

A New Rumen Ciliate from the Turkish Domestic Goat (*Capra hircus* L.): *Entodinium salmani* n.sp. (Entodiniidae, Entodiniomorhida)

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Abstract: In the course of examining rumen contents obtained from 8 domestic goats (*Capra hircus* L.) from the south-east of Turkey, a new ciliate species *Entodinium salmani* n.sp. (Entodiniidae, Entodiniomorhida) and 4 formae [*E. salmani salmani* n.sp., n.f., *E. salmani monospinosum* n.sp., n.f., *E. salmani bispinosum* n.sp., n.f., *E. salmani trispinosum* n.sp., n.f.] were distinguished. The main characteristics of these species and formae are described in detail and compared with those of similar ones previously reported.

Key Words: *Entodinium salmani* n.sp., New Rumen Ciliates, *Capra hircus* L., Turkey

Türkiye Evcil Keçilerinden (*Capra hircus* L.) Yeni Bir İşkembe Siliyatı, *Entodinium salmani* n.sp. (Entodiniidae, Entodiniomorhida)'dır

Özet: Türkiye'nin Güneydoğusunda yaşayan evcil keçi (*Capra hircus* L.)'lerin işkembe içerikleri araştırılırken yeni bir siliyat türü *Entodinium salmani* n.sp. (Entodiniidae, Entodiniomorhida) ve bu türe dahil olacak şekilde 4 forma; *E. salmani salmani* n.sp., n.f., *E. salmani monospinosum* n.sp., n.f., *E. salmani bispinosum* n.sp., n.f., *E. salmani trispinosum* n.sp., n.f. saptanmıştır. Bu türün ve formlarının temel özellikleri detaylı olarak tanımlanmış ve daha önce tanımlanan benzer türlerle karşılaştırılmıştır.

Anahtar Sözcükler: *Entodinium salmani* n.sp., Yeni İşkembe Siliyatları, *Capra hircus* L., Türkiye

Introduction

Although some detailed investigations have been conducted in domestic cattle and sheep in Turkey (Öktem and Göçmen, 1996; Göçmen and Öktem, 1996; Göçmen, 2000; Göçmen et al., 2001; 2003a), only a limited number of studies have been reported on the rumen fauna of goats (Göçmen and Atatür, 2002; Göçmen et al., 2003b; Rastgeldi and Göçmen 2003). Therefore, the rumen contents of domestic goats (*Capra hircus* L.) living in southeast Turkey, which has an important geographical position, were investigated. During the course of the investigation, some unusual forms of entodinia were recognized in the rumen content of one of the goats. They were classified into 1 species and 4 formae.

Materials and Methods

Samples of rumen contents were obtained from 8 mature domestic goats (*Capra hircus* L.) at

slaughterhouses in Adana (Kadirli, Ceyhan) and Urfa on 10.2.1999, 28.3.1999 and 30.10.2000. The animals had been allowed to graze on the plateaus all day and were fed 0.5-1 kg of wheat straw and barley twice a day. The rumen wall was cut with a knife and a sample of rumen contents was removed via a catheter (Göçmen and Öktem, 1996). A well-mixed sample of the rumen contents was diluted with an equal volume of 50% Formalin (18.5% formaldehyde) as soon as possible after the animal was killed (Dehority, 1994). A portion of each sample was also immediately fixed and stained in methyl-green formalin saline (MFS) solution (Ogimoto & Imai, 1981) for total and differential counts. The MFS served as a nuclear stain. Differential counts of specimens were estimated from smear slides, with a total of 400 to 500 cells identified. All cell measurements were obtained with a calibrated ocular micrometer. Specimens were examined with a Jena NF-binocular microscope and photomicrography accessory.

The terminology for orientation used in describing the structure of new ciliate species conforms to the conventional system of the ciliate kingdom proposed by Dogiel (1927) and Grain (1994).

The Excel (Microsoft Office XP) program was used to organize the observations on various morphological characteristics.

In order to determine the degree of difference between some characteristics of variations within the new species, the coefficient of difference (CD) value, which was first used by Mayr (1969), was also calculated. According to Mayr (1969), if the CD value of 2 populations for 1 character is higher than or equal to 1.28, these 2 populations are considered different in terms of this character.

Results and Discussion

Entodinium salmani n.sp.

Diagnosis. Body ellipsoidal (37.3-58.3 μm x 25.6-41.9 μm); dorsal side slightly depressed in mid-body; widest in anterior half of the body; macronucleus elongate, located along the dorsal middle of the body; micronucleus relatively big, triangular to ellipsoidal,

situated near the anterior or the posterior edge of the macronucleus; a contractile vacuole is situated anterior to the macronucleus on a line ventral to its axis; At the posterior end of the body 0-3 caudal processes.

Description. Body is ellipsoidal in side view (Figures 1 and 2). Body length on average $44.6 \pm 4.45 \mu\text{m}$ [37.3-58.3], width $33.3 \pm 3.62 \mu\text{m}$ [25.6-41.9], length/width ratio 1.35 ± 0.14 [1.06-1.75] (n = 50) (Table 1). Anterior end flattened to form the oral area, posterior end rounded. There is an invagination on the dorsal side at the mid-point of the body. Adoral ciliary zone (ACZ) is at an angle of 30° to the main body axis and slightly slanted away from the macronucleus. Oesophagus (nasse) is funnel-shaped and bent towards the macronucleus. An elongate macronucleus is situated in the middle of the body (length on average $12.5 \pm 2.41 \mu\text{m}$ [8.7-16.3]), very close to the dorsal surface. The anterior end is thick and the posterior end narrower. There is a relatively big (3.6 μm across) and triangular to ellipsoidal micronucleus. In most of the specimens (65%) it lies near the anterior end of the macronucleus closer to the ventral side of its axis. In 35% of the specimens it is located near the posterior end of the macronucleus at the ventral side

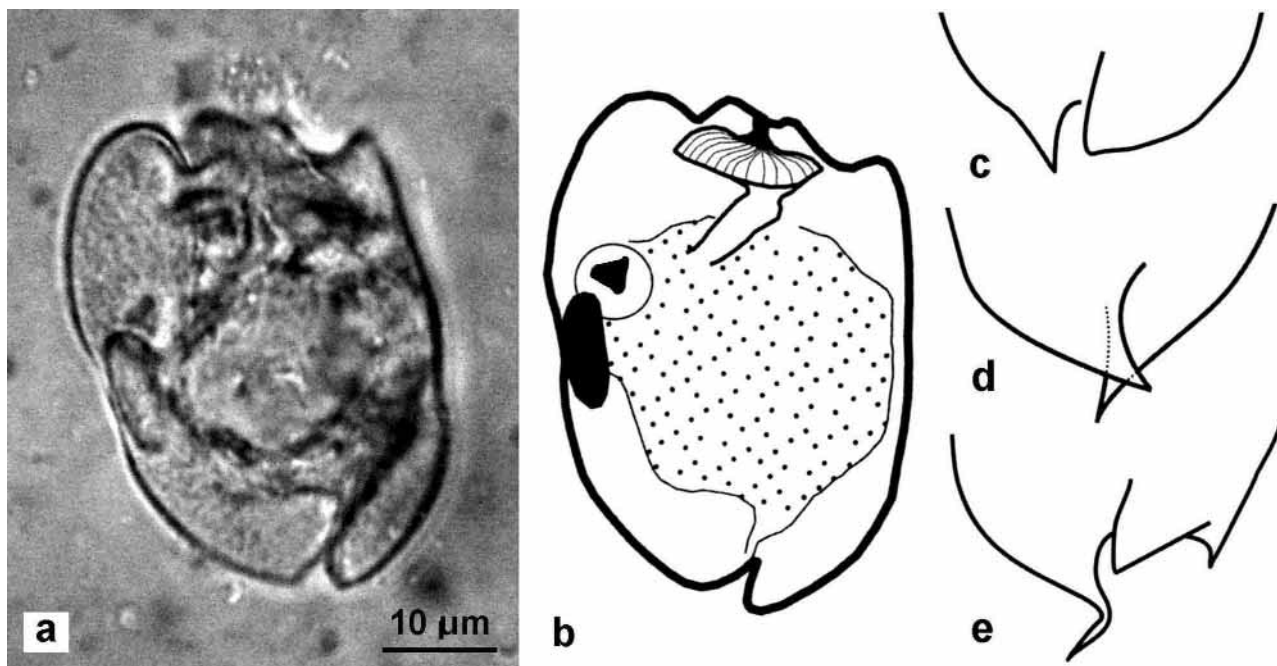


Figure 1 a. Photomicrograph of the right aspect of *Entodinium salmani salmani* n.sp., n.f. (Phenon 1); b. Drawing of *Entodinium salmani salmani* n.sp., n.f. from the right side view; c-e. The caudal armatures of *E. salmani monospinosum* n.sp., n.f. (c); *E. salmani bispinosum* n.sp., n.f. (d) and *E. salmani trispinosum* n.sp., n.f. (e) [All specimens were fixed and stained with MFS solution].

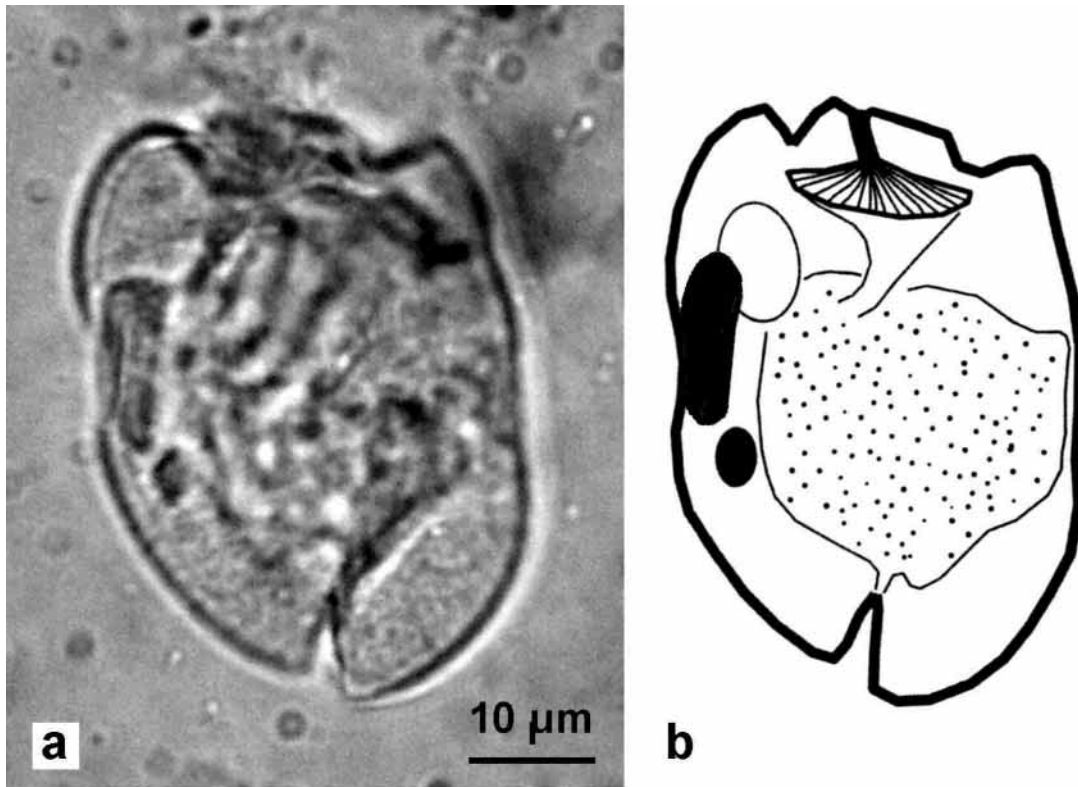


Figure 2 a. Photomicrograph (a) and drawing (b) of a variation (Phenon 2) of *E. salmani salmani* n.sp., n.f. from the right aspect [All specimens were fixed and stained with MFS solution].

Table 1. Morphometric data (μm) of *Entodinium salmani* n.sp. from Turkish domestic goat rumen contents [SD = standard deviation (All measurements were made after the staining and fixing with MFS solution)].

Characteristic	Dimensions in μm (n = 50)	
	Mean \pm SD	Range
Length (L)	44.64 \pm 4.45	37.28–58.25
Width (W)	33.27 \pm 3.62	25.63–41.94
Length of macronucleus (MaL)	12.47 \pm 2.41	8.66–16.31
Width of macronucleus (MaW)	6.34 \pm 1.63	4.66–9.32
LW	1.35 \pm 0.14	1.06–1.75
MaL/MaW	2.08 \pm 0.60	1.25–3.00
L/MaL	3.68 \pm 0.67	2.43–5.00

of its axis. Contractile vacuole is located on the anterior end of the macronucleus on its left side. According to Latteur's (1968) classification it is of the anteropulsatum type. The peripheral periplasm (endoplasm) occupies most of the body, but does not enter the spine or lobes. The central periplasm (ectoplasm) of the dorsal side of

the body is thicker than that of the ventral side. The cytoproctal tube is narrow and bends towards the dorsal side of the body.

Measurements of 50 cells of *Entodinium salmani* n.sp. from Turkish domestic goat no: 6 are given in Table 1.

Type specimens. Holotype and paratypes are deposited in the ZDEU Museum (Ege University, Faculty of Science, Department of Biology, Zoology section, 35100 Bornova, İzmir, Turkey) on the slides numbered ZSBEU-RCG.1/PN 1-3, and dated Sept. 15, 2003.

Type host and locality: Domestic Goat, *Capra hircus*, in Urfa, Turkey.

Habitat. Rumen

Variations. In most of the individuals (Phenon 1, 65%) the micronucleus is located near the anterior end of the macronucleus, but there are also some specimens (Phenon 2, 35%) that have a micronucleus at the posterior end of the macronucleus (Figure 2). However, all other taxonomical characteristics, like the size and shape of the body and macronucleus, location of the

contractile vacuole in the 2 phena, are very similar. All CD values came out to be less than 1.28 (Table 2). Therefore, these 2 populations or phena were considered to be of the same species.

There are also some variations in the shape of the micronucleus, which can vary from triangular to ellipsoidal. In 40% of the specimens, the micronucleus is triangular.

Although there are some differences between specimens in the caudal armature, these differences are not sufficient to affect species designation. Many reports (Dogiel, 1927; Wilkinson and Van Hoven, 1976; Imai et al., 1981; Ito and Imai, 1990) suggested that the shape and number of caudal spines were poor characters for the determination of species, because wide and continuous variations have been observed in these characters in some rumen ciliates (Göçmen and Öktem, 1996). Variations in the caudal projections of *E. salmani* n.sp. therefore served as a criterion for the establishment of 4 new formae (*E. salmani* f. *salmani*, *E. salmani* f. *monospinosum*, *E. salmani* f. *bispinosum*, *E. salmani* f. *trispinosum*). The 2 phena based on the micronucleus localisation mentioned before occur in all these formae.

Occurrence. *E. salmani* n.sp. constituted 6% of the total ciliate protozoa in Turkish domestic goat no. 6. The frequency of appearance is 12.50%.

Derivatio nominis. *Entodinium salmani* n.sp. is named in honour of Prof. Dr. Selahattin SALMAN who has carried out many important studies on Turkish invertebrates at Gazi University, Gazi Educational Faculty, Department of Biological Education, in Ankara, Turkey.

***Entodinium salmani salmani* n.sp., n.f.**

Diagnosis. No caudal processes (Figure 1a, b and Figure 2).

Frequency. In 12.50% of goats (no: 6) surveyed. Rate of occurrence is 1.55%.

***Entodinium salmani monospinosum* n.sp., n.f.**

Diagnosis. On the posterior dorsal side of the body, a small, pointed spine (Figure 1c).

Frequency. In 12.50% of goats (no: 6) surveyed with an occurrence rate of 1.60%.

***Entodinium salmani bispinosum* n.sp., n.f.**

Diagnosis. Two caudal processes: 1 posterior-dorsal spine, 1 posterior-ventral spine, generally of the same length (Figure 1d).

Frequency. In 12.50% of goats (no: 6) surveyed. Rate of occurrence is 2.20%.

***Entodinium salmani trispinosum* n.sp., n.f.**

Diagnosis. Three caudal processes: 1 long, posterior dorsal spine, 1 ventral left and 1 ventral right spine (Figure 1e).

Frequency. In 12.50% of goats (no: 6) surveyed. Rate of occurrence is 0.65%.

Taxonomic Evaluation: Some morphological characters of *E. salmani* n.sp., such as the shape of the body and macronucleus, are similar to those of *E. exiguum* (Dogiel, 1925) but there are differences in body and micronucleus size and the localisation of the contractile vacuole. *Entodinium salmani* n.sp. is bigger

Table 2. Comparison of the dimensions (µm) of 2 phena of *Entodinium salmani* n.sp. from the Turkish domestic goat. Phenon 1: Micronucleus is located near the anterior of the macronucleus. Phenon 2: Micronucleus is located near the posterior of the macronucleus [n = 25 for each phenon, SD = Standard Deviation, CD = Coefficient Difference value (All measurements were obtained after the staining and fixing with MFS solution)].

Characteristic	Mean ± SD		CD
	Phenon 1	Phenon 2	
Length (L)	44.55 ± 2.34	42.24 ± 2.33	0.49
Width (W)	32.55 ± 4.61	32.99 ± 2.30	0.06
Length of macronucleus (MaL)	14.16 ± 1.89	10.78 ± 1.52	0.99
Width of macronucleus (MaW)	7.17 ± 1.63	5.50 ± 1.14	0.60
L/W	1.38 ± 0.17	1.31 ± 0.10	0.26
MaL/MaW	1.75 ± 0.67	2.05 ± 0.54	0.25
L/MaL	3.28 ± 0.43	4.09 ± 0.62	0.77

than *E. exiguum* in body size [length 37-58 µm, width 26-42 µm in *E. salmani*; length 21-29 µm, width 14-18 µm in *E. exiguum* (Williams and Coleman, 1992)] and has a bigger micronucleus (3.6 µm across in *E. salmani*). *E. exiguum* is of the cephalopulsatum type according to the localisation of the contractile vacuole (Latteur, 1968; 1969; Williams and Coleman, 1992) but *E. salmani* n.sp. is of the anteropulsatum type.

This new species also resembles *E. nanellum* (Dogiel, 1923) and *E. simplex* (Dogiel, 1927) in the shape of body and macronucleus but the size, shape and the location of

the micronucleus are different. *E. nanellum* and *E. simplex* have smaller micronuclei, located in the middle of the macronucleus. However, in *E. salmani* n.sp. it is located either near the anterior or posterior of the macronucleus. In *E. simplex* the macronucleus is very close to the anterior end of the body but it is in the middle of the dorsal side in *E. salmani* n.sp. (Figure 1a, b).

E. salmani n.sp. has not been reported to date. Therefore it seems to be an endemic species of the ciliated fauna in the rumens of Turkish domestic goats.

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