

Reinvestigation of Two Agglutinated Species of the Genera *Norvanganina* and *Spirotextularia* (Textulariana, Foraminifera)

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Abstract

Reinvestigation of the two agglutinated species *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981 and *Spirotextularia floridana* (Cushman, 1922) belonging to the subclass Textulariana, orders Textulariida Delage & Herouard, 1896 and Spiroplectamminida Mikhalevich, 1992 respectively, shows that both species possess additional peripheral apertures. Additional apertures in *N. pseudorugosa fistulosa* are simpler and communicate with their surroundings through a passage that is much wider than the canaliculi in its shell wall, while in *Spirotextularia floridana* these additional apertures are separated from the chamber lumen by a sieve plate. A special character of the canaliculated shell wall of *Norvanganina pseudorugosa fistulosa* is the fact that it is covered from above by flat plates. The noncanaliculate character of the *Spirotextularia floridana* shell wall is also demonstrated. The simple additional apertures of *Norvanganina* lacking peripheral chamberlets are regarded as representing a more primitive evolutionary development of this feature. The genus *Norvanganina* is here reinstated and separated from the genus *Textularia*.

INTRODUCTION

Concerning the priority of the shell morphological features as opposed to the shell wall composition and ultrastructure in foraminiferal taxonomy (Mikhalevich, 1992, 2013), the presence, position and form of additional apertures is of great importance. These features have been investigated insufficiently, especially among the agglutinated representatives, and mostly in the light microscope. The present study represents an attempt of further study these structures in two agglutinated species belonging to two different genera: *Norvanganina pseudorugosa* (Lacroix, 1931) *fistulosa* Mikhalevich, 1981 and *Spirotextularia floridana* (Cushman, 1922), belonging to the orders Textulariida Delage & Herouard, 1896 and Spiroplectamminida Mikhalevich, 1992 respectively, both orders within the subclass Textulariana Mikhalevich, 1980.

MATERIAL AND METHODS

Norvanganina pseudorugosa fistulosa shells were collected near the West African Coast, in Conakry Islands and Monrovia, depth between 57 – 620 m, in sandy and muddy sediments (ATLANTNIRO vessels, 1966–1967). *Spirotextularia floridana* was gathered in the Caribbean Sea and along the East South American Coast up to the estuary

of the Amazon River, depth 38 – 200 m, in sandy and muddy sediments (Belogorsk vessel, II expedition, 1965). Shells of both species were studied under the light microscope and in SEM (Hitachi model S-570).

RESULTS

Results on *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981

The shells of *Norvanganina pseudorugosa fistulosa* are medium-sized, with a rough and hard wall (Text-fig. 1, figs 1, 2; Plate 1, figs 1, 2). Openings are rather regularly disposed along the peripheral margins at the lateral edges of their chambers (Plate 3), and they are also encircled with a slight rim of finer material towards the chamber lumens, suggesting they are not mere breaks in the chamber wall. Viewed from the apertural side (Plate 1, fig. 4) they are masked by elongated peripheral outgrowths of the chambers. The main aperture appears in SEM images like a fissure or low arc. In SEM it has a more complex outline with the rather acute projection of the wall forming bifurcate fissures (Plate 1, fig. 6; Plate 2, fig. 7), sometimes the aperture is divided into two openings (Plate 1, fig. 5). The same variability can be seen in the inner aperture. The

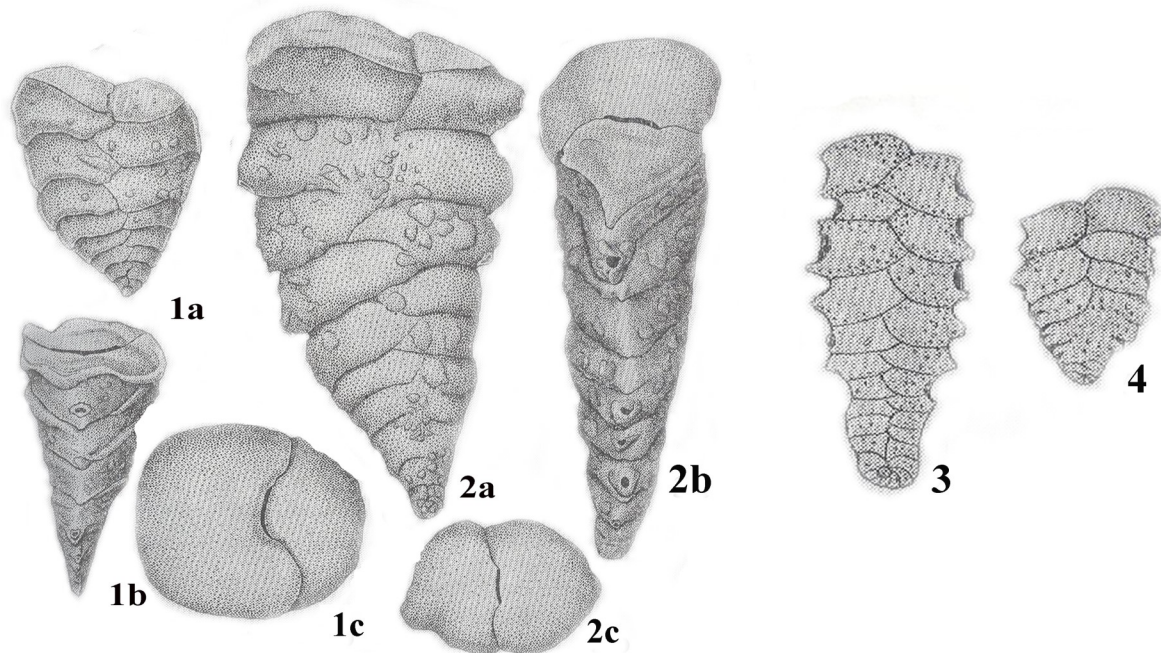


Figure 1 – 2. *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981, (x 78), 1 a, b, c. microspheric, 2. megalospheric forms; 3,4. *Spirotextularia floridana* (Cushman, 1922), (x60), 4. megalospheric, 5. microspheric form.

additional aperture of the last chamber may be rather large (Plate 1, fig. 2; Plate 2, fig. 10).

The variability of the outline of the inner aperture is similar to the outer one, and the canaliculated character of the wall can be clearly seen in the broken shells (Plate 2, figs 7 and 10). Canaliculi are disposed only at the lateral sides of the chambers, not at the chamber floor (Plate 2, figs 7, 10). Canaliculi going inside the additional peripheral apertures are much wider (Plate 2, figs 10, 11), resembling short canals providing better communication with the environment.

The outer wall is formed by a layer of rather large flat plates of irregular form with rare irregularly dispersed small openings (Plate 2, fig. 8). Some of these flat plates often fall away, uncovering the underlying structure (Plate 2, figs 9, 9a) where the densely disposed canaliculi openings are seen. Thus some additional space is formed between the canaliculi openings and superficial plates, and communication of the inner chamber lumen with the environment goes from canaliculi to this additional space and finally through the small irregular openings of the plates, covering the shell surface.

In figures 12–16 of Plate 3 some additional peripheral openings can be seen. Those of the last chambers may be of rather large size (Plate 3, figs 15–16). In figures 15a and 16

this opening is paved along its outer perimeter by the regularly disposed large flattened particles, which would not be the case if it appeared merely as a result of breakage. The rather regular character of these peripheral openings (they are absent only in the very earlier chambers) permits to consider them as additional peripheral apertures. They play the same role as the other additional apertures in many other foraminiferal groups providing the better communication with surrounding water.

They represent simple additional apertures without the formation of additional chamberlets.

The special character of the apertural structure may serve as an additional taxonomic feature of this genus.

Results on *Spirotextularia floridana* (Cushman, 1922)

In *Spirotextularia floridana*, the test is small, smooth, and the additional apertures along the peripheral margin are more distinct (Text-fig. 1, figs 4, 5; Plate 4, fig. 17), though at the earlier chambers (Plate 4, fig. 19) they are less developed and may be absent like in some chambers of *N. pseudorugosa fistulosa* (Text-fig. 1, 2). The edges of its additional apertures are often broken (Plate 4, figs 17-17c), similarly to *N. pseudorugosa*. The principal difference is that its additional apertures are separated from the chamber

lumen by the sieve plate (Plate 4, figs 17a–c, enlarged) thus forming peripheral chamberlets that are absent in *Norvanganina*. The presence of peripheral septae was known for *Spirotextularia* but their sieve character was insufficiently studied, at least in *S. floridana*. The ultrastructure of the shell wall also differs in both species: in *S. floridana* it is noncanaliculate, though rare irregular openings at its surface and in the broken shell wall are visible (Plate 4, figs 18, 20).

DISCUSSION

Norvanganina belongs to the subfamily Norvanganinae of the family Textulariidae Ehrenberg, 1838, superfamily Textularioidea Ehrenberg, 1938 (order Textulariida Delage & Herouard, 1896).

Loeblich & Tappan (1987) considered *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981 (= *Textularia valeriae* Loeblich & Tappan, 1987) to be “probably synonymous” to *Textularia* and marked that its canaliculate wall was not demonstrated. These authors also suggested that the openings situated along the peripheral margin may be the “result of breakage”. The present studies in SEM demonstrate that the position and structure of the openings situated along the peripheral margin of *N. pseudorugosa fistulosa* have a regular character and a special ultrastructure (Plate 1, fig. 3; Plate 3, figs 13, 15): passages going from their opening to the inner chamber lumen are wider than canaliculi, the perimeter of their outer opening is paved by rather regular flattened sand particles (Plate 3, figs 15–16).

All these features are hardly visible in the light microscope because of the shell wall character, composed of large and rough sand grains. The SEM data permit to reinstate the genus *Norvanganina* from the synonymy of the genus *Textularia* lacking this feature.

The canaliculate character of the *Norvanganina* shell wall and the special character of its outer structure with the flat plates covering the wall and masking the canaliculi openings were also revealed during this study.

Spirotextularia has a distinctly expressed planispiral coil in its initial part, and it belongs to the Spirotextulariinae Saidova, 1975, family Spirotextulariidae Saidova, 1975, of the superfamily Spirotextularioidea Saidova, 1975, order Spiroplectamminida Mikhalevich, 1992. Additional peripheral apertures are also observed in some other agglutinated genera: in some species of *Sahulia* Loeblich & Tappan, 1985 by Hottinger *et al.* (1993), in *Plotnikovina* Mikhalevich, 1981, in *Siphoniferoides* Saidova, 1981, also in *Olgia* Mikhalevich, 2011.

The occurrence of additional apertures in different agglutinated multichambered genera having different arrangement of their initial shell part (planispiral, biserial, trochoid, triserial) and erected elongated biserial or triserial later part, points to the formation of additional peripheral apertures in different groups in parallel. The simple additional apertures of *Norvanganina* lacking peripheral chamberlets could be regarded as representing a more primitive evolutionary development of this feature.

CONCLUSIONS

1. In *Norvanganina pseudorugosa fistulosa*, regularly developed openings along the peripheral margin of the shell communicating with the environment through inner tubes wider in diameter than canaliculi can be regarded as additional peripheral apertures, and represent a stable feature distinguishing the genus from other genera of the family Textulariinae. The canaliculate character of its shell wall is also shown.
2. In *Spirotextularia floridana* additional apertures along the peripheral margin are more distinct than in *N. pseudorugosa fistulosa*, and are separated from the chamber lumen by a sieve plate forming peripheral chamberlets, which are absent in *Norvanganina*. The ultrastructure of its shell wall is noncanaliculate.
3. Simple additional apertures of *Norvanganina* lacking the peripheral chamberlets represent a primitive evolutionary development of this feature.

SYSTEMATICS

PHYLUM FORAMINIFERA d'Orbigny, 1826
 Class TEXTULARIATA Mikhalevich, 1980
 Subclass TEXTULARIANA Mikhalevich, 1980
 Order Textulariida Delage & Herouard, 1896
 Superfamily Textularioidea Ehrenberg, 1938
 Family Textulariidae Ehrenberg, 1938

Genus *Norvanganina* Mikhalevich, 1981

Type species. *Textilina pseudorugosa fistulosa* Mikhalevich, 1973 (= *Textularia valeriae* Loeblich & Tappan, 1987, nom. nov.).

Description. Test free, elongated, biserial throughout, microsphaeric form may have accidental very small third chamber at the very beginning of the shell, wall agglutinated, canaliculate; main aperture at the base of the last chamber, slit-like, additional apertures at the peripheral

margins of the chambers, gradually increasing in size in the later formed chambers. They are connected with the interior by a passage wider than canaliculi, often widening at its outer end. Recent, shallow-water, tropical-subtropical; eastern Atlantic Ocean.

Remarks. Regarded by Loeblich & Tappan (1987) to be a junior synonym of *Textularia*, the genus differs from it by the presence of additional apertures at the peripheral margins of the chambers along the peripheral side of the shell. From *Spirotextularia* this genus differs in the structure of its initial part of the shell and in more simple structure of its peripheral apertures. Because of the rough characters of the type species wall, the additional apertures of *Norvanganina* may be taken mistakenly as mere breaks, but the regular character of their disposition (Plate 1, figs 2–4, Plate 3, figs 13, 15) and the special pavement along the periphery of these apertures (Plate 3, figs 15a, 16) confirms that this is a constant structural feature providing better communication with environment, and permits to reevaluate the genus *Norvanganina*.

Norvanganina pseudorugosa fistulosa (Mikhalevich, 1973)
Plates 1–3

Synonymy. *Textilina pseudorugosa fistulosa* Mikhalevich, 1973, *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981, *Textularia valeriae* Loeblich & Tappan, 1987, nom. nov.

Description. Test free, elongated, rather thick, gradually widening to the apertural end, with slightly convex lateral faces, in megalosphaeric generation longer and with softly rounded base, much shorter and thick microsphaeric form sharply widening, nearly triangular in outline, with acute base, peripheral margin obtuse and crenate in megalospheric, more plain and wide in microsphaeric form, apertural face flat or slightly convex, wider, nearly circular in outline in microsphaeric form, broad oval with narrowing peripheral margins in megalosphaeric form, chambers rather broad and low in both forms; main aperture at the base of the last chamber as a narrow slit or bifurcating slit, additional apertures at the peripheral edges of chambers, irregularly circular or ovate in outline, increasing in size from the earlier to the later chambers, connected with interior by the passages wider than canaliculi; wall rough, formed by rather large angled sand grains, outer wall (except the apertural face) pierced by rather wide canaliculi, their dense openings on the lateral sides of the shell are

covered by plates irregular in outline and pierced by rare irregularly scattered openings of lesser diameter than the openings of canaliculi tubes. Recent.

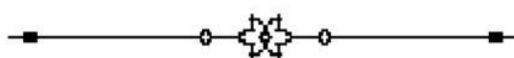
Dimensions. In the microsphaeric form: length 0.92–0.98 mm, breadth 0.70–0.73 mm, thickness 0.40 mm; in megalosphaeric forms these parameters are correspondingly 1.18–1.73 mm, 0.75–0.88 mm, 0.55–0.58 mm.

Distribution. Tropical and subtropical eastern Atlantic, on the shelf and upper slope of the West African coast, at depths 57–620 m, sandy and muddy sediments, most abundant near Conakry and Monrovia.

Remarks. In some megalospheric specimens the outer and inner fissure of the main aperture was divided into two or even three parts (Plate 1, fig. 5, Plate 2, fig. 10).

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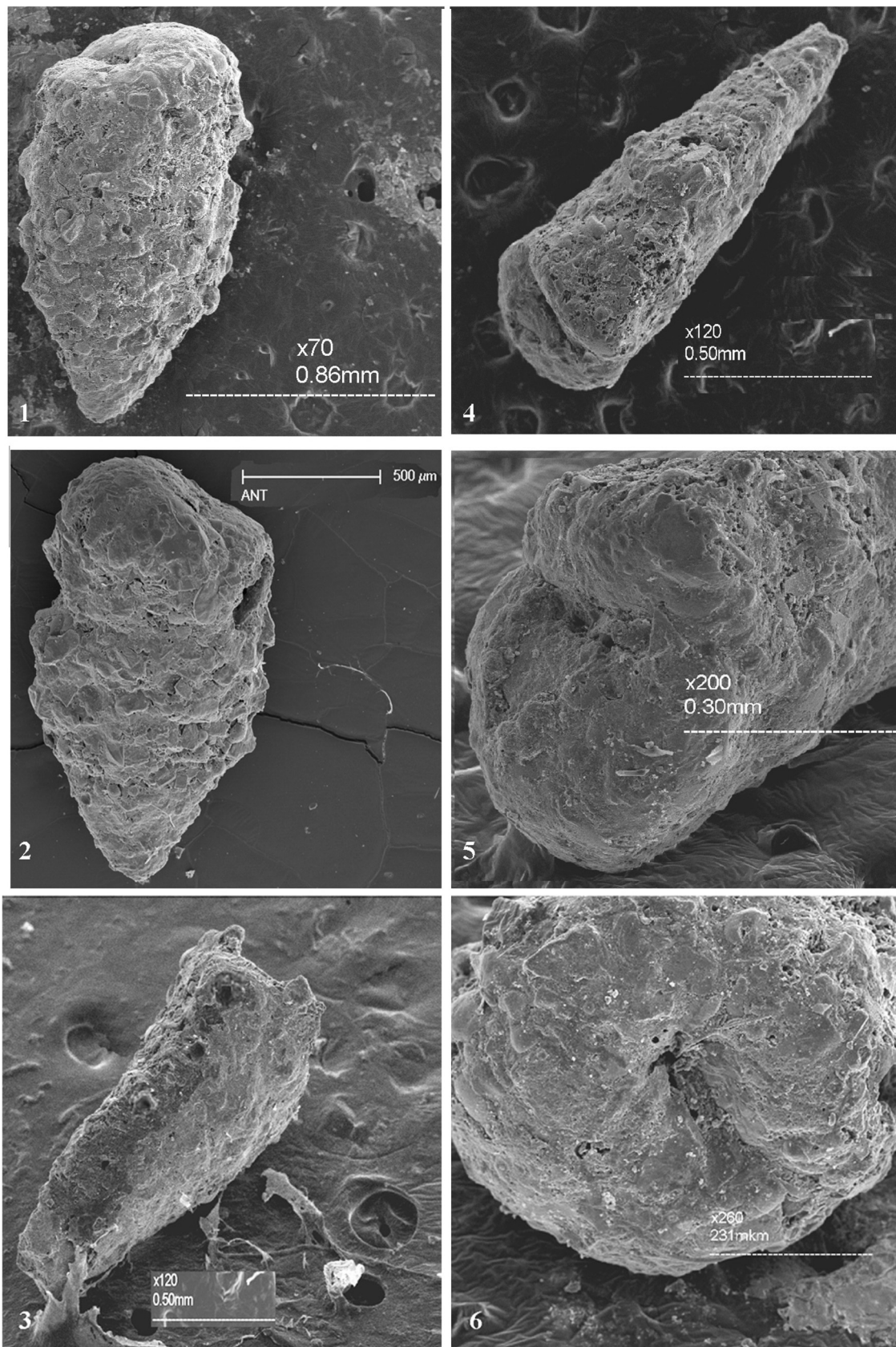


Plate 1. *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981.

1. view of the shell; **2.** outer view with the visible big additional peripheral aperture of the last chamber; **3.** peripheral view with the row of the peripheral apertures; **4.** view of the peripheral edge from the apertural side: chamber outgrowths covering the additional peripheral apertures; **5, 6.** views of the apertural side.

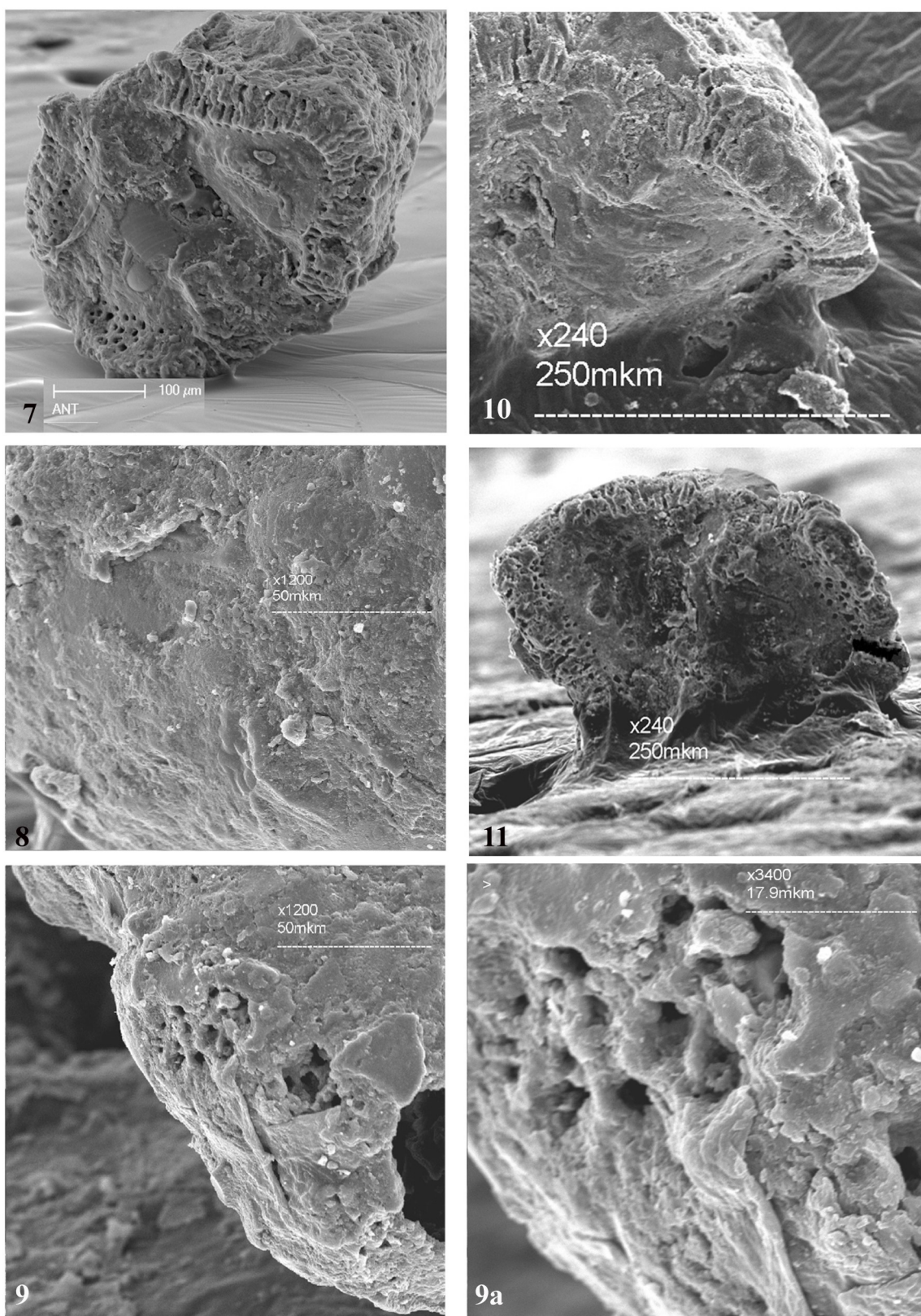


Plate 2. *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981.

7. the broken shell showing the canaliculate wall, circular canalicular openings at the lateral side of the broken chamber and the bifurcated fissure of the inner aperture; **8.** surface of the outer wall; **9 a, b.** wall surface with detached flat upper plates showing the canaliculi openings; **10.** the broken shell showing the canaliculate wall, circular canaliculi openings at the part of the lateral side of the broken chamber and the inner aperture divided into two openings (note the wide passage of the additional aperture at the angled right side; **11.** another broken shell showing the canaliculated character of the wall and the wider passage of the additional peripheral aperture at its lower angled right side.

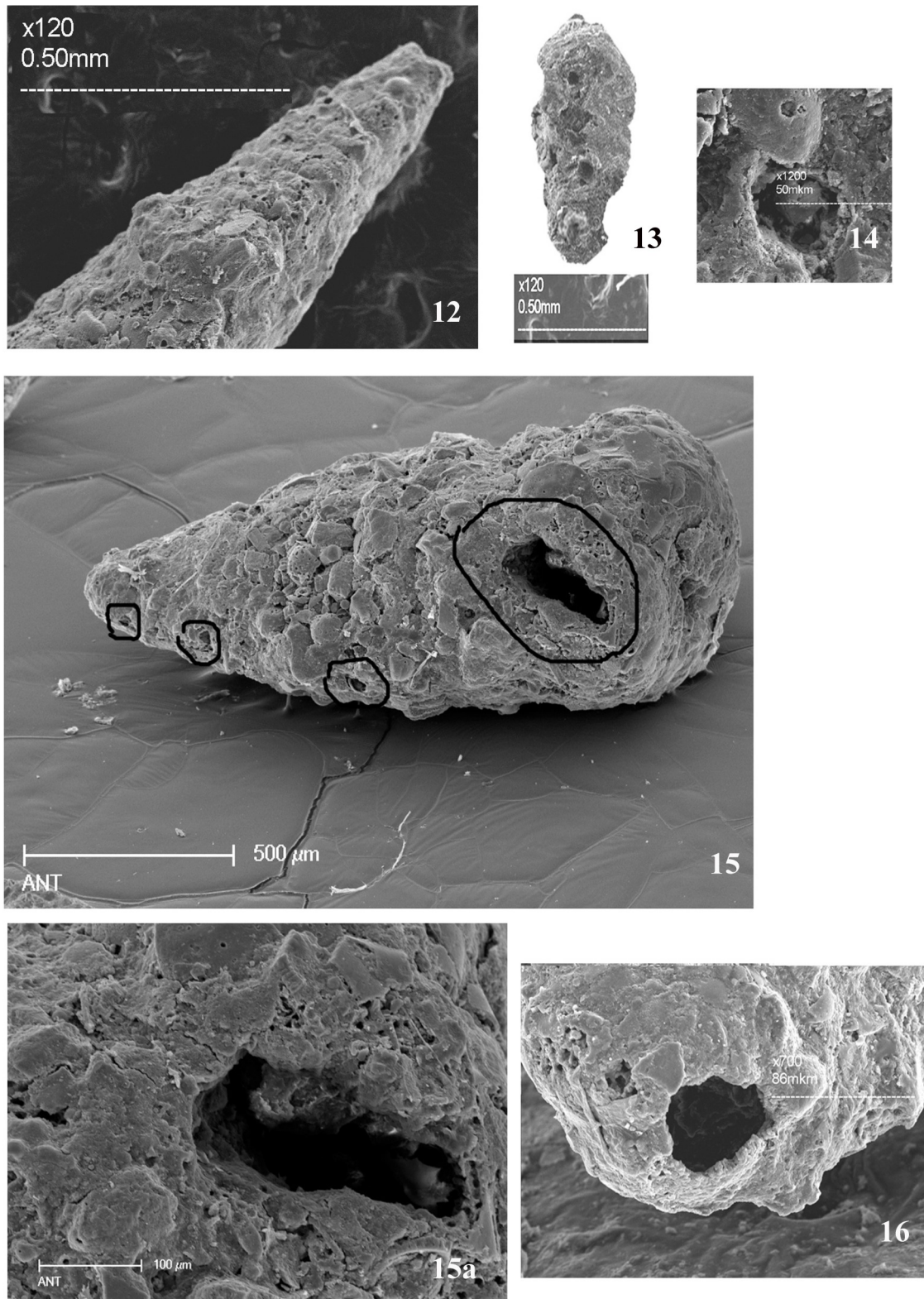


Plate 3. *Norvanganina pseudorugosa fistulosa* Mikhalevich, 1981.

12. peripheral view of the shell with the broken initial part showing the peripheral chamber outgrowths covering additional apertures; **13.** initial part of the other exemplar showing the peripheral apertures; **14.** one of the peripheral apertures of the fig. **13**, enlarged; **15.** peripheral view of the shell showing the small initial peripheral apertures and the big peripheral aperture of the last chamber; **15 a.** big peripheral aperture of the last chamber of the specimen in the figure 15 showing the packing of the sand grains around it; **16.** packing of the sand grains around the additional peripheral aperture of the last chamber of another specimen.

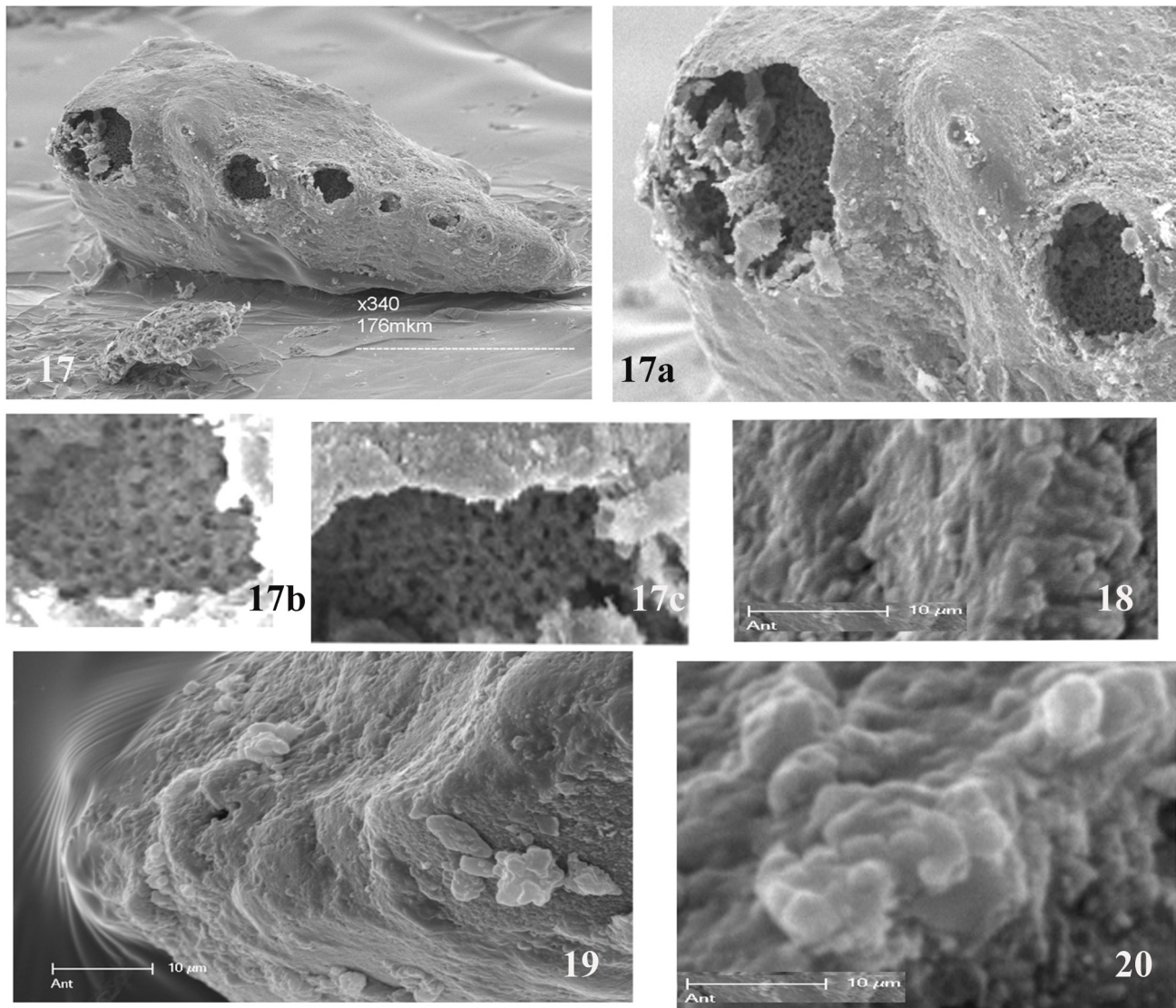


Plate 4. *Spirotextularia floridana* (Cushman, 1922).

17. peripheral view of the shell showing a row of additional peripheral apertures; **17 a – c.** peripheral apertures enlarged showing the inner sieve plates; **18, 20.** non caecanaliculate shell wall of *S. floridana* with rare irregular openings; **19.** peripheral view with the additional aperture of one of the initial chambers.