ciliate species recorded during the present study have been listed along with information on their occurrence at different sites in Anatolia, namely Mogan Lake, Ankara, Sır Dam lake, Kahramanmaraş, and Van Province, and the distribution of ciliates has been discussed from a broader perspective.

Key words: Ciliate community, ciliate sampling device, moderate endemicity model, morphology

1. Introduction

The ciliated protozoa constitute an important component of freshwater environments and are the most conspicuous group of eukaryotic unicellular organisms (Corliss, 1979; Laybourn-Parry, 1984; Fenchel, 1987). The ciliated protozoa occur in various kinds of aquatic environments, wherein sufficient nutrients, moisture, and appropriate microhabitats are available (Hattori, 1994; Corliss, 2002).

Ciliates are known to be useful to man for many purposes such as the determination of water quality and the description of habitat type within the water column (Foissner, 1988; Finlay and Fenchel, 1996; Finlay et al., 1997; Madoni, 2005). Despite the usefulness of such knowledge, studies on ciliates remain scarce within Turkey, probably because of the low number of experts within the field and difficulties in identification of species. In the current study, a new freshwater system is examined for contributing new knowledge to the ciliate fauna of Turkey. Furthermore, with the exception of the earlier report from Çapar (2003), this is a new contribution detailing Central Anatolian ciliate fauna with 4 newly reported species recorded for this region. Moreover, descriptions and original drawings of the newly recorded species isolated from a small pond in Beytepe, Ankara, and a list of all ciliate species recorded along with information on their occurrence at different sites in Anatolia have been provided.

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2. Materials and methods

2.1. Study area and sampling

All samples were collected from a water body in Beytepe (39°53′N, 32°45′E) Ankara, Turkey, which is a man-made pond at approximately 970 m above sea level (Figure 1). The lake water has a mean annual pH of 7 (mean = 6.9, min = 6.5, max = 7.12), salinity of 0.015%, electrical conductivity of 800 mS/cm (mean = 799.7, min = 617, max = 860). Seasonal water temperature generally varies between 0 and 25 °C; however, within the present study, temperature changes varied between 1.75 and 24.5 °C (mean = 13.5). Maximum water depth is 16 m (Metin, 2005). All the parameters were measured using a YSI model 33SCT meter.

All the selected stations were designated input and output points of the water body. The sample site descriptions are given below.

Site 1: Located to the southwest, generally windy and surrounded by *Phragmites australis*; Maslak Brook obtains flow input from this site.

Site 2: Located to the west and creates an inlet; aggregated stony bottom.

Site 3: Located to the north and has a pound lock.

Site 4: Located to the southeast and has a rain water collector.

The samples were collected and measured monthly from October 2007 to September 2008 from the

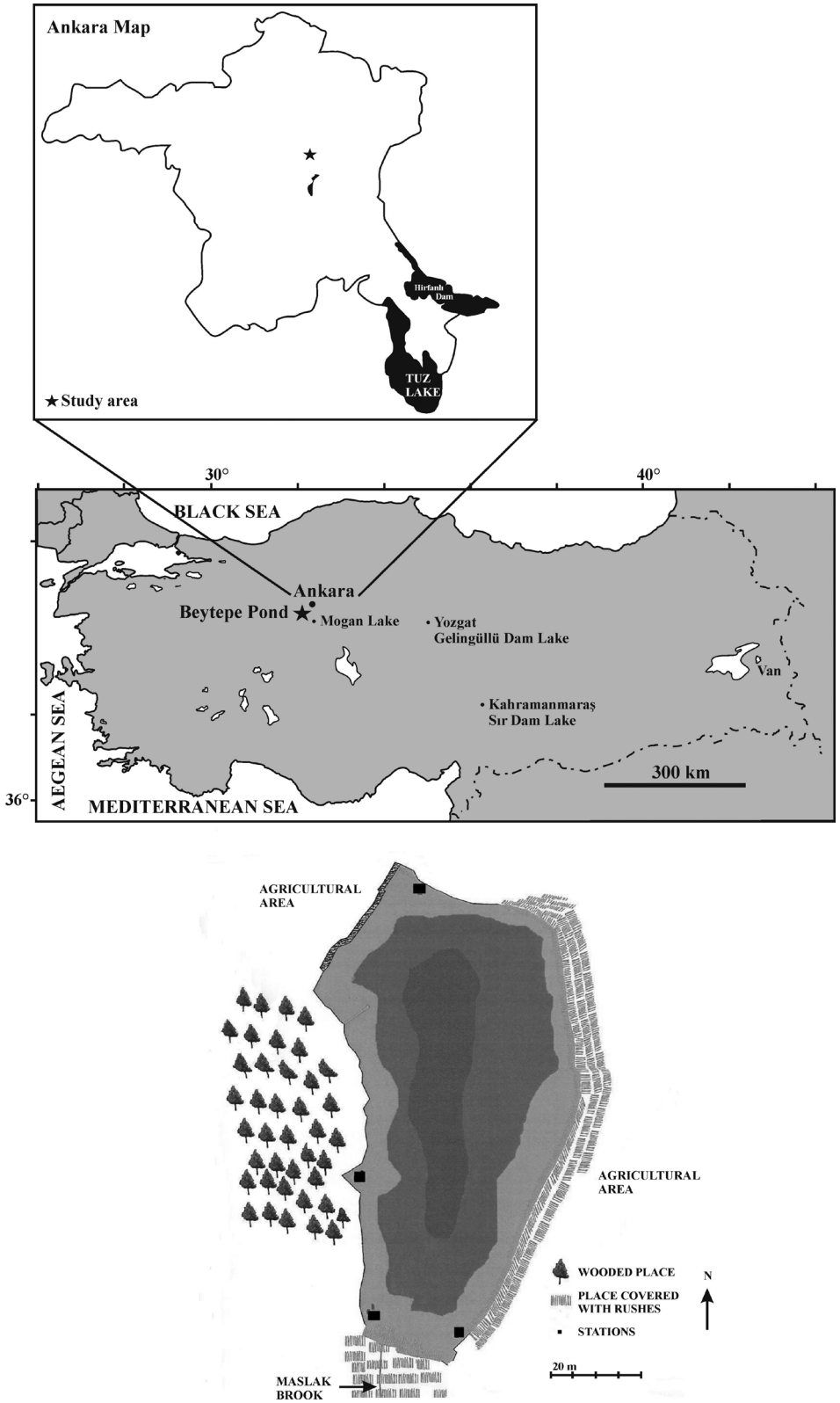

Figure 1. Sampling area.

littoral zone using a 10-μm plankton net and sampling equipment in the form of artificial substrates (Patent No. WO2014123498). For the artificial substrate sampler, glass slides were clipped to a frame and immersed in water at a depth of approximately 0.5 m below the surface for 1 month.

2.2. Sample processing and investigation

The plankton net samples were transported to the laboratory in 50-mL plastic bottles and immediately investigated by obtaining subsamples. Sampling equipment in the form of artificial substrates was removed from of the lake concurrently with lake water to prevent the desiccation of slides and observed after inspection of the plankton net samples.

2.3. Identification and preparation of species

All species were carefully studied in vivo using a high-power (100× and 63×) oil immersion objective and Leica DMR differential interference contrast microscopy. The in vivo observations and staining methods, which were described by Foissner (1991, 1993), were used to reveal the infraciliature and various cytological details using Leica DMR bright field microscopy. In general, over 20 individuals of each morphotype were selected using a micropipette and then identified to species level.

Illustrations of the newly recorded species were based on free-hand sketches and/or micrograph prints. Measurements and counts were performed on randomly selected individuals using the Leica IM50 image manager system and Leica QWin program. Identification, nomenclature, and terminology were according to several studies by Foissner et al. (1991, 1992, 1994, 1995, 1999).

3. Results

3.1. The description of species

A total of 57 freshwater ciliates were collected from Beytepe Pond (Table 1). The following four species were newly identified within Turkey: *Oxytricha similis*, *Pleuronema crassum*, *Astylozoon pyriforme*, and *Pseudovorticella monilata*. The descriptions of the sampled populations of these species are given below.

3.1.1. *Oxytricha similis* (Engelmann, 1862)

Size in vivo 70–80 × 35–40 μm, body slenderly ellipsoidal; right and left body margins almost parallel to each other. Posterior and anterior ends rounded. Macronuclear nodules 10–12 μm long, each nodule comprising a single globular micronucleus of approximately 2 μm in diameter. A contractile vacuole at right body margin, slightly in front of the midbody, 6–8 μm in diameter, without distinct collecting canals. Cortical granules absent; cytoplasm colorless. Adoral zone of membranelles approximately 45% of body length. A right and left marginal cirral row, left row begins approximately at the proximal end of the adoral zone of membranelles; right row commences at level of last frontal cirrus. Both marginal rows end above rear body and row ends posteriorly; marginal cirri, 7–8 μm long. The genus's specific cirral pattern includes 3 frontal, 1 buccal, 4 frontoventral, 3 postoral, 2 ventral, and 5 transverse cirri. All transverse cirri distinctly protrude beyond the posterior end. Dorsal cilia short, approximately 2–3 μm long. Two prominent caudal cilia, 20–21 μm long (dorsal side did not impregnate well; thus, the line drawing is not given). Feeds on bacteria and flagellates (Figure 2; Table 2).

Distribution: The species has been found in the aufwuchs and detritus of various water bodies. To date, all records originate from the Holoarctics (Berger, 1999).

3.1.2. *Pleuronema crassum* (Dujardin, 1841)

Size in vivo 50–70 × 25–35 μm, body ovoid to ellipsoid, left side straight, right convex, both ends rounded. Oral apparatus long with a large conspicuous undulating membrane beginning near the anterior end of the cell and extending to more than 3/4 of the body length. Adoral membranelles approximately 20%–25% of body length and composed of 3 parts, membranelle 1 short; membranelle 2 anteriorly with some disordered basal bodies and posteriorly hook-like, the most posterior end of membranelle 2 U-shaped; membranelle 3 inverted Y-shaped, composed of 2–4 basal body rows. Macronucleus, 10–12 μm in diameter, spherical to ovoid, located approximately centrally; always comprising more than one micronucleus. Contractile vacuole on the dorsal side and situated subterminally, 8–10 μm in diameter. Trichocysts 3–4-mm long, rod-shaped and covering the cell margin. Approximately 35–40 uniform ciliary rows with somatic cilia, 10–12 μm long; no caudal cilia. Feeds on bacteria, small algae, and detritus (Figure 3; Table 3).

Distribution: The species has been found in freshwater, brackish water, and marine environments, and to date it has been recorded from the Holoarctics and Paleotropis (Foissner et al., 1994).

3.1.3. *Astylozoon pyriforme* (Schewiakoff, 1893)

Size in vivo 60–70 × 30–45 μm, body basically campanulate; occasionally left side slightly convex; posterior end stalkless with an inconspicuous scopula, bears inconspicuous bristles; anterior end carries an oral apparatus. Peristomial collar often conspicuous; adoral ciliary spiral inconspicuous, peristomial disc distinctly convex and slightly raised; vestibulum extends to approximately 1/2 of body length. Macronucleus vermiform, extending to more or less over the entire body. Contractile vacuole 8–9 μm across, slightly underneath peristomial collar at ventral wall of vestibulum, but appears to be located at the right side of the cell when laterally viewed. Pellicle uncertainly striated. Solitary; feeds on bacteria (Figure 4; Table 4).

Distribution: The species has been found in freshwater environments and is recorded from the Holoarctics (Foissner, 1977; Foissner et.al., 1999).

Table 1. Taxonomic and geographic summary of freshwater ciliates of Beytepe Pond.

	Species	Taxonomic group[1]	Geographic distribution[2]					Mogan Lake, Ankara[3]	Van Province[4]	Bostaniçi Pond, Van[5]	Erçek Lake, Van[6]	Sır Dam Lake[7]
			H	N	P	A	Ar					
1	*Actinobolina radians*	L	+	+	+	–	–	+	–	-	-	–
2	*Actinobolina vorax*	L	+	–	–	–	–	+	–	-	-	–
3	*Amphileptus* spp.	L	+	+	+	–	–	–	+	-	-	–
4	*Aspidisca cicada*	S	+	+	+	+	+	–	+	+	-	–
5	*Astylozoon fallax*	O	+	–	–	–	–	+	–	-	-	–
6	*Astylozoon faurei*	O	+	–	–	–	–	+	–	-	-	–
7	*Astylozoon pyriforme*	O	+	–	–	–	–	–	–	-	-	–
8	*Bursaria truncatella*	C	+	+	+	+	–	–	–	+	-	–
9	*Coleps hirtus*	P	+	+	–	–	–	+	+	+	-	+
10	*Coleps nolandi*	P	+	+		–	–	–	–	-	-	–
11	*Cyclidium glaucoma*	O	+	+	+	–	+	–	+	+	+	+
12	*Cyclidium heptatrichum*	O	+	+	–	–	–	–	+	-	-	–
13	*Didinium nasutum*	L	+	–	+	–	–	+	–	-	-	–
14	*Dileptus* sp.	L	+	+	–	–	+	–	+	-	-	-
15	*Disematostoma buetschlii*	O	+	+	+	–	–	+	–	-	-	–
16	*Enchelyodon elegans*	L	+	–	–		–	+	–	-	-	–
17	*Euplotes* sp.	S	+	+	+	+	+	+	+	*E. patella* *E. moebiusi*	*Euplotes* sp.	+
18	*Frontonia angusta*	O	+	–	–	–	–	–	+	+	-	+
19	*Glaucoma reniforme*	O	+	–	–	+	–	+	–	-	-	–
20	*Glaucoma scintillans*	O	+	+	–	–	+	–	+	-	-	
21	*Halteria grandinella*	S	+	+	+	–	+	–	+	-	-	+
22	*Histriculus vorax*	S	+	–	–	–	–	+	–	-	-	–
23	*Holophrya discolor*	P	+	+	+	+	–	–	+	*Holophyra* sp.	-	–
24	*Holosticha kessleri*	S	+	–	–	–	–	+	+	-	-	-
25	*Holosticha pullaster*	S	+	–	–	–	+	+	+	-	-	-
26	*Kahlilembus attenuatus*	O	+	–	–	–	–	–	–	-	-	–
27	*Lacrymaria olor*	L	+	–	–	–	+	+	+	-	-	–
28	*Lagynophrya acuminata*	L	+	–	–	–	–	+	–	-	-	–
29	*Lembadion lucens*	O	+	–	–	–	–	+	+	-	-	–
30	*Litonotus crystallinus*	L	+	+	–	–	–	+	+	-	-	-
31	*Litonotus cygnus*	L	+	+	–	+	+	+	+	+	-	-
32	*Mesodinium* sp.	L	+	–	–	–	–	+	–	-	-	–
33	*Monodinium balbiani*	L	+	+	–	–	–	+	+	-	-	–
34	*Oxytricha similis*	S	+	–	–	–	–	–	–	-	-	–
35	*Paracolpidium truncatum*	Hy	+	–	–	–	–	+	–	-	-	–
36	*Paramecium bursaria*	O	+	–	–	–	–	+	+	-	-	+
37	*Paramecium putrinum*	O	+	–	–	–	–	+	+	+	-	–
38	*Phascolodon vorticella*	Ph	+	–	–	–	–	+	–	-	-	–
39	*Philasterides armatus*	O	+	–	–	–	–	+	+	-	-	+

Table 1. (Continued).

40	*Platycola decumbens*	O	+	+	–	–	–	–	+	-	-	–
41	*Pleuronema coronatum*	O	+	–	–	–	–	–	+	+	-	–
42	*Pleuronema crassum*	O	+	–	+	–	–	–	–	-	-	–
43	*Pseudovorticella monilata*	O	+	+	–	–	–	–	–	-	-	–
44	*Sphaerophrya magna*	Ph	+	+	+	+	–	–	+	-	-	–
45	*Spirostomum teres*	H	+	+	–	+	+	+	+	-	-	+
46	*Sterkiella histriomuscorum*	S	+	+	–	–	–	+	–	-	-	–
47	*Strobilidium caudatum*	S	+	–	–	–	–	+	+	-	-	–
48	*Strobilidium humile*	S	+	–	–	–	–	+	+	-	-	–
49	*Stylonychia mytilus*	S	+	+	+	+	–	+	+	+	-	–
50	*Tetrahymena pyriformis*	O	+	+	–	–	–	–	+	-	-	–
51	*Trichodina pediculus*	O	+	+	–	–	–	+	–	-	-	–
52	*Uroleptus piscis*	S	+	+	+	–	–	+	+	+	-	-
53	*Uronema nigricans*	O	+	+	+	–	+	–	+	+	+	–
54	*Urotricha* sp.	P	+	–	–	–	+	+	+	*U.globosa* *U.platystoma*	-	-
55	*Vorticella natans*	O	+	–	–	–	–	+	+	-	-	+
56	*Vorticella octava*	O	+	–	–	–	–	–	+	-	-	–
57	*Zoothamnium* sp.	O	+	+	–	–	–	–	+	-	-	–

[1]Classification mainly after Lynn et. al. (1997). C: Colpodea; H: Heterotricha; Hy: Hymenostomata; L: Litostomatea; O: Oligohymenophorea; P: Prostomatea; Ph: Phyllopharyngea; S: Spirotrichea.
[2]Classification of geographic regions according to Foissner (1998). H: Holoarctics (North America, Greenland, Eurasia with Iceland, Canary Islands, Korea, Japan, North Africa); P: Paleotropis (Africa south of the Sahara Desert, Madagascar, India); A: Australis (Australia); N: Neotropis (Central and South America); Ar: Archinotis (Antarctica and islands in southern oceans).
[3]Çapar (2003); species recorded from Mogan Lake, Ankara.
[4]Şenler and Yıldız (1998, 1999, 2004); species recorded from Van Province.
[5]Yıldız (2004); species recorded from Bostaniçi Pond, Van.
[6]T.C. Orman ve Su İşleri Bakanlığı (2012).
[7]Kaplan (2007); species recorded from Sır Dam Lake, Kahramanmaraş.

3.1.4. *Pseudovorticella monilata* (Tatem, 1870)

Size in vivo 60–80 × 50–55 µm, body basically campanulate; posterior end with stalk containing myonemes; anterior end carries an oral apparatus. Peristomial collar and adoral ciliary spiral distinct, peristomial disc flat; vestibulum extending to approximately 1/2 of the body length. Macronucleus J-shaped. Two contractile vacuoles, each about 10–11 µm in diameter, one vacuole slightly underneath peristomial collar at ventral wall of vestibulum, the second at proximal end of vestibulum. Pellicle with many tiny globules. Silver line system mesh-like, approximately 24–25 silver lines from anterior to aboral ciliary wreath and approximately 15–16 from aboral ciliary wreath to scopula. Solitary; feeds on bacteria (Figure 5; Table 5).

Distribution: The species has been found in freshwater environments and the Holoarctics and Neotropis (Foissner et al., 1992).

3.2. Faunistic analysis

In Beytepe Pond, most of the ciliates identified belong to three systematic assemblages: Oligohymenophorea (44%, 24 species), Spirotrichea (21%, 12 species), and Litostomatea (21%, 12 species). The most abundant taxon, Oligohymenophorea, comprised hymenostomatids (16 species) and peritrichids (9 species), followed by Spirotrichea comprising hypotrichids (9 species) and oligotrichids (3 species) and Litostomatea comprising gymnostomatids (8 species), pleurostometids (3 species), and cyclotrichids (1 species). When comparing the freshwater ciliate fauna of the pond to other sites of Anatolia, 34 species have been additionally found in Van Province (38°29′N, 43°24′E), 34 species in Mogan Lake in Ankara (33°54′N, 36°13′E), 9 species in Sır Dam Lake (37°35′N, 36°43′E), in Kahramanmaraş, 11 species in Bostaniçi Pond (43°25′E, 38°32′N), and 2 species in Erçek Lake (38°39′N, 43°33′E) (Table 1) (Şenler and Yıldız, 1998; 1999, 2004; Çapar, 2003; Çapar, 2007; Kaplan, 2007).

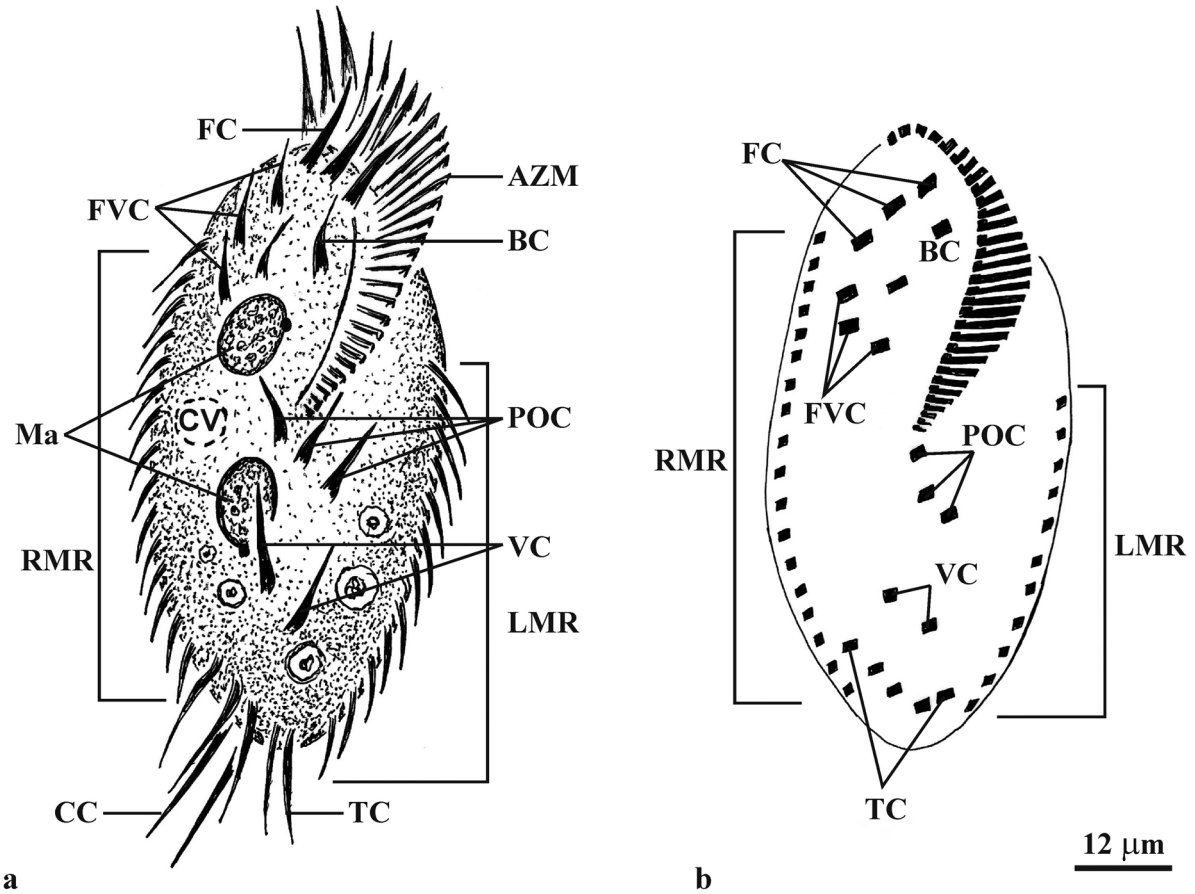

Figure 2. *Oxytricha similis* live specimen (a) and after protargol impregnation (b). a) A specimen from ventral side with slenderly ellipsoid outline and the typical *Oxytricha* cirral pattern with 2 conspicuous caudal cilia. b) Ciliary pattern from ventral side. AZM, Adoral zone of membranelles; BC, buccal cirrus; CC, caudal cirri; FC, frontal cirri; FVC, frontoventral cirri; CV, contractile vacuole; LMR; left marginal cirral row; Ma, macronucleus; POC, postoral cirri; RMR, right marginal cirral row; TC, transverse cirri; VC, ventral cirri.

4. Discussion

In all, 57 taxa were identified from Beytepe Pond. According to sampling sites, approach, and equipment, an attempt was made to sample the entire freshwater ciliate community of the pond. The results of this process demonstrated that only 15 species are eupelagic, namely those of Litostomatea (*Actinobolina vorax*, *Actinobolina radians*, *Lagynophrya acuminata*, *Mesodinium* sp., *Monodinium balbiani*, and *Didinium nasutum*), Oligohymenophorea (*Astylozoon fallax*, *Astylozoon faurei*, *Disematostoma buetschlii*, and *Trichodina pediculus*), Spirotrichea (*Halteria grandinella*), Prostomatea (*Coleps nolandi*, *Coleps hirtus*, and *Urotricha* sp.), and Phyllopharyngea (*Phascolodon vorticella*), in the pond. Although all the above eupelagic species were found in Mogan Lake (Çapar, 2003, 2007), none of these species were reported in either Sır Dam Lake or Van Lake. This is likely because of the specialized water quality of Van Lake and the neomorphism of Sır Dam Lake with regard to the sampling period of the former investigations. Moreover, the following nine taxa were identified on several occasions within plankton net samples and on artificial substrate in Beytepe Pond (Table 1): *Cyclidium glaucoma*, *Dileptus* sp., *Euplotes* sp., *Holophrya discolor*, *Litonotus cygnus*, *Paramecium bursaria*, *Spirostomum teres*, *Strobilidium caudatum*, and *Stylonychia mytilus*. None of these nine species are either pelagic or anaerobic (Foissner et al., 1991, 1992, 1994, 1995, 1999). The profile of the above taxa generally indicates that 1/4 (26%) of the total taxa were eupelagic, indicating that they always take shelter within pelagic environments, whereas 1/6 (16%) of the community was composed of immigrant benthic taxa. The remaining (58%) occur in the water column. If we confirm the knowledge given in the literature (Laybourn-Parry, 1992; Foissner et al., 1999), we see that although the species originating from the benthos were common in Beytepe Pond, using the repetitive sampling strategy, we can determine that their frequency of occurrence was low in the pelagic environment. When we compare these

Table 2. Morphometric data on *Oxytricha similis*.

Characters	$\bar{X}$	M	SD	SE	CV	Min	Max	n
Body, length	75	75	3.78	1.26	0.050	70	80	9
Body, width	37.5	38	1.94	0.64	0.05	35	40	9
Macronuclear nodules, number	2	2	0	0	0	2	2	9
Macronuclear nodules, length	11	11	0.87	0.29	0.08	10	12	9
Micronuclei, length	2	2	0	0	0	2	2	8
Adoral zone membrane, length	33	33.5	1.30	0.43	0.039	31	35	9
Contractile vacuole, size	7	7	0.71	0.23	0.10	6	8	9
Frontal cirri, number	3	3	0	0	0	3	3	9
Buccal cirri, number	1	1	0	0	0	1	1	9
Frontoventral cirri, number	3.44	3	0.53	0.17	0.15	3	4	9
Postoralventral cirri, number	3	3	0	0	0	3	3	9
Ventral cirri, number	2	2	0	0	0	2	2	9
Transverse cirri, number	5	5	0	0	0	5	5	9
Left marginal row, cirri number	11.44	12	1.01	0.34	0.09	10	13	9
Right marginal row, cirri number	15.89	15	1.45	0.48	0.09	14	18	9
Caudal cirri, number	2	2	0	0	0	2	2	9
Dorsal cilia, length	2.44	2	0.52	0.17	0.21	2	3	9
Somatic cilia, length	7.44	7	0.53	0.17	0.07	7	8	9

Measurements in μm. CV: Coefficient of variation in %; M: median; Max: maximum; Min: minimum; n: number of individuals investigated; SD: standard deviation; SE: standard error of arithmetic mean; $\bar{X}$: arithmetic mean.

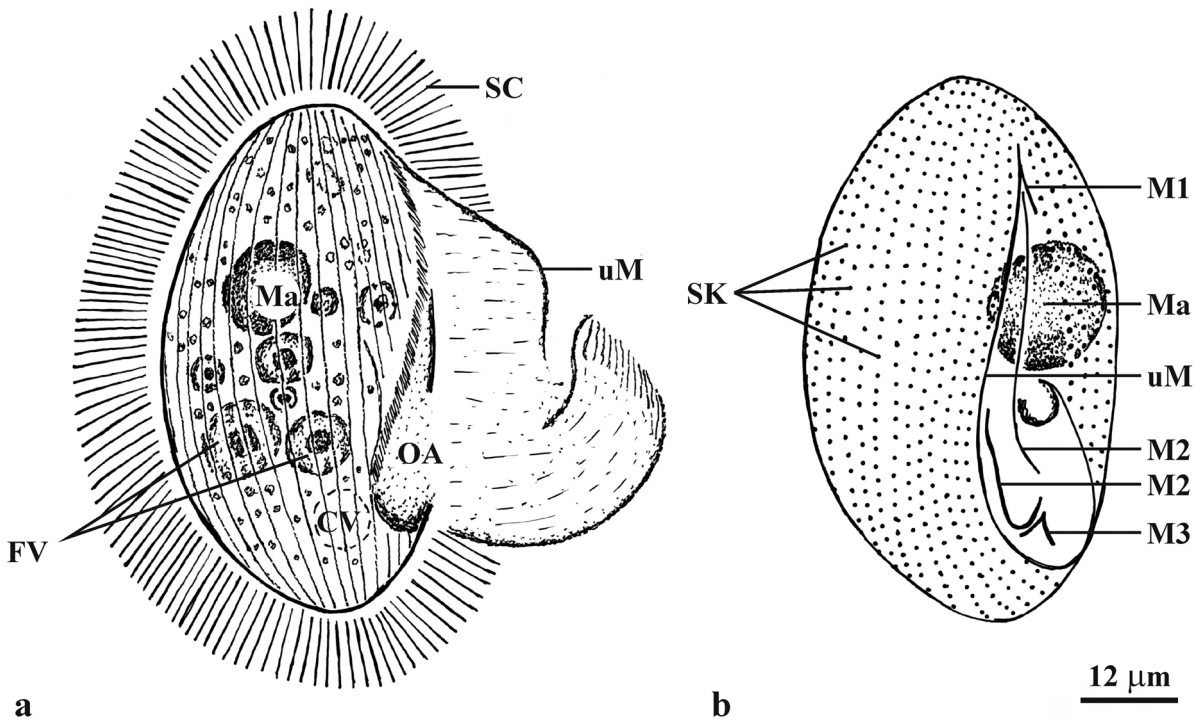

Figure 3. *Pleuronema crassum* live specimen (a) and after protargol impregnation (b). a) A typical specimen with ellipsoid outline and a conspicuous undulating membrane. b) Ventrolateral view of ciliary pattern, which includes 3 adoral membranelles and a single undulating membrane. FV, Food vacuoles; CV, contractile vacuole; M1–M3, adoral membranelles 1–3; Ma, macronucleus; SK, somatic kineties; SC, somatic cilia.

Table 3. Morphometric data on *Pleuronema crassum*.

Character	$\bar{X}$	M	SD	SE	CV	Min	Max	n
Body, length	62	65	6.67	2.22	0.11	50	70	9
Body, width	28.44	28	5.05	1.68	0.178	22	35	9
Body, length/body, width	2.23	2	0.42	0.14	0.19	1.71	2.91	9
Macronucleus, number	1	1	0	0	0	1	1	9
Macronucleus, length	11	11	0.867	0.29	0.08	10	12	9
Oral opening, length	47.37	48	4.03	1.344	0.08	41	52	9
Contractile vacuole, size	8.88	9	0.93	0.312	0.10	8	10	9
Trichocysts, size	3.44	3	0.53	0.17	0.15	3	4	9
Somatic cilia, length	11.11	11	0.78	0.26	0.07	10	12	9

Measurements in μm. CV: Coefficient of variation in %; M: median; Max: maximum; Min: minimum; n: number of individuals investigated; SD: standard deviation; SE: standard error of arithmetic mean; $\bar{X}$: arithmetic mean.

9 species that originated from the benthos with the results of earlier studies from different water bodies, Van Lake (Şenler and Yıldız, 2004) contains all the above species. Of those, while *Stylonychia mytilus* was recorded within Mogan Lake and Bostaniçi Pond, *Strobilidium caudatum* was recorded only from Mogan Lake (Yıldız, 2004; Çapar, 2007). These 2 species are widely distributed in freshwater habitats throughout the year, with peaks during spring and autumn. While *S. mytilus* is usually classified as an alpha-mesosaprobic indicator of water quality (Berger, 1999), *S. caudatum* is a species that shows the highest abundances at salinities of 6%–20%, and temperature has less influence on this species (Agatha and Riedel-Lorje, 1998). *Cyclidium glaucoma*, a bacterivorous ciliate with a slow growth rate (Posch et. al., 2001), was recorded within both Bostaniçi Pond and Erçek Lake (T.C. Orman ve Su İşleri Bakanlığı,

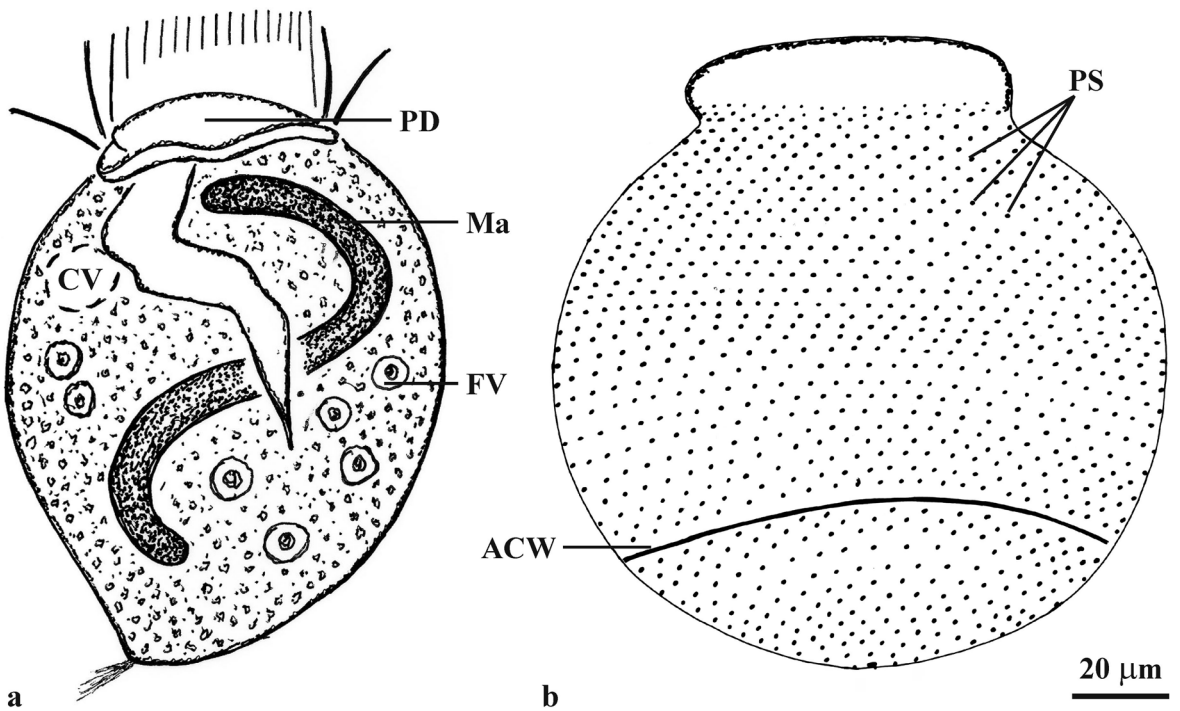

Figure 4. *Astylozoon pyriforme* live specimen (a) and after silver impregnation (b). a) Lateral view of a typical specimen. b) View of the pellicular striation. ACW, Aboral ciliary wreath; FV, food vacuole; CV, contractile vacuole; Ma, macronucleus; PD, peristomial disk; PS, pellicular striation.

Table 4. Morphometric data on *Astylozoon pyriforme*.

Character	$\bar{X}$	M	SD	SE	CV	Min	Max	n
Body, length	65.78	65	4.32	1.44	0.06	60	70	9
Body, width	38.33	35	5.85	1.95	0.15	30	45	9
Body, length/body, width	1.74	1.8	0.16	0.05	0.09	1.55	2	9
Vestibulum, length	33.11	33	2.09	0.69	0.063	30	35	9
Contractile vacuole, size	8.22	8	0.83	0.28	0.10	7	9	9

Measurements in μm. CV: Coefficient of variation in %; M: median; Max: maximum; Min: minimum; n: number of individuals investigated; SD: standard deviation; SE: standard error of arithmetic mean; $\bar{X}$: arithmetic mean.

2012). According to the former investigations, only *Paramecium bursaria* and *Spirostomum teres* were recorded from Sır Dam, Mogan, and Van lakes (Table 1). These two species are sensitive to heavy metals; therefore, they are suitable indicators for pure water quality (Madoni, 2000). Consequently, determining the taxonomic assemblage of ciliates in aquatic systems up to species level is important for gaining an understanding of ecological conditions. This requires long-term monthly qualitative and quantitative biomonitoring studies.

In principle, the freshwater planktonic ciliate community characterized by the high percentage of oligohymenophorean species was thus correctly classified as Oligotrichetea (Foissner et al., 1991, 1995). In such environments, the dominance of oligohymenophoreans makes sense as they have extremely effective morphological adaptations to the pelagic environment, including small size, shape, spines, and a special movement strategy utilizing long membranelles that can additionally be used for feeding (Foissner et, al., 1999). In our case, the oligohymenophorean group was the most dominant taxon with 21 species represented by hymenostomatids and peritrichids.

With regard to feeding strategies, the same oligohymenophorean group consisted mainly of filter feeders. However, the second largest recorded taxon,

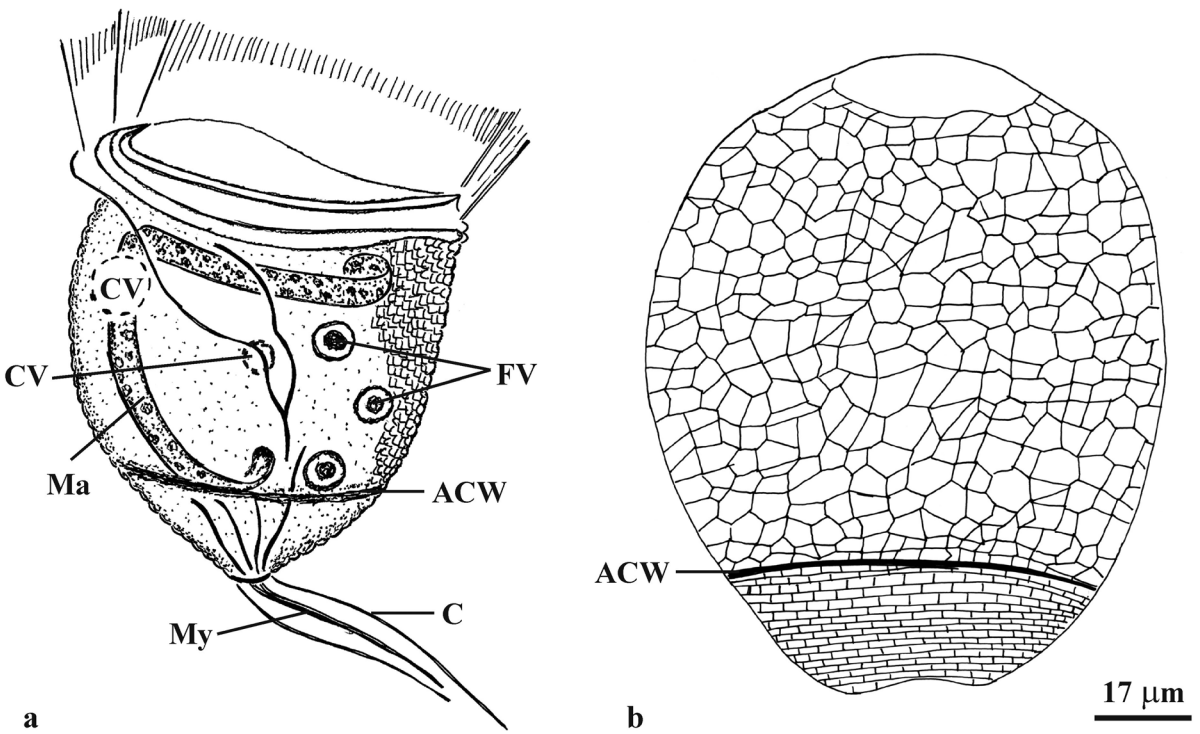

Figure 5. *Pseudovorticella monilata* live specimen (a) and after silver impregnation (b). a) Lateral view of a typical specimen. b) Mesh-like silver line system. ACW, Aboral ciliary wreath; FV, food vacuoles; CV, contractile vacuole; My, myoneme; Ma, macronucleus.

Table 5. Morphometric data on *Pseudovorticella monilata*.

Character	$\bar{X}$	M	SD	SE	CV	Min	Max	n
Body, length	72.89	75	7.18	2.39	0.10	60	80	9
Body, width	53.22	53	1.56	0.52	0.03	50	55	9
Body, length/body, width	1.37	1.44	0.11	0.04	0.08	1.2	1.46	9
Vestibulum, length	36.22	36	3.50	1.16	0.10	30	40	9
Contractile vacuole, size	10.44	10	0.53	0.182	0.05	10	11	9

Measurements in µm. CV: Coefficient of variation in %; M: median; Max: maximum; Min: minimum; n: number of individuals investigated; SD: standard deviation; SE: standard error of arithmetic mean; $\bar{X}$: arithmetic mean.

Litostomatea, comprised 11 predator species in the pond, except for *Mesodinium* sp., which is omnivorous. Spirotrichea, the last well-represented taxon with 12 species, was completely omnivorous. According to these results, the pond community is composed largely of filter feeders (42.1%), followed by omnivores (22.8%) and predators (21.05%). The species profile (Table 1) of this pond overlaps with that given in the literature for other locations (Foissner et al., 1991, 1992, 1994, 1995, 1999; Foissner, 1998).

When fundamentally referring to the lower taxa, the freshwater plankton comprises gymnostomes, followed by peritrichs, hymenostomes, prostomatids, and hypotrichs. All other taxa contribute less than 10% of the total community (Foissner et al., 1999). When the ciliates move through the water column, the species profile undergoes a marginal change, as evident in Beytepe Pond: hymenostomes (16 species), peritrichs (9 species), hypotrichs (9 species), gymnostomes (8 species), and prostomatids (3 species). Such differences may occur because of using different sampling equipment, as in our case.

Overall, the total number of species in each taxon changed over the year. It is likely that there was a distinct ciliate bloom during spring and a marked decrease during summer and winter. These seasonal changes of the pelagic ciliate community may be related to the seasonal occurrence of predators, particularly rotifers and crustaceans, and the varying food resources. These results clearly show the importance of monthly or even yearly sampling. Concerning our sampling approach, the number of taxa identified was higher in the substrate sampling as compared to the plankton net sampling; however, there was no distinct difference among the stations. The taxa Litostomatea (*Actinobolina vorax*, *Lagynophrya acuminata*, *Mesodinium* sp., *Monodinium balbiani*, and *Didinium nasutum*), Oligohymenophorea (*Astylozoon fallax*), Spirotrichea (*Halteria grandinella*), Prostomatea (*Coleps nolandi* and *Coleps hirtus*), and Phyllopharyngea (*Phascolodon vorticella*) were distributed in all sampling stations throughout the year. The basic systematic assemblages and their species from Litostomatea (*Didinium nasutum*), Oligohymenophorea (*Astylozoon faurei*), Spirotrichea (*Halteria grandinella*), and Phyllopharyngea (*Phascolodon vorticella*) indicated eutrophic conditions.

On the other hand, according to alpha taxonomy, the following 17 species constitute new reports for Central Anatolia: *Amphileptus* spp., *Aspidisca cicada*, *Coleps nolandi*, *Cyclidium glaucoma*, *Cyclidium heptatrichum*, *Dileptus* sp., *Frontonia angusta*, *Glaucoma scintillans*, *Halteria glaucoma*, *Holophrya discolor*, *Litonotus crystallinus*, *Platycola decumbens*, *Pleuronema coronatum*, *Tetrahymena pyriformis*, *Uronema nigricans*, and *Vorticella octava* (Table 1).

All species identified in the current study have additionally been recorded from the Holoarctics. All observed species have additionally been previously reported from at least one other geographical region, namely 28 species from the Neotropis, 15 species from the Paleotropis, 9 species from the Australis, and 13 species from the Archinotis regions (Table 1) (Foissner et al., 1991, 1992, 1994, 1995, 1999; Berger, 1999). Among these species, *Aspidisca cicada* was the only species recorded within all geographical regions. *Bursaria truncatella*, *Holophrya discolor*, *Sphaerophrya magna*, and *Stylonychia mytilus* were found in all other geographical regions, but were not registered in the Archinotis (Table 1). According to the distinctness of morphospecies and the comparatively large size of these 4 species, they could have been overlooked if they had been in the Archinotis.

Although the species identified in the present study were not flagship (Foissner et al., 2008) endemic morphotypes, all knowledge gained on the local diversity is important.

With regard to MacArthur and Wilson's theory of island biogeography, the number of species increases with the size of the area investigated. Currently, this approach links with the 'everything is everywhere' (Fenchel et al., 1997) model. At first glance, this seems to be rational.

However, until now, 4500 free-living ciliate morphospecies have been described, and it is estimated that 83%–89% of the ciliate diversity is still undescribed (Foissner, 2006; Foissner et al., 2008). This illustrates the current main topic of the conversation in which the moderate endemicity model is referred to. To prove any of these models and to reveal the biogeography and dispersal of ciliates, ciliate investigations on representative ecosystems are required. Under these premises, all local knowledge gained on the morphology and distribution of ciliates is valuable. The present paper contributes to this intensively discussed topic. With these four new reports, the number of freshwater ciliates identified in Turkey has reached 185 species. It is assumed that this number remains too low to be representative of reality.

Acknowledgments

The author would like to thank Nazlı Deniz Eyice and Murat Teberoğlu for their valuable technical assistance in the laboratory and the office. Special thanks are given to Dr İsmail Yıldız for sharing his personal literature.

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