Acta Protozool. (2003) 42: 75 - 80

ACTA
PROTOZOOLOGICA

# *Corythionella golemanskyi* sp. n.: a New Freshwater, Filose, Testate Rhizopod

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**Summary.** A previously undescribed species of *Corythionella* was discovered in three widely separated freshwater lakes in Ontario, Canada. A formal description of this species (*Corythionella golemanskyi* sp. n.) is given, together with comments on related taxa in the Testacea-filosia. Tightly packed elliptical (and occasionally circular) scales, a small, flared oral collar and a rounded-triangular cross-sectional shape of the test set *C. golemanskyi* apart from all other *Corythionella* species.

**Key words**: *Corythionella golemanskyi* sp. n., Cyphoderiidae, Euglyphida, Filosea, Psammonobiotidae, Pseudocorythionidea, Testaceafilosia.

## INTRODUCTION

Over the past three decades, a rich and diverse assemblage of testate amoebae inhabiting the supralittoral zones of marine beaches has been described (Golemansky 1974, 1998a; Chardez 1977). Comparable freshwater communities are not known, perhaps because these habitats have been largely ignored in limnological and biotic surveys of freshwater lakes. Beginning in 1997 (Nicholls 1998), the supralittoral of some freshwater beaches and nearshore littoral sands were sampled as part of a broader investigation of testate rhizopods in freshwater habitats in Ontario, Canada. The purpose of this paper is to describe *Corythionella golemanskyi* sp. n., a previously undescribed filose testacean discovered in three widely separated freshwater lakes in Ontario, Canada.

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## MATERIALS AND METHODS

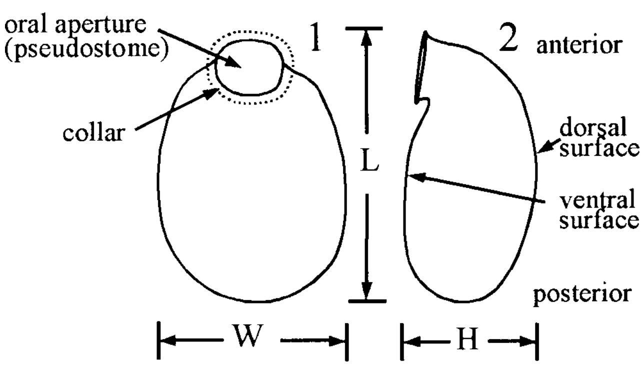
Samples of nearshore (submerged) and supralittoral sand (100-1000 cm$^3$) were collected with a garden trowel and placed in a clean pail with about 1 l of lake water. After thorough mixing to dislodge and suspend any organisms attached to sand grains, the supernatant was poured off into 500 ml polycarbonate screw-capped bottles for transportation on ice to the laboratory. Another portion (25 ml) was immediately preserved with formalin (about 1.5 % formaldehyde).

Living and preserved samples were examined with an inverted microscope using a 10x objective under dark-field illumination for initial detection and high power (40x and 100x oil immersion objectives) with Zernike phase-contrast for critical measurements and examination of scale structure of rhizopod tests. Isolation of single specimens was done with a micro-pipette (drawn out in a flame); manipulation of single specimens to facilitate measurements in two dimensions was by hand with a single-hair brush. Specimens were mounted in Styrax® or Canada Balsam to aid in measurement of scales and for permanent preservation of type material. Test dimensions and terminology were as portrayed in Figs 1 and 2. Statistical data describing test morphology (mean, standard deviation, median, minimum, maximum, coefficient of variation) and Mann-Whitney *U*-tests of significant difference between populations were done in *CoStat* (CoHort Software 1995).

## RESULTS

### *Corythionella golemanskyi* sp. n.

Phylum, Rhizopoda; Class, Filosea; Subclass, Testaceafilosia; Family, Cyphoderiidae




**Figs 1, 2.** Diagrammatic representation of the, **1** - ventral and **2** - left lateral views of *Corythionella golemanskyi* sp. n. illustrating the main test dimensions for which descriptive statistics were compiled (Table 2); keyed as follows: L - total test length; W - test width; H - test height.

**Diagnosis:** test, translucent, pale yellow in colour, elongate-elliptical to nearly circular in outline (ventral and dorsal views); wider than high, rounded-triangular in cross-section. Oral aperture not invaginated, but separated from the main body of the test by a short neck and surrounded by a flared collar about 2 µm wide. Diameter of the oral aperture 15-22 µm, including the flared collar. Test length, 45-62 µm; width, 31-49 µm; height, 23-30 µm. Test covered with small elliptical (occasionally circular) silica scales, 1.5-2.7 µm. Scales are densely arranged, sometimes overlapping at their margins. Protoplast with long, sometimes branching filose pseudopodia.

**Etymology:** the specific epithet is in honour of Prof. Dr. Vassil Golemansky, who pioneered the study of marine sand-dwelling rhizopods over the past 35 years and who has provided much help with reprints and other information during the course of my investigations.

**Type specimen:** the type specimen mounted in Canada Balsam on a glass slide, was deposited with the Invertebrate Zoology Division, Canadian Museum of Nature, Catalogue No. CMNI-2002-0001.

**Holotype material:** retained by the author in sample No. V-1321, collected 12 October, 1999.

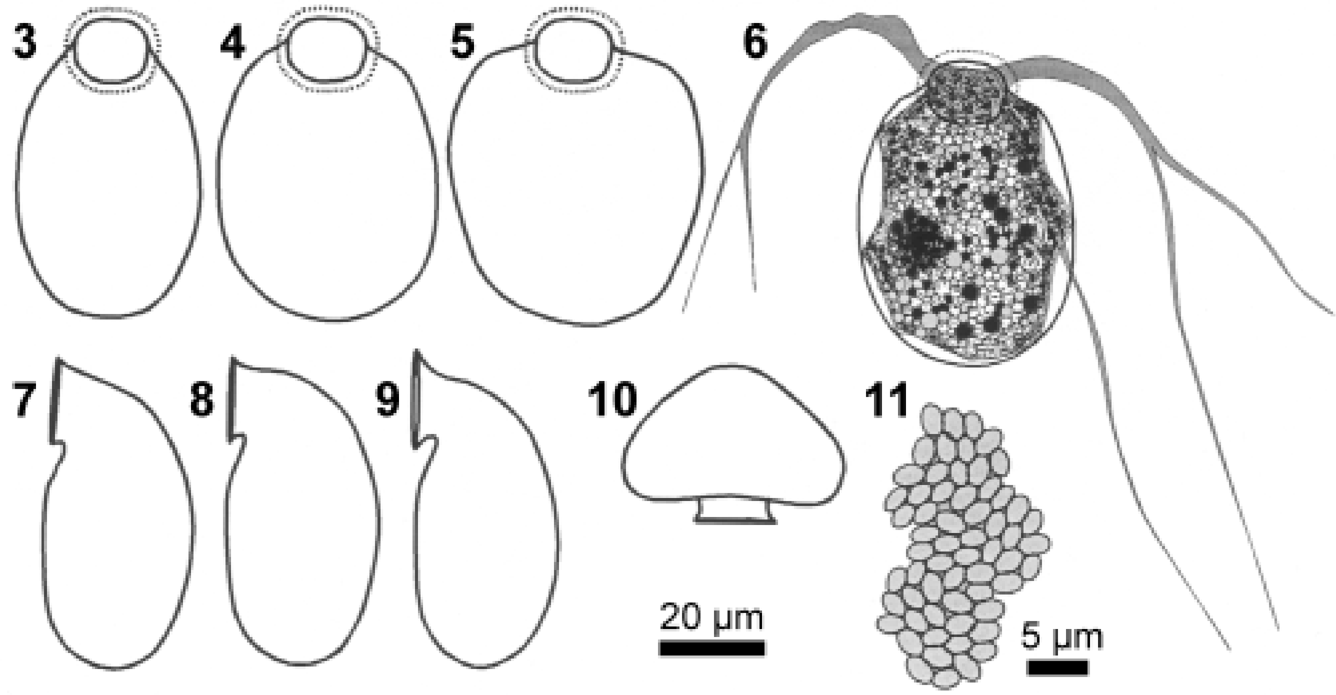
**Type Locality:** littoral zone sands of Sibbald Point Provincial Park, Lake Simcoe, Ontario, Canada (44° 18' N; 79°18' W).

Specimens of *C. golemanskyi* were first found in samples collected 12 October, 1999 at Sibbald Point Provincial Park, Lake Simcoe, but others were later discovered in collections of submerged beach sand made September 5, 2001 at Dorcas Bay, Lake Huron (45°11'30"N; 81°35' W), and January 23, 2002 from the littoral zone of Mazinaw Lake, Ontario (44°50'N; 77°15' W). These three lakes range widely in size and depth, but all have generally excellent water quality with low concentrations of N and P (Table 1). The Lake Simcoe and Lake Huron collections contained specimens in adequate abundance for statistical comparisons of the test dimensions of the two populations (Table 2).

There was no significant difference in test length between the Lake Simcoe and Lake Huron populations (medians of 55.5 and 55 µm, respectively); although in all

**Table 1.** Comparative morphometric and water quality data for the three Ontario lakes from which *Corythionella golemanskyi* sp. n. was collected. Data are summer average values from OWRC (1971), Nicholls (1995) and the Ontario Ministry of the Environment (unpublished).

| | Lake Huron | Lake Simcoe | Mazinaw Lake |
|---|---|---|---|
| Lake area (km$^2$) | 59500 | 722 | 16 |
| Maximum depth (m) | 230 | 40 | 145 |
| Total alkalinity (mg/l) | 80 | 125 | 20 |
| Conductivity (µmhos/cm) | 220 | 350 | 100 |
| Total phosphorus (µg P/l) | 8 | 11 | 6 |
| Total inorganic N (µg N/l) | 550 | 20 | 50 |
| Total organic N (µg N/l) | 310 | 380 | 250 |
| Total chlorophyll *a* (µg/l) | 4 | 5 | 1.2 |

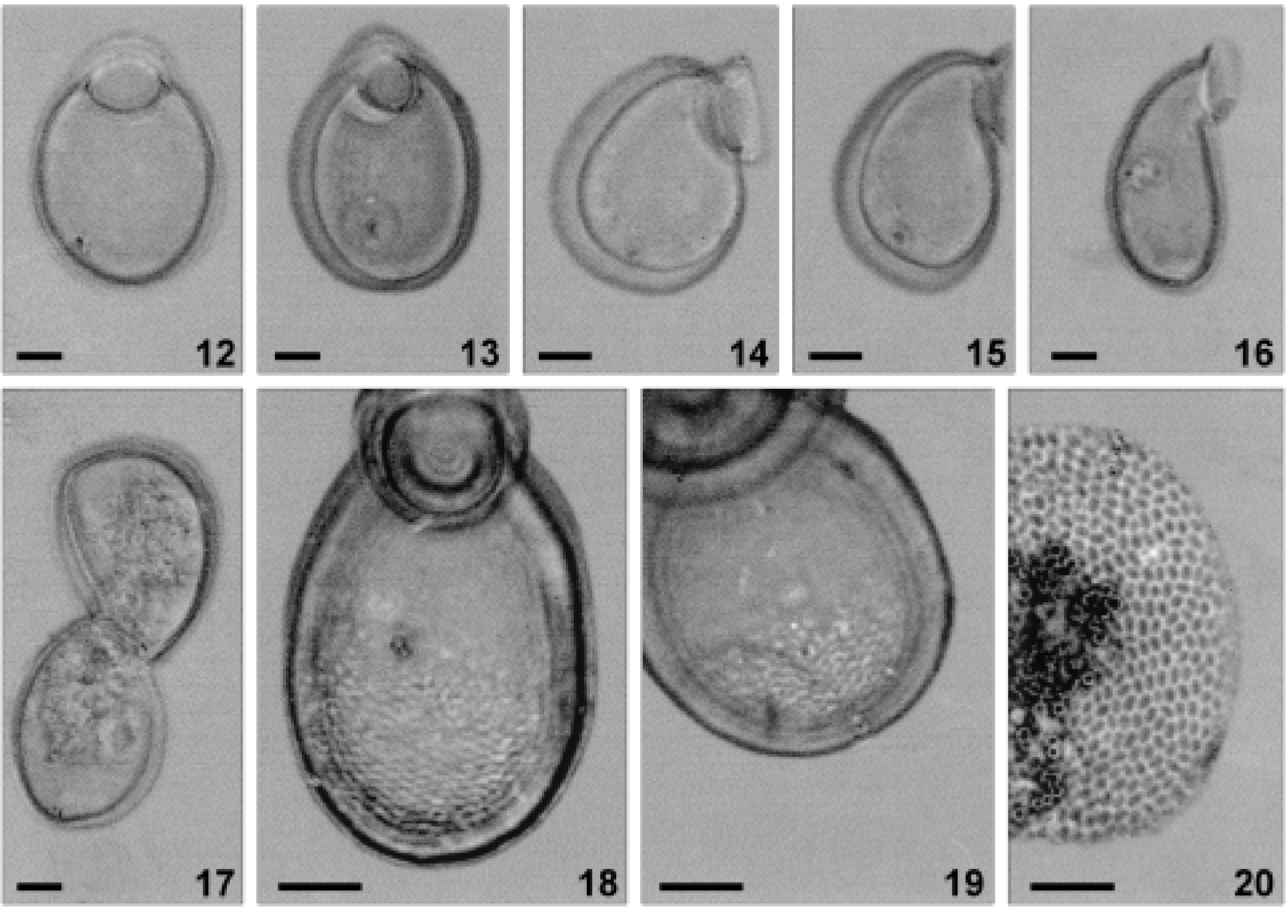



**Figs 3-11.** Some examples of form variation in test, pseudopod and test scales of *Corythionella golemanskyi* sp. n.; **3-5** - test shapes in ventral views; **6** - representation of a living cell with extended pseudopodia; **7-9** - test shapes in left lateral views; **10** - optical cross-section of the test showing rounded triangular form; **11** - scales covering the test.

**Table 2.** Descriptive statistics for critical test dimensions of *Corythionella golemanskyi* sp. n. from Lake Huron and Lake Simcoe. Units of measurement are µm; L = length; W = width; H = height; PS = oral aperture excluding collar; CO = outer diameter of oral collar (see Figs 1 and 2). Mann-Whitney *U*-test probabilities greater than 0.05 are considered indicative of a strong likelihood of no significant difference between the two populations.

| | | | | | | |
|---|---|---|---|---|---|---|
| Lake Simcoe | | L | W | H | PS | CO |
| | Mean | 55.2 | 34.3 | 27.4 | 13.4 | 17.6 |
| | Median | 55.5 | 33.5 | 28 | 13 | 17 |
| | Minimum | 45 | 31 | 24 | 12 | 15 |
| | Maximum | 62 | 42 | 30 | 16 | 22 |
| | SD | 4.6 | 3.0 | 1.9 | 1.3 | 1.9 |
| | CV (%) | 8.5 | 8.7 | 6.9 | 9.7 | 10.7 |
| | N | 22 | 22 | 21 | 21 | 21 |
| Lake Huron | | L | W | H | PS | CO |
| | Mean | 54.9 | 38.2 | 25.2 | 14.6 | 18.8 |
| | Median | 55 | 39 | 25 | 15 | 19 |
| | Minimum | 47 | 33 | 23 | 13 | 16 |
| | Maximum | 59 | 49 | 30 | 16 | 21 |
| | SD | 3.0 | 3.8 | 1.4 | 0.8 | 1.5 |
| | CV (%) | 5.5 | 10.2 | 5.5 | 5.6 | 8.0 |
| | N | 21 | 21 | 21 | 21 | 21 |
| Mann-Whitney *U*-test probability | | 0.751 | 0.0008 | 0.0002 | 0.001 | 0.031 |

other dimensions, the tests from Lake Huron were significantly larger (Mann-Whitney U-test probabilities all < 0.05; Table 2). Despite some variability in overall test shape in both populations (Figs 3-5, 7-9, 12-16), test width was greater than test height in all 42 specimens measured. The ratio W:H was significantly greater in the Lake Huron population. Test cross-section had the appearance of a very rounded isosceles triangle with a




**Figs 12-20.** Photographs of *Corythionella golemanskyi* sp. n. tests. **12, 13** - ventral views; **14** - oblique lateral view; **15, 16** - lateral views; **17** - reproduction (tests are joined at their oral apertures); **18, 19** - scales covering the test are faintly visible in the posterior regions of the tests (mounted in water); **20** - Scales covering test (dried and mounted in Canada Balsam). Scale bars 10 µm.

slightly concave base that was greater in length than height (Fig. 10). In optimum optical cross-sectional views (most easily achieved after the specimen was transferred to a viscous medium (e.g. glycerol) and manipulated with a single hair brush), the collar surrounding the oral aperture could be seen as a projection from the base of the test (Fig. 10).

Scales on the test surface (Figs 11, 18, 19) were difficult to see, even with oil immersion, phase contrast optics. Visualization improved after drying and mounting in media with a high refractive index (Fig. 20), but this method tended to obscure the slight marginal overlap of many of the scales seen in specimens mounted in water. Most scales on the main body of the test were elliptical, measuring 1-1.5 µm wide x 1.5-2.7 µm long. Occasional circular scales were also present. Scales in the anterior region of the test in the area surrounding the oral aperture were smaller than those on the main body of the test.

Protoplasts observed in living specimens of this species appeared to be typical of the family; for example, pseudopodia were very *Cyphoderia*-like (Fig. 6). Another typical characteristic of living cells was the occurrence of multiple attachment points of the plasma membrane with the interior of the test, separated by concavities in regions of the protoplast where there was no contact with the test wall (Fig. 6).

## DISCUSSION

The genus *Corythionella* was erected by Golemansky (1970) to include *Pseudocorythion*-like taxa with tests covered with endogenously produced elliptical or oval

(*Corythion*-like) scales *(Pseudocorythion* tests have circular imbricated scales). *Corythionella* differs from *Corythion* in the structure of the pseudostome which, in *Corythion*, is invaginated and surrounded by a series of specialized toothed scales; *Corythionella* lacks these toothed scales and its pseudostome is not invaginated. In all but one species (*C. acolla* Gol.) the pseudostome is surrounded by a flared collar, which, like the rest of the test, is covered with scales. There are six known species of *Corythionella*: *C. pontica* Gol., *C. acolla* Gol. *C. minima* Gol., *C. anteroplanata* Chardez, *C. sudzukii* Chardez, and *C. minima* var. *nipponica* Sudzuki [I presume that Sudzuki (1979a) intended this latter taxon to be a subspecies, not a variety, as defined by Article 45 (g) of the Int. Code Zool. Nomenclature (ICZN 1985). There is, however, considerable confusion surrounding the nomenclature for this taxon. In Sudzuki (1979a, bottom of p. 288) he refers to it as *"P. minima* var. *nipponica"* (implying *Pseudocorythion*?) in a section of the paper headed *Corythionella*; but, in the same paper the caption of his Fig. 12 clearly states "*Corythionella minima* var. *nipponica*". In a companion publication (Sudzuki 1979b), he referred to this taxon as "*C. minima* f. *nipponica* Sud. '79"].

The flared collar in *C. golemanskyi* is only slightly greater than the pseudostome diameter. *C. minima*, *C. minima* var. *nipponica*, and *C. pontica* all have flared pseudostome collars that are much greater in size, being about equal in diameter to the main body of the test. *C. acolla* lacks a pseudostome collar. Other differences between *C. golemanskyi* and *C. acolla* include the apparently large inter-scale spaces in the investiture of test scales [e.g. see figure 5 in Golemansky (1973)] and the smaller size of *C. acolla*. Chardez (1977) reports sizes for *C. acolla* that are about one-half those measured for *C. golemanskyi*.

*Corythionella sudzukii* Chardez (1977) is closest to *C. golemanskyi* in the proportional sizes of the pseudostome and flared collar, but overall test size in *C. sudzukii* is much smaller (L = 26-30 µm; W = 10-15 µm; H = 8-10 µm; PS = 4-7 µm; CO = 6-11 µm). Also, Chardez's (1977) figure 6 suggests that test scales in *C. sudzukii* are large and much more elongate than in *C. golemanskyi*. The main feature separating *C. anteroplanata* (Chardez 1977) from all other species of this genus is its highly compressed anterior (marked dorso-ventral flattening). The tightly packed elliptical (occasionally circular) scales, the small flared oral collar and the rounded triangular cross-sectional shape of the test set *C. golemanskyi* apart from all other *Corythionella* species.

The only critical study of *Corythionella* scales has been done by Ogden and Coûteaux (1989). They showed that the SEM structure of the scales on the collar of *C. pontica* were smaller than those covering the main body of the test; they also differed in shape, being more elongate with nearly parallel sides (their figure 11). There is, however, some question about whether or not their specimen is really *C. pontica*; the collar (though damaged - see their figure 9) is very narrow relative to the test body width, and the total test length, estimated at about 40 µm from their figure 9, is much too short for *C. pontica*. Test lengths for *C. pontica* given by Golemansky (1970, 1998b) are 77-96 µm. Ogden and Coûteaux (1989) may have described the scales on *C. minima*, or some other (perhaps undescribed) species.

The taxonomy of the genus *Corythionella* and the related genera *Pseudocorythion* and *Messemvriella* is not clearly defined at the family level. All three were placed in the family Psammonobiontidae along with other marine psammonobionts like *Psammonobiotus* and *Chardezia* by Golemansky (1974); but Sudzuki (1979b) proposed a new family (Pseudocorythionidae) for *Pseudocorythion* (and others) and that a new sub-family, Corythionellinae, be erected for *Corythionella* and another taxon he described as "*Pseudowailesella*". Unfortunately, several of the new taxa described by Sudzuki (1979b) were inadequately described, so the logic of his proposed family and sub-family taxonomy is not entirely convincing at this point in time. Taxa like Sudzuki's "*Corythionelloides*", *Micropsammelloides*", and "*Pseudowailesella*" await rediscovery and critical examination before Sudzuki's taxonomy can be accepted. In the interim, Meisterfeld (2002) has suggested an appropriate (but perhaps temporary) solution to the taxonomy of this group, whereby both *Pseudocorythion* and *Corythionella* were placed in the family Cyphoderiidea de Saedeleer, 1934. This proposal is attractive because it groups together at the family level all taxa having (i) a test covered in endogenously produced scales, and (ii) a non-invaginated pseudostome at the anterior terminus of a curved neck. The revised family Psammonobiotidae continues to include genera with pseudostome morphology like those in the Cyphoderiidae, but their tests consist of an uncovered organic matrix or are covered in particles of exogenous, not endogenous, origin.

Although it has a test structure that would otherwise qualify it for membership in the Cyphoderiidae, *Corythion* must remain in the separate family Trinematidae, because it has an invaginated pseudostome with a surrounding row of specialized toothed scales (like its sister genera *Trinema*, *Pileolus* and *Puytoracea*, in the same family).

It was not without considerable vacillation that I assigned *C. golemanskyi* to the genus *Corythionella*. Some characteristics of this species (the occasional presence of circular, overlapping scales) suggest affinities with the genera *Pseudocorythion* and *Messemvriella*. The scale structure of *C. golemanskyi* is intermediate between that generally typical of *Corythionella* (ellipsoidal, or oval and non-imbricate) and that of *Pseudocorythion* and *Messemvriella* (circular, imbricate). The dorsal-ventral compression (width>height), the cross-sectional rounded-triangular shape and rounded posterior, together with its predominantly elliptical scales is justification for assignment of *C. golemanskyi* to the genus *Corythionella*, in my view. Still, the distinguishing features of the three genera *Corythionella*, *Pseudocorythion* (test with a pointed posterior) and *Messemvriella* (tests with a rounded posterior) relating to minor differences in scale structure and test shape might be better ascribed to species differences within a single genus rather than generic differences. For example, Chardez (1979) has shown that the posteriors of specimens of *Pseudocorythion undulacollis* Chardez & Thomas from Corsica are highly variable and include some with rounded as well as pointed posteriors. It is possible that further study of these and related taxa will result in some new taxonomic combinations.

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Received on 7th October, 2002; accepted on 29th November, 2002