

Notes on the Poorly-known Marine Peritrichous Ciliate, *Zoothamnium plumula* Kahl, 1933 (Protozoa: Ciliophora), an Ectocommensal Organism from Cultured Scallops in Qingdao, China

Weibo SONG¹, Khaled A. S. AL-RASHEID² and Xiaozhong HU¹

¹Laboratory of Protozoology, KLM, Ocean University of Qingdao, Qingdao, People's Republic of China; ²Zoology Department, King Saud University Riyadh, Saudi Arabia

Summary. The living morphology and the infraciliature of a poorly-known marine ectocommensal peritrich ciliate, *Zoothamnium plumula* Kahl, 1933 (pro *Zoothamnium plumosum* Perejaslawzewa, 1886) have been investigated based on specimens collected from within the mantle cavity and the shell surface of the cultured scallop, *Chlamys farreri*, off the coast of Qingdao, China. The Qingdao-population measures about 50-100 x 30-50 μm *in vivo* and is characterized by having one apically located contractile vacuole, one-layer peristomial collar, slender body shape and alternatively arranged colony branches. The C-shaped macronucleus is horizontally oriented. Number of silverlines between oral area and aboral ciliary wreath, *ca* 70; between aboral ciliary wreath and scopula, 24-28. Unlike most other congeners, zooids of this species are often enlarged at the distal end of branches.

Key words: ectocommensal, marine peritrich, morphological studies.

INTRODUCTION

Colonial peritrichs are commonly found in marine biotopes usually as ectocommensals on aquatic animals including on some cultured animals of economical importance (Kahl 1933; Precht 1935; Sommer 1951; Lom 1961; Dietz 1964; Stiller 1971; Jankowski 1976; Song 1986, 1997; Schödel 1987; Hu and Song 2001). Compared with those in fresh water habitats, however, most of the marine forms, remain poorly know or only

insufficiently described in terms of their morphological features.

Zoothamnium plumula Kahl, 1933 was originally described from the Black Sea and has been only very superficially described as *Zoothamnium plumosum* (Perejaslawzewa, 1886). Since then, over 100 years have passed, but no detailed morphological studies have been conducted though in Kahl's comprehensive monograph (Kahl 1935), confirmed its taxonomical validity.

In the summer of 2000, ciliate communities in mollusc culture waters near the Qingdao coast were examined. During the survey, a population of *Zoothamnium* was isolated and investigated using silver impregnation methods, which revealed that it might represent a population of the poorly-known *Zoothamnium plumula*. The re-

Address for correspondence: Weibo Song, Laboratory of Protozoology, KLM, Ocean University of Qingdao, Qingdao 266003, People's Republic of China; Fax: [+86] 532 203 2283; E-mail: wsong@ouqd.edu.cn

sults of the present study thus represents a new contribution for this marine peritrich.

MATERIALS AND METHODS

Scallop mollusc (*Chlamys farrer*) were collected from the mollusc-culture waters (salinity about 32-36‰) off the coast of Qingdao. Ciliates were found as ectocommensal forms within the mantle cavity or on the shell surface and then removed to a Petri dish. The raw culture was kept at room temperature for several days.

Cells were examined *in vivo* using a high-power oil immersion objective and differential interference contrast microscopy. The following silver methods were used to reveal the infraciliature and cytological details (about 20 zooids examined): the "dry" silver nitrate method as described by Foissner (1976) and protargol impregnation according to Wilbert (1975).

Drawings of impregnated specimens were made with a camera lucida at 1250-fold magnification. Systematics and terminology are mainly according to Corliss (1979), Foissner *et al.* (1992) and Warren (1986).

RESULTS

Class: Oligohymenophora de Puytorac et al., 1974

Order: Peritrichida Stein, 1859

Family: Vorticellidae Ehrenberg, 1838

Genus: *Zoothamnium* Bory de St. Vincent, 1826

Zoothamnium plumula Kahl, 1933 (pro *Zoothamnium plumosum* Perejaslawzewa, 1886) (Figs 1-21)

Since this species was only very superficially described from observations made *in vivo* and no clear definition was given, a detailed redescription is here provided based on observations of the Qingdao population.

Improved diagnosis

Marine *Zoothamnium* with alternatively branched colony; zooids slender, *in vivo* about 50-100 x 30-50 µm with thin, one-layer peristomial collar; one apically located contractile vacuole; macronucleus C-shaped and horizontally oriented; zooids often enlarged at distal end of branches. Number of silverlines: from oral area to aboral ciliary wreath *ca* 70; from aboral ciliary wreath to scopula: 24-28.

Deposition of new types

Since no information concerning the deposition of types was given in original description (Perejaslawzewa 1886), two slides as protargol and silver nitrate impregnated cells have been deposited as voucher specimens in

the Laboratory of Protozoology, Ocean University of Qingdao, China.

Host and site

Scallop (*Chlamys farrer*), off the coast of Qingdao (36°08'N, 120°43'E), China.

Morphology

Body highly form-constant, slender and elongated vase-shaped, only slightly constricted below peristomial collar with maximum width at oral border; peristomial disc large and flattened (Fig. 1). Zooids often in two different sizes: mostly ("normal" ones) about 50-60 µm long, but zooids at distal end of branches often considerably larger (*ca* 80-100 µm in length) (Figs 5, 14, arrowheads). Nevertheless, this size diversion is unlikely to represent physiological differentiation of macro- and microzooids for zooids of both types seem to be able to form the telotroch independently while exhibiting the same morphological features (except the size) during "nutritional period".

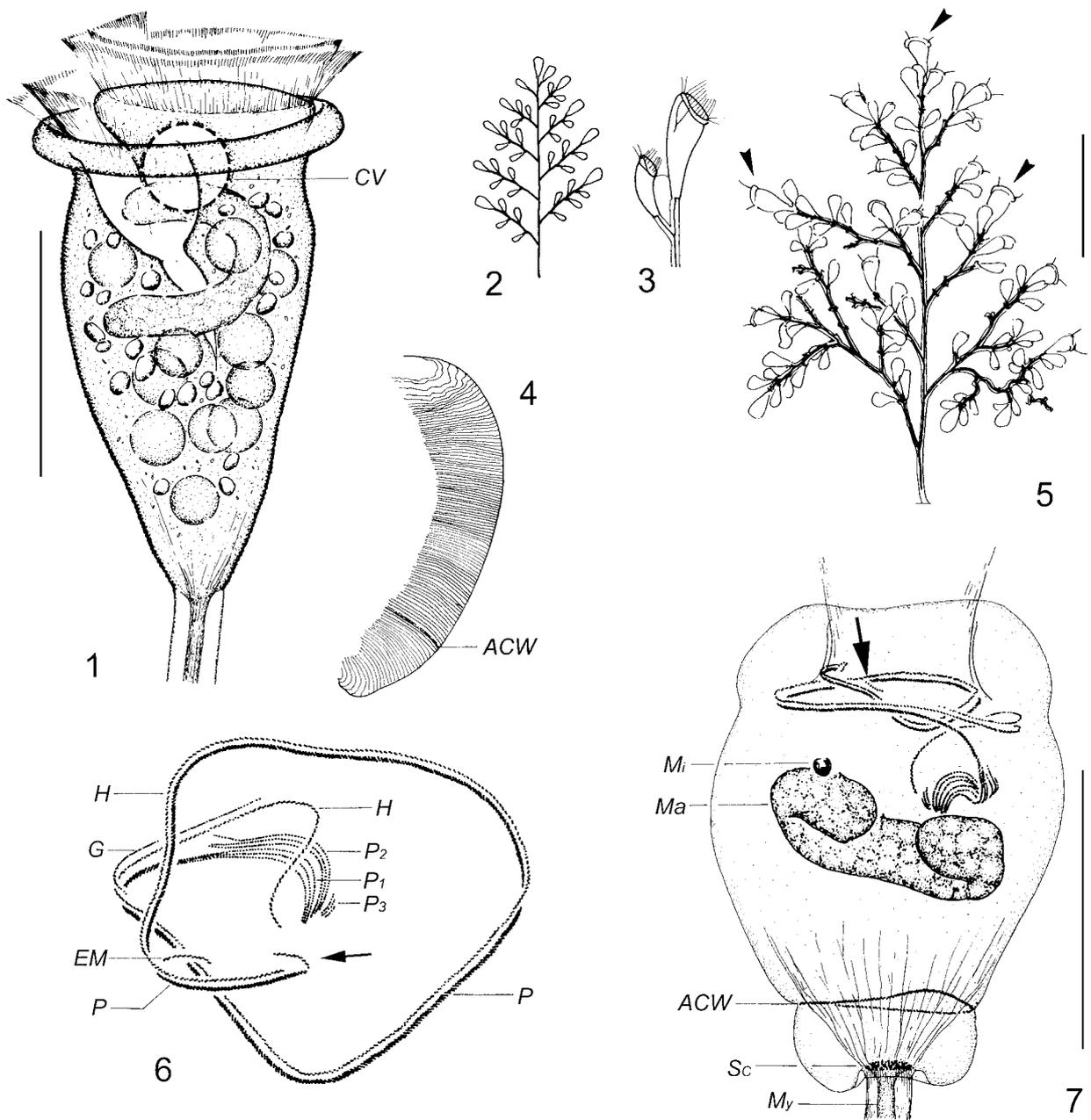
Cells not very sensitive to stimuli. When contracted, zooids usually elongated triangle-shaped but does not contract as strongly as in many of its congeners. Pellicle smooth when observed at low magnification, fine striations recognizable only under high magnification (x 400 or higher), on which no granules or any other pellicular structure are visible.

Cytoplasm colourless or slightly greenish, usually containing several large food vacuoles (about 5-8 µm across) and many "light-reflected" granules, which are oval or irregularly shaped and measure about 3 µm in length (Fig. 1). One large, apically located contractile vacuole (CV) lying slightly below peristomial disc, which contracts at a rate of about 30 s. Macronucleus (Ma) band-like and C-shaped, transversely oriented; micronucleus (Mi) small, anteriorly positioned (Fig. 7).

Stalk with smooth surface, about 8 µm thick. Colony branching alternatively with zooids located regularly in pairs, which consists of over 100 zooids and reaches a total length of over 1 mm (Fig. 5).

Infraciliature and silverline system

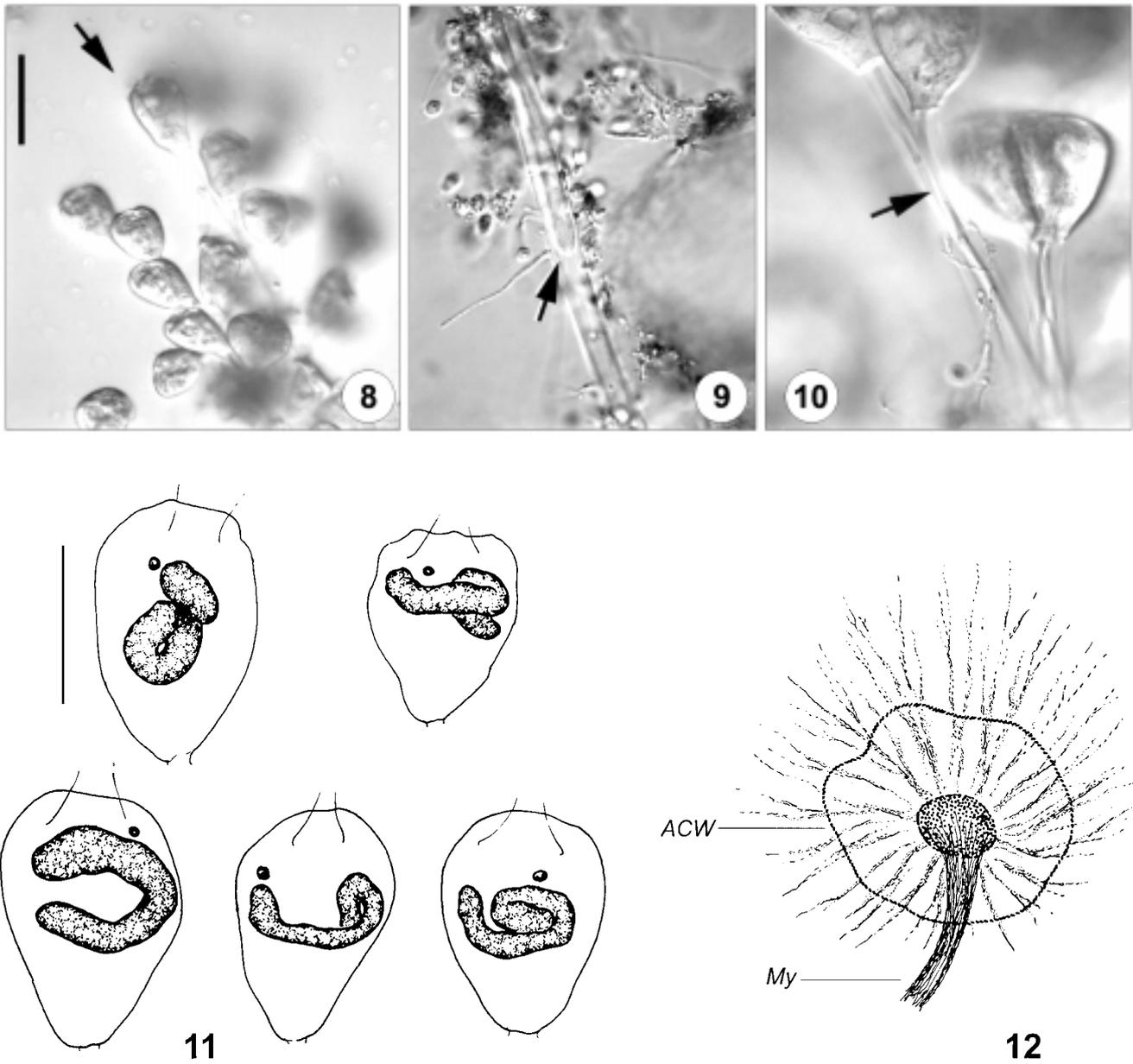
Infraciliature as shown in Figs 6 and 7. Structure of both haplokinety (H) and polykinety (P) basically similar to those in other congeners, which circle about one and half turns around peristomial disc before enter the vestibulum. At distal end of haplo- and polykinety often one kinety fragment forming hook-like structure (Fig. 6, arrow). Polykinety forming three peniculi in lower half of



Figs 1-7. *Zoothamnium plumula* from life (1-3, 5), after silver nitrate (4) and protargol (6, 7) impregnations. **1** - general view of a typical zooid; **2, 3** - colony and 2 zooids of the Black Sea population (redrawn after Perejaslawzewa 1886); **4** - silverline system; **5** - colony of the Qingdao-population, arrowheads mark the enlarged zooids; **6** - apical view of the oral apparatus, note that the peniculus 3 is much shorter than the other two peniculi (P_1 , P_2); arrow marks the hook-like distal fragment; **7** - general infraciliature, arrowhead indicates the epistomial membrane. Abbreviations: ACW - aboral ciliary wreath, CV - contractile vacuoles, EM - epistomial membrane, G - germinal kinety, H - haplokinety, Ma - macronucleus, Mi - micronucleus, My - myoneme (= spasmoneme), P - polykinety, P_{1-3} - peniculus 1-3, Sc - scopula. Scale bars: 1, 7 - 40 μm ; 5 - 300 μm

vestibulum: peniculus 1 (P_1) and 2 (P_2) about equal length, reaching end of vestibulum and converging with short peniculus 3 (P_3). Haplokinety passing around ves-

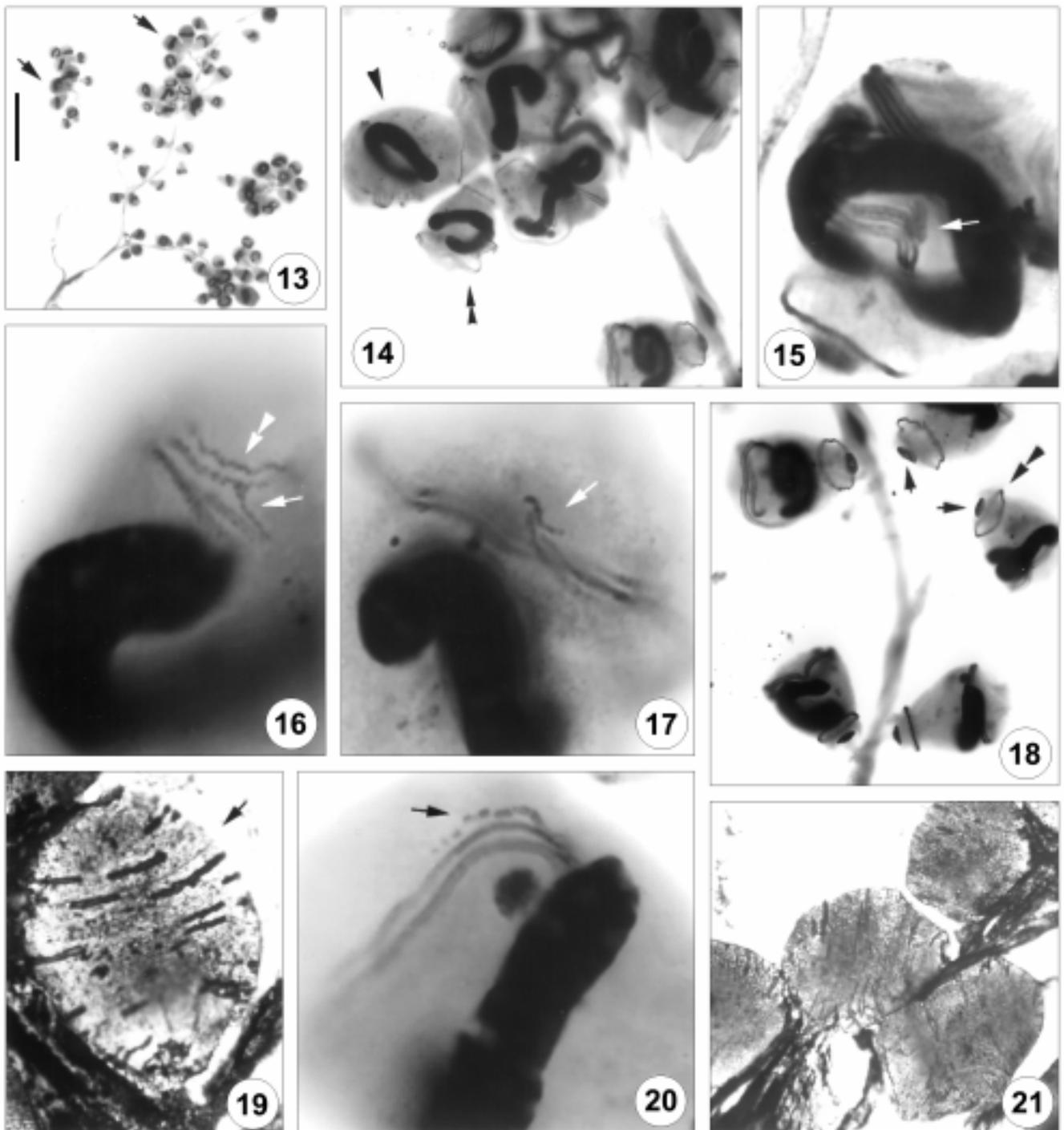
tibulum on opposite wall to peniculi. Germinal kinety (G) consisting of densely arranged kinetosomes, extending to upper 1/2 of vestibulum where it passes parallel to the



Figs 8-12. *Zoothamnium plumula* from life (8-10) and after protargol (11-12) impregnations. **8** - to show the distal end of branches, arrow marks the enlarged zooid; **9** - stalk of a colony, arrow indicates the thick myoneme within the main stalk, which ends somehow away from the attaching end; **10** - to show the myoneme (arrow) and the young zooids, which are usually small and plum in body shape; **11** - to demonstrate the different shaped macronucleus; **12** - aboral end of cell, to show the scopula and the aboral ciliary wreath. Abbreviations: ACW - aboral ciliary wreath, My - myoneme. Scale bar - 50 μ m

haplokinety. Epistomial membrane (EM) short, located away from distal end of polykinety (Fig. 7, arrow). Aboral ciliary wreath (ACW) composed of zig-zag structure of kinetosomes (Figs 7, 12).

Myoneme system consisting of thick spasmoneme within stalk (My), which is generally thicker in main stalk than in distal branches (4-5 vs. 2-3 μ m), while in some old colonies often becomes irregularly shaped: broken or



Figs 13-21. Photomicrographs of *Zoothamnium plumula* after silver nitrate (19, 21) and protargol (13-18, 20) impregnations. **13** - to show the branching form of a colony, note that some zooids at the distal end of branches are enlarged (arrows); **14** - to show the shapes of macronucleus and different size of the enlarged (arrowhead) and "normal" zooids (double-arrowheads); **15** - oral apparatus, arrow indicates the peniculi; **16** - detailed part of buccal apparatus, arrow marks the "branched" kineties of the peniculus 2, while the double-arrowheads exhibit the germinal kinety; **17** - to show the epistomial membrane (arrow); **18** - general appearance, to show the scopula (arrows) and the aboral ciliary wreath (double-arrowheads); **19, 21** - silverline system, arrow in Fig. 19 marks the aboral ciliary wreath; **20** - to show the germinal kinety. Scale bar - 200 μ m

thinned (Figs 9, 10). Around scopula (Sc), myoneme extending anteriorly towards central region of cell (Figs 7, 12).

Silverline system as shown in Figs 4, 19 and 21, striations conspicuously close-set and no conspicuous pellicular pores associated with silverlines.

Comparison

Compared with original descriptions, the population studied here is identified basically due to the following points: (1) the same branching pattern of the colony, i.e. alternatively branched stalk with zooids located in pairs; (2) zooids at the distal end of branches often considerably enlarged, (3) cells having the similar body shape and size (slender bell-shaped with thin peristomial collar), and (4) similar habitat (both found from marine biotopes).

In the author's previous description (Song 1991), this organism was incorrectly identified as *Zoothamnium thiophilum* Stiller, 1946. The latter resembles the former in the similar body shape and the form of colony branching but differs from *Z. plumula* in considerably larger size (90-95 vs. 50-60 μm in normal zooids while 150-180 vs. ca 80-100 μm in large forms) and different habitats (freshwater, "solfataras" vs. marine).

Based on some morphological features, i.e. the position of contractile vacuole, the appearance of the peristomial lip and the branching pattern of colony, comparison should be also made with *Zoothamnium commune* and *Z. sinense*, which were often found from the same habitat (Song 1991). However, according to the original and subsequent reinvestigations (Kahl 1935; Precht 1935; Küsters 1974; Song 1986, 1991), these two species have much smaller colony size (about 20-30 zooids), short and "plump" body shape (i.e. typically bell-like vs. elongated and slender in *Z. plumula*) and considerably smaller cell size (30-60 vs. 50-100 μm in length). In addition, both of them have "identically" sized zooids rather than enlarged ones at the distal end of branches as in *Z. plumula*.

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