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TROGLOBIONTIC SUCTORIAN AND APOSTOME CILIATES (CILIOPHORA): AN OVERVIEW

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SYNOPSIS

The article deals with suctorian and apostome ciliate species which are host-specific commensals or parasites of subterranean animals and may be considered as troglobionts. The data on cavernicolous suctorians *Spelaeophrya troglocaridis* from antennae and legs of shrimps, *Tokophrya niphargi* from subterranean amphipods, *T. bathynellae* from syncarids and *Echinophrya stenaselli* and *T. microcerberi* from subterranean isopods along with apostome *Gymnodinioides* sp. from the amphipods of the genus *Niphargus* are cited. The own findings of *T. niphargi* on amphipods from the Eastern Carpathians and the Crimea (Ukraine) as well as of *S. troglocaridis* and *Gymnodinioides* sp. on shrimps from the caves of the Western Caucasus (Abkhazia) are discussed.

INTRODUCTION

The list of ciliated protozoans living in the cavernicolous and subterranean waters comprises about 150 species (Gitterson and Hoover, 1969; Perez and Hernandes, 1986; Dovgal, 1993). However only a few ciliate species (suctorians and peritrichs mainly) which are host-specific commensals or parasites of subterranean animals (arthropods in general) possibly should be considered as troglobionts. Suctorian species from troglobiont shrimp was firstly described by Stammer (1935). Since then only six suctorian species and one apostome ciliate species have been found on subterranean arthropods. In this article we discuss these findings and some own investigations of suctorian and apostome ciliate species from the cave of the Western Caucasus and subterranean waters of the Eastern Carpathians and the Crimea.

MATERIAL AND METHODS

Numerous specimens of *Troglocaris* sp. were collected by the second author 4 August 2006 in the underground water of Nizhnyaya Shakuranskaya Cave, Western Caucasus, Abkhazia. The cave is situated on the right bank of Dzhampal River, about 200 m a.s.l., 1.5 km south to the village Amtkel. The cave is developed in Upper Cretaceous limestone; its length is 1300 m and amplitude 60 m; the entrance is situated almost on the bottom level of the valley. The spring outflows from the cave, sometimes it covers all profile of the cave and sometimes reaches up to 2 m depth; there are many ponds and gours. Air temperature along the cave was 11.8-12.8^{0}C and water temperature 11.2^{0}C. Shrimps were collected along the stream bottom mainly between 500 and 900 m from the entrance with the help of small plankton net and fixed in 90% alcohol.

Several specimens of *Gammarus balcanicus* Schäferna, 1922 were collected by the first author 28 August 1990 in the spring near the village Sinevirskaya Polyana, Eastern Carpathians, Ukraine (water temperature was 4^{0}C and pH=7), and by Dr. L. Samchyshyna 25 July 2007 in the spring near the village Rodnikovoe, Crimean Peninsula, Ukraine (water temperature was 12^{0}C).

10 specimens of *Troglocaris* sp. and 8 specimens of *G. balcanicus* were examined in the laboratory using a dissective microscope for the presence of ciliates. In order to produce permanent preparations the material in addition was fixed in Bouin's fluids during 5 minutes prior to staining. For staining of macronucleus we used the Boehmer's haematoxylin. Finally, the suctorian and apostome specimens were mounted in Canada balsam.

The photomicrography was made with the use of digital video camera DC-1200 for microscopy. The interference contrast photo was obtained in the Schmalhausen Institute of Zoology Centre of Shared Service of Unique Equipment by using microscope AxioImager M1 Zeiss and computer program Zeiss Axio Vision v.4.63.

Measurements were made by means of the computer program ScopePhoto 3.0 for processing of digital imaging.

DISCUSSION

H. J. Stammer (1935) firstly described the suctorian species named by the author as *Spelaeophrya troglocaridis* Stammer, 1935 from antennae and legs of cavernicolous shrimps *Troglocaris schmidti* Dormitzer, 1853 collected in the Yugoslavian caves (Fig. 3.2). Thereupon the same ciliate species was found by J. Matjašič (1956) in the cave Malograjska Jama near the village Planina (Slovenia). Matjašič observed the reproduction of the species for the first time and recognized that *S. troglocaridis* reproduces by the vermigemmic budding (Fig. 3.3), i.e. forming

the vermiform nonciliary swarmers similar to other representative of the genus *S. polypoides* (Daday, 1910) which inhabits epigean freshwater shrimp species (Mattes,1962; Matthes and Plachter, 1978; Fernandez-Leborans et al., 2006).

Strouhal (1939) found two suctorian species on amphipod *Niphargus strouhali* Schellenberg, 1933 from subterranean spring near Warmbad Villach, Karnten (Austria) which were described by the author under the names *Podophrya niphargi* Strouhal, 1939 and *Tokophrya stammeri* Strouhal, 1939.

Karaman (1940) made casual mention that he observed unidentified suctorians on the pleopods of cavernicolous isopod *Microcharon profundalis* Karaman, 1940 from South Serbia.

Chappuis (1947) described *Tokophrya bathynellae* Chappuis, 1947 (Fig. 1.1-1.2) from syncarid crustaceans of the genus *Bathynella* Vejdovsky, 1882 found in subterranean waters near Somes River (Cluj, Romania). In the same article author mentioned about M.G. Fryer's finding most likely the same suctorian species on *Thermobathynella* sp. in Bangweloa, Nothern Rhodesia. More recently (Curds, 1985) the species was transferred into genus *Brachyosoma* Batisse, 1975.

Matjašič (1963) found some individuals of suctorian ciliate described as *Choanophrya stenaselli* Matjašič, 1963 (Fig. 1.3) on the pleopods of isopod *Stenasellus virei* Dollfus, 1897 among the material collected in several undergrounds of France: Lestelas Cave (Cazavet, Ariége), karst groundwater well Béguet (Juszet d'Izaut, Haute-Garonne) and Gourgue Cave (Abras, Haute-Garonne). Afterwards the species was transferred by Dovgal (2002) into the genus *Echinophrya* Swarczewsky, 1928 with the name combination *E. stenaselli* (Matjašič, 1963).

Finally, Delamare Debouteville and Chappuis (1956) described a new suctorian species *Tokophrya microcerberi* Delamare Debouteville et Chappuis, 1956 (Fig. 1.4) from subterranean isopod *Microcerberus remyi* Chappuis, 1954 collected in the vicinity of the Atlas Mountains, North Africa.

Schödel (1998) mentioned the findings of the suctorian *Acineta puteana* Moniez, 1888 on the amphipod *Niphargus aquilex* Schiödte, 1855, from underground springs of Fränkische Alb Natural Park (Germany). H. Schödel in personal communication to the first author indicated that he did not observe reproduction of the species that have no lorica and can be related to genera *Podophrya* Ehrenberg, 1834 or *Discophrya* Lachmann, 1859. In our opinion due to the species morphology this one most probably represents *Tokophrya manueli* Matthes et Rebhan, 1983. *T. manueli* is nonspecific to the host and consequently can not be considered as a troglobiont.

The same is true for *Metacineta micraster* (Penard, 1914) which was found by Perez and Hernandes (1986) in caverns of Cuba because the species was described by Penard (1914) from the moss growing at the old stone walls and this is also common in freshwater reservoirs (Dovgal, 1994).

We investigated the suctorian ciliates on the amphipods from the Carpathians and Crimea and found the same species as those discovered by Strouhal (1939).

The specimens observed were located in joints between trunk leg segments among setae from 5 to 10 ciliates on one host.

It is Dovgal's opinion that the suctorians from Carpathian amphipods are identical to those described by Strouhal and it is possible that the latter author mistakenly identified individuals of the same species which were oriented in the different planes as two species from different genera. As a result the name *T. stammeri* was recognized as a younger synonym of *P. niphargi* and the species was redescribed (Dovgal, 1993) under the name combination *Tokophrya niphargi* (Strouhal, 1939).

The redescription of the species after Dovgal, 1993 is assumed below.

Tokophrya niphargi (Strouhal, 1939) emend. Dovgal, 1993 (Fig. 3.1)

Syn.: *Podophrya niphargi* Strouhal, 1939; *Tokophrya stammeri* Strouhal, 1939

Suctorian with nearly spherical and weakly lateral flattened body. At the lateral view has a form of elongate ellipse. Tentacles clavate, irreducible and arranged in two fascicles on apical part of cell body. Actinophores are absent. Macronucleus is oval and centrally located. Single contractile vacuole located above macronucleus. The stalk is extremely short, generally submerged in the cell body and badly visible. The developed basal disc of stalk is absent and attaching to the substrate is realized by means of secreta film, of nearly the same width as in cell body. The aberrant specimens with long stalk similar to those observed by Strouhal were not found. Reproduction was not observed.

Dimensions (in μm): body height 20-25 (after Strouhal, 1939 – 20-40), body width 25-30 (20-30), thickness of body 20-23 (16-24), macronucleus dimensions 6-8X10-13, the length of stalk 4-5, stalk diameter 4-7.

Localities: Warmbad Villach, Karnten (Austria), type locality, indicated here; spring near the village Sinevirskaya Polyana (Eastern Carpathians, Ukraine), and spring near village Rodnikovoe (Crimean Peninsula, Ukraine).

Hosts: *Niphargus strouhali* Schellenberg, 1933 (type host, indicated here), *Gammarus balcanicus* Schäferna, 1922[1].

On the shrimps from Abkhazian cave (Fig. 2) we found suctorian ciliates *S. troglocaridis* which are indistinguishable from those described by Stammer. However in Stammer's diagnosis the absence of tentacle knobs was pointed and no mention

[1] In the Dovgal's article the host species was mistakenly identified as *Iphigenella shablensis* (Càràusu, 1943).

was made on semilorica. Because we observed these structures, the redescription of the species is required.

Spelaeophrya troglocaridis Stammer, 1935 character emend. (Fig. 3.2-3.5).

Suctorians with strongly elongated peg-shaped body which smoothly expands upwards. Numerous (up to 100 after Stammer), very subtle crimped clavate tentacles are placed on the apical surface of the cell body. Macronucleus elongate, somewhat flared upwards and slightly convoluted, located centrally and parallel to the long axis of the body. A short semilorica is situated near the base of the body; it coats from one quarter to one third of body. The body attaching is effected by the base of semilorica whereas stalk is absent. Reproduces by vermigemmic budding with forming of single vermiform swarmer without ciliature.

Dimensions (in μm): body length 66-98 (90-110 after Stammer, 1935), maximum body width 30-36 (40-65 after Stammer, 1935), length of tentacles 32-95, dimensions of macronucleus 38-46X3-12, length of semilorica 17-57.

Localities: Malograjska Jama Cave near the village Planina, Slovenia; Nizhnyaya Shakuranskaya Cave, Western Caucasus, Abkhazia.

Hosts: shrimps of the genus *Troglocaris* Dormitzer, 1853. Type host - *Troglocaris schmidti* Dormitzer, 1853, indicated here.

We know only one finding of apostome ciliates on the subterranean arthropods. Schödel (1998) observed phoronts of the genus *Gymnodinioides* Minckiewicz, 1912 (Fig. 4.1) on the coxal plates and proximal segments of the legs of amphipod *Niphargus aquilex* Schiödte, 1855 from underground waters in natural park Fränkische Alb (Germany). According to Schödel the observed phoronts are similar to those in *G. zonatum* (Pénard, 1922) found by Percy (1929) on freshwater amphipods *Gammarus pulex* (Linnaeus, 1758) and isopods *Asellus aquaticus* (Linnaeus, 1758) however, the investigations of trophont stages are necessary for species identification. Jankowski (2007) believed that individuals from *Niphargus* are possibly representatives of the new species of *Gymnodinioides*.

On the shrimps from Nizhnyaya Shakuranskaya Cave we found several specimens of phoront stages of apostome ciliates in all probability of the genus *Gymnodinioides.* The observed phoronts (Fig. 4.2-4.4) were attached to leg and maxilla setae of shrimps. They have oviform shapes and covered by compact envelope. The cytoplasm is strongly granular, so that internal structure is indistinct. The stalk-like structure whereby a phoront is attached to substrate in our materials is imperceptible.

Phoront dimensions (in μm): length 22-41, width 15-21, the thickness of envelope 2.

In our opinion the phoronts examined by us can be related to some representatives of the genus *Gymnodinioides* such as *G. caridinae* (Miyashita, 1933)

from freshwater shrimps (Miyashita, 1933; Bradbury et al., 1996). However, the investigations of trophont or swarmer stages are necessary for the identification of the species. Although the findings of apostome cilates on freshwater shrimps have been already known, our finding is a first registration of representatives of the subclass on troglobiont shrimps.

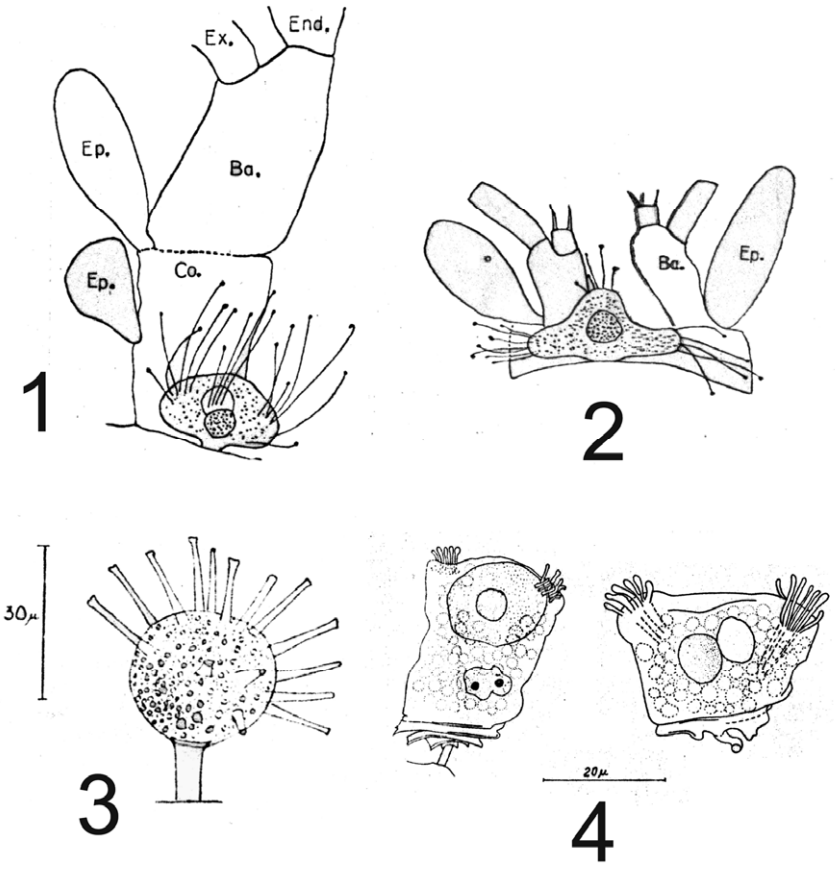

Figure 1: Suctorian cilates from different troglobiont crustaceans. 1-2. *Brachyosoma bathynellae* (Chappuis, 1947) on the body of *Bathynella* sp. Ba. – basipodite; Ep. – epipodite; Ex. – exopodite; End. – endopodite; Co. – coxal plate. 3. *Echinophrya stenaselli* (Matjašič, 1963). 4. *Tokophrya microcerberi* Delamare Debouteville et Chappuis, 1956. 1-2 after Chappuis, 1947, 3 after Matjašič, 1963 and 4 after Delamare Debouteville and Chappuis, 1956.

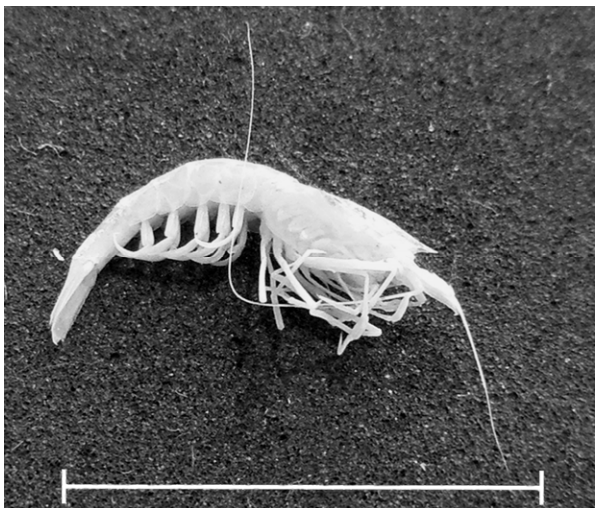

Figure 2: Troglobiont shrimp *Troglocaris* sp. from Nizhnyaya Shakuranskaya Cave (Abkhazia). Scale bar 15 mm.

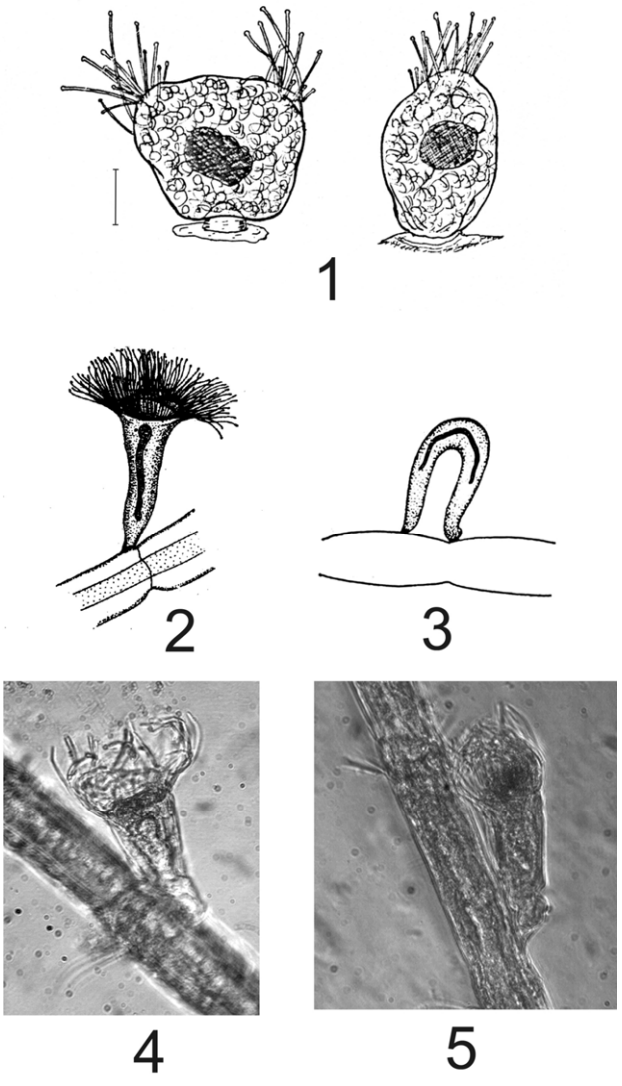

Figure 3: Suctorian cilates from subterranean amphipods and decapods. 1. *Tokophrya niphargi* (Strouhal, 1939) from *Gammarus balcanicus* Schäferna, 1922. (after Dovgal, 1993). Scale bar 10 µm. 2. *Spelaeophrya troglocaridis* Stammer, 1935 (after Stammer, 1935). 3. Swarmer of *S. troglocaridis* (after Matjašič, 1956). 4-5. Specimens of *S. troglocaridis* on antennae of *Troglocaris* sp. (orig., X640).

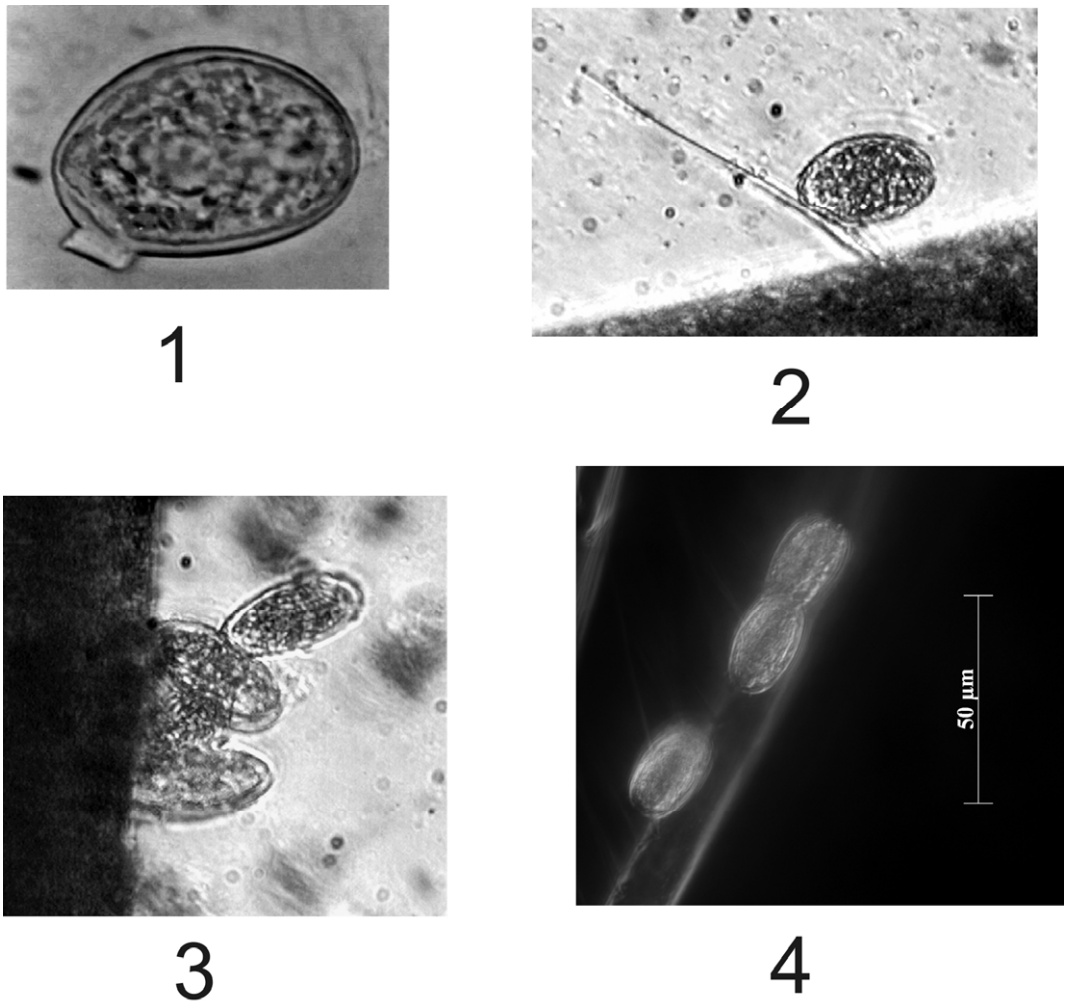

Figure 4: Apostome cilates from subterranean amphipods and decapods. 1. Phoront of *Gymnodinioides* sp. from *Niphargus aquilex* Schiödte, 1855 (after Schödel, 1998). 2. Phoront of *Gymnodinioides* sp. on the leg seta of *Troglocaris* sp. (orig., X640). 3. Phoronts of *Gymnodinioides* sp. from legs of *Troglocaris* sp. (orig., X640). 4. Phoronts of *Gymnodinioides* sp. on maxilla seta of *Troglocaris* sp. (orig., interference contrast).

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