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Contribution to the Revision of Some Late Callovian Serpulids (Annelida, Polychaeta) of Central Russia: Part 2

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Abstract—This paper deals with the revision of the species of the genera *Mucroserpula, Propomatoceros*, and *Spiraserpula* (family Serpulidae) from the Upper Callovian of the locality Peski (Moscow Region). All taxa are described in accordance with the current classification of fossil serpulid tubes. Two new species are described: *Propomatoceros barskovi* sp. nov. and *Spiraserpula oligospiralis* sp. nov.

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INTRODUCTION

The present paper continues the first part of this work (Ippolitov, 2007).

The material described comes from the Upper Callovian deposits (*Q. lamberti* Zone) of the locality Peski I (Kolomna district of the Moscow Region). Most of the tubes are attached to the surface of marl concretions that form a condensation horizon, the others encrust the skeletal remains of other invertebrate organisms.

SYSTEMATIC PALEONTOLOGY

Family Serpulidae Rafinesque, 1815

Subfamily Serpulinae Rafinesque, 1815

Genus *Mucroserpula* Regenhardt, 1961

Mucroserpula: Regenhardt, 1961, p. 47; Lommerzheim, 1979, p. 151.

T y p e s p e c i e s. *Mucroserpula mucroserpula* Regenhardt, 1961; Germany, Hauterivian.

D i a g n o s i s. Tubes solitary, medium-sized, loop-like curved, increasing at moderate rate. At early stages cross section triangular, rapidly giving way to pentagonal. Longitudinal median keel, forming short denticle over aperture, and paired supralateral keels, located on supralateral folds, present on tube.

S p e c i e s c o m p o s i t i o n. *M. nitida* Ware, 1975 (Great Britain; Aptian); *M. arcuata* (Muenster in Goldfuss, 1831) (Germany; Cenomanian); *M. mucroserpula* Regenhardt, 1961 (Germany; Hauterivian–Middle Cenomanian); *M. quinquareata* (Parsch, 1956) (Germany; ?Callovian); ?*M. jaegeri* Radwanska, 2004 (Poland; Upper Oxfordian), and the species described below.

The genus may also include *M. versabunda* Regenhardt, 1961 (Germany; Hauterivian) with a questionable status of a separate species.

C o m p a r i s o n. This genus differs from the genera *Pomatoceros* Philippi, 1844, *Propomatoceros* Ware, 1975, and other closely allied genera in the smaller size, the tube being regularly wound like a loop, and the appearance of pentagonal cross sections early in ontogeny.

R e m a r k s. In order to distinguish *Mucroserpula* from the tubes of the most morphologically similar genera *Pomatoceros* and *Propomatoceros*, the author of the genus used the cross section of the tube as a main criterion. This is a dependable criterion for Cretaceous serpulids; however, pentagonal tubes from the Jurassic could have a morphology typical of *Propomatoceros*. I believe that among the above distinguishing characters the necessary presence of looped tubes is the main diagnostic feature of *Mucroserpula*.

Mucroserpula tricarinata (Sowerby, 1829)

Plate 12, figs. 1a, 1b, 2

Serpula tricarinata: Sowerby, 1829, p. 227, pl. DCVIII, figs. 3, 4; 1837, p. 642, pl. 608, figs. 3 and 4 [cop. 1829]; Brauns, 1874, pp. 26–27; non Goldfuss, 1831 (primary homonym), p. 214, pl. LXVIII, figs. 6a–6c; Deshayes in Lamarck, 1838, pp. 629–630 [cop. Goldfuss, 1831]; Quenstedt, 1867, p. 321, pl. 24, fig. 10.

non *Serpula* (*Tetraserpula*) *tricarinata*: Parsch, 1956, p. 224, pl. 21, fig. 21.

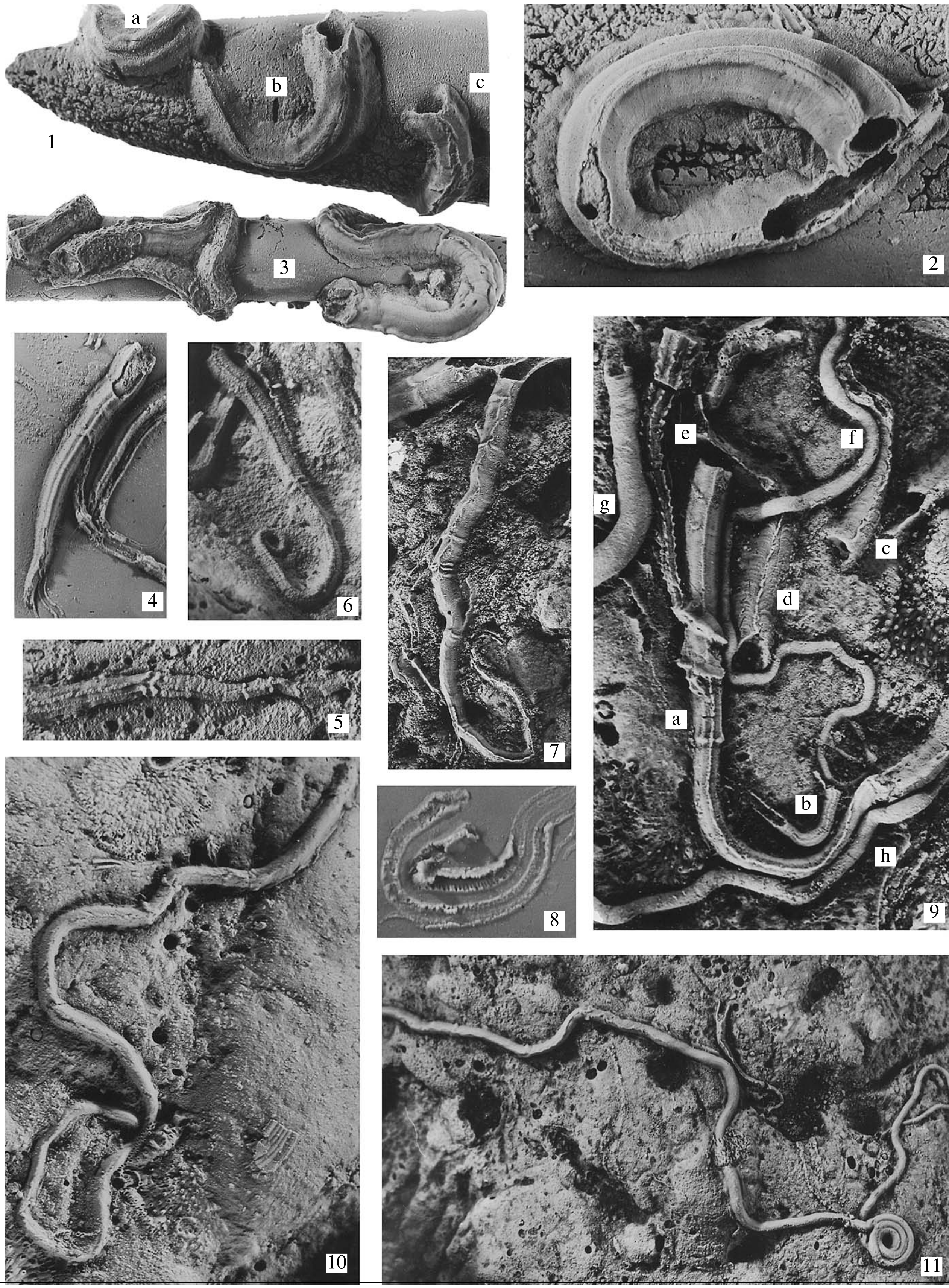
Serpula quinquangularis: Goldfuss, 1831, p. 215, pl. LXVIII, figs. 8a?, 8b–8e; Lamarck, 1838, p. 629 [cop. Goldfuss, 1831]; Quenstedt, 1858, p. 776; non Gallinek, 1895, pp. 405–406, pl. I, fig. 9. [= *Filogranula runcinata* Sowerby, 1829].

Serpula (*Tetraserpula*) *quinquangularis*: Parsch, 1956, p. 224, pl. 19, fig. 9, pl. 20, fig. 13, pl. 21, fig. 25; (pars) Sazonova and Sazonov, 1967, pl. LXI, fig. 3.

H o l o t y p e. Not designated. Type series comes from the Upper Jurassic of Great Britain.

D e s c r i p t i o n. The tubes are looped at the later stages, they are large-sized and pentagonal in cross section. The lateral sides are slightly convex. The longitudinal ornamentation is coarse, the median keel is thick and most prominent, slightly undulating at the later

Plate 12



stages. The lateral keels are also thick, but less prominent. Under the lateral keels there are well-defined longitudinal sutures, at the later stages a well-defined suture in the middle of the median keel may also be visible. The direction of looping varies. Wide basal margins and irregularly alveolar tubules are present. The surface of the tubes bears distinct growth lines. The thickness of the wall is one-sixth to one-seventh of the tube diameter.

M e a s u r e m e n t s in mm. Specimen no. 5071/19: aperture diameter 4.8; estimated length 50–55.

C o m p a r i s o n. This species differs from all the other species of *Mucroserpula* in its large size and very coarse ornamentation.

R e m a r k s. One of the specimens of the type series (Sowerby, 1829, pl. DCVIII, fig. 3) has a rounded elevated stage and has no denticle over the aperture; however, the presence of the symbiont *Protulophila gestroi* in the tube allows these characters to be considered aberrant.

The species described has structural features suggesting that this species is one of the early members of the genus. The indistinct looping, large size of the tube, and the considerable (in comparison with the Cretaceous *Mucroserpula*) development of the triangular stage show that this species is close to the typical *Propomatoceros*. It is probable that the divergence of the genera occurred in the Bathonian–Callovian, and that the first *Mucroserpula* coexisted with the members of *Propomatoceros* that were not looped and had three keels. Two such species are known, and both come from Jurassic deposits: *P. sublimax* (Gerasimov, 1955) from the Middle Callovian–Upper Oxfordian of the Russian Platform, and *P. davidsoni* (Loriol, 1876) from the Portlandian of Switzerland.

O c c u r r e n c e. Callovian–Tithonian (Parsch, 1956). Germany, Great Britain, and central Russia.

M a t e r i a l. Two specimens come from concretions, four specimens come from the section (on belemnite rostra).

Genus *Propomatoceros* Ware, 1975

Propomatoceros: Ware, 1975, p. 99.

T y p e s p e c i e s. *Propomatoceros keepingi* Ware, 1975; Aptian of Great Britain.

D i a g n o s i s. Tubes of large and medium size, attached along entire length or rising above substrate at their anterior end. Cross section triangular, at later stages rounded-triangular, rounded-pentagonal, occasionally sharply pentagonal, or circular. Median keel well developed, with prominent denticle over aperture. Peristomes sharp, bent forward in the region of median fold. Longitudinal sutures present in the middle of lateral sides and on median keel. Attachment structures consist of slightly to moderately developed tubules, hollow or divided into chambers by closely spaced, irregular or noncontinuous septa. Operculum not calcified.

S p e c i e s c o m p o s i t i o n. Triassic and Jurassic forms: *P. slavicus* (Ziegler in Ziegler and Michalik, 1980) (western Carpathians; ?Lower Rhaetian); *P. sulcatus* (Sowerby, 1829) (Great Britain; Bajocian–Oxfordian), *P. conformis* (Goldfuss, 1831) (Germany; Middle Jurassic (?Bathonian)–Kimmeridgian), *P. limatus* (Muenster in Goldfuss, 1831) (Europe; Upper Jurassic), *P. gibbosus* (Goldfuss, 1831) (Germany; Upper Jurassic), ? *P. pentagonus* (Goldfuss, 1831) (Germany, ?Oxfordian), *P. canaliculatus* (Muenster in Goldfuss, 1831) (Germany; Kimmeridgian–Tithonian); *P. davidsoni* (Loriol, 1873) (Switzerland; Tithonian); *P. torquatus* (Quenstedt, 1858) (Germany; Middle Jurassic); *P. sublimax* (Gerasimov, 1955) (Central Russia; Middle Callovian); *P. triferulatus* (Parsch, 1956) (Germany, Lower Kimmeridgian); and the two species described below.

E x p l a n a t i o n o f P l a t e 12

All specimens come from the Upper Callovian locality Peski, Moscow Region, and all, unless specially marked, are attached to concretions from the condensation horizon. The originals are housed in the Paleontological Institute of the Russian Academy of Sciences (PIN), coll. no. 5071.

Fig. 1. Accumulation of tubes on a rostrum, ×2.5: (1a, 1b): *Mucroserpula tricarinata* (Sowerby, 1829): (1a) specimen PIN, no. 5071/16, (1b) specimen PIN, no. 5071/17; (1c) *Propomatoceros lumbricalis* (Schlotheim, 1820), specimen PIN, no. 5071/18.

Fig. 2. *Mucroserpula tricarinata* (Sowerby, 1829), specimen PIN, no. 5071/19, on the rostrum of a belemnite, ×3.8.

Fig. 3. *Propomatoceros lumbricalis* (Schlotheim, 1820), specimen PIN, nos. 5071/24–28, accumulation of tubes on a rostrum, all specimens display (at the left) remains of the colony of the symbiont *Protulophila gestroi*, ×1.

Figs. 4 and 5. *Propomatoceros barskovi* sp. nov.: (4) paratype PIN, no. 5071/39, on the rostrum of a belemnite, ×3.5; (5) paratype PIN, no. 5071/40, tube of a juvenile specimen with numerous peristomes, ×4.

Figs. 6–8. *Propomatoceros lumbricalis* (Schlotheim, 1820: (6) specimen PIN, no. 5071/21, with a spiral initial stage, ×2.5; (7) specimen PIN, no. 5071/36, ×1; (8) specimen PIN, no. 5071/23, tubules with poorly developed transverse strengthening elements, ×8.

Fig. 9. Accumulation of tubes on the surface of concretion, ×3.5: (9a, 9b) *Propomatoceros barskovi* sp. nov.: (9a) holotype PIN, no. 5071/41, (9b) paratype PIN, no. 5071/42; (9c, 9d) *Propomatoceros lumbricalis* (Schlotheim, 1820): (9c) specimen PIN, no. 5071/43, peristomial part displaying a thin septum; (9d) specimen PIN, no. 5071/44; (9e) *Filogranula runcinata* (Sowerby, 1829), specimen PIN, no. 5071/45; (9f–9h): *Cycloserpula flaccida* (Goldfuss, 1831): (9f) specimen PIN, no. 5071/46; (9g) specimen PIN, no. 5071/47; (9h) specimen PIN, no. 5071/48.

Figs. 10 and 11. *Spiraserpula oligospiralis* sp. nov.: (10) paratype, specimen PIN, no. 5071/49, ×4; (11) holotype PIN, no. 5071/50, ×2.6.

Cretaceous species: *P. obtusus* (Sowerby, 1829) (Europe; Santonian–Maastrichtian); *P. semicostatus* (Regenhardt, 1961) (Germany; Barremian); *P. biplicatus* (Reuss, 1845) (Germany, Turonian); *P. trachinus* (Goldfuss, 1831) (Germany; Cenomanian); *P. triangularis* (Goldfuss, 1831) (Europe, Santonian–Maastrichtian); *P. lophiodus* (Goldfuss, 1831) (Europe; Cenomanian); *P. sulcicarinatus* Ware, 1975 (Great Britain; Aptian); *P. keepingi* Ware, 1975 (Great Britain; Aptian); and *P. ares* (Ziegler, 1984) (Czech Republic; Lower Turonian).

About 20 nominal species with a questionable species status or uncertain generic affiliation may be added to this list.

C o m p a r i s o n. This genus differs from *Mucroserpula* Regenhardt, 1961 in the tube being not looped and larger in size; from *Neovermilia* Day, 1961, in the irregularly shaped septa in tubules and in the annular peristomes being predominantly slender rather than thick and having a prominent denticle; and from *Parsimonia* Regenhardt, 1961; in the presence of tubular structures and a well-developed median keel.

It differs from the members of the genera *Pomatoceros* Philippi, 1844 and *Spirobranchus* Blainville, 1818 in the operculum devoid of calcified elements and in the tubules with noncontinuous, irregular septa. It differs from the genus *Pomatostegus* Schmarda, 1861 in the relatively simple ornamentation of tubes. It differs from the genus *Galeolaria* Savigny, 1818 in the unpaired median keel. It differs from *Chitinopoma* Levinsen, 1884 in the absence of brood chambers on the tube. It differs from *Placostegus* Philippi, 1844 in having a single denticle on the aperture and in the absence of a free stage growing vertically and coiled around the longitudinal axis.

R e m a r k s. The members of *Pomatoceros* most closely resemble *Propomatoceros* in the external structures of the tubes. The first occurrences of tubes that morphologically resemble *Pomatoceros* are known from the Upper Triassic. They are abundant in Jurassic and Lower Cretaceous deposits. *Pomatoceros* is one of the few serpulid genera that have a calcified operculum. Despite the abundance of large *Pomatoceros*-like tubes in Jurassic deposits, the earliest record of the plates of opercula of the *Pomatoceros–Spirobranchus* type comes from Cenomanian deposits (Lommerzheim, 1979). This fact may be considered as circumstantial evidence that the Triassic–Jurassic forms have no calcified opercula (Lommerzheim, 1979). If so, this strongly suggests that they should be established as a separate genus. All members of the family Spirorbidae have a calcified (at least partly) operculum, and opercula have been repeatedly found in Cretaceous deposits, although this group was not numerous during this epoch and the opercula are small in size. In the Jurassic *Propomatoceros* the plates of opercula would have been 4–5 mm in diameter or, in the largest forms, up to 8–9 mm in diameter. It is unlikely that such remains could go unnoticed for so long.

In addition, the fossil *Pomatoceras*-like forms clearly differ from the tubes of the modern forms in the tubules not divided into regular longitudinally separated chambers. In the structure of tubules there is a closer resemblance to the genus *Neovermilia* (Jurassic–Recent) and the Cretaceous *Sclerostyla*. The results of the study of microstructures also support the convergence of the modern *Pomatoceros* and Jurassic *Propomatoceros*.

Propomatoceros lumbricalis (Schlotheim, 1820)

Plate 12, figs. 1c, 3, 6–8, 9c, 9d

Serpulites lumbricalis: Schlotheim, 1820, p. 96.

Serpula lumbricalis: Quenstedt, 1858, p. 392, pl. 53, figs. 10–11; p. 777, pl. 95, figs. 31 and 32; 1867, p. 320, pl. 24, fig. 26; Dumortier, 1874, pp. 219–220; Lahusen, 1883, p. 18; non *Serpula lumbricalis* L., 1758 [= *Vermetus lumbricalis*: Mollusca, Gastropoda]; non *Serpula* cf. *lumbricalis*: Makowski, 1952, p. 4, pl. 2, figs. 2–3 [= *Neovermilia* sp. nov.].

Serpula (*Dorsoserpula*) *lumbricalis*: Parsch, 1956, p. 227, pl. 20, figs. 18 and 20; non Pugaczewska, 1965, pp. 83–84, pl. VI, fig. 3, pl. VII, figs. 2–4 [= *Sclerostyla* sp.].

Vermilia ? *obtorta*: (?) Defrance, 1827, pp. 330–331.

Serpula limax [primary homonym *Serpula*? *limax* Defrance, 1828]: Goldfuss, 1831, p. 212, pl. LXVII, fig. 12; (?) Roemer, 1836, p. 35; Deshayes in Lamarck, 1838, pp. 627–628 [cop. Goldfuss, 1831]; Quenstedt, 1846, pl. 28, fig. 2; Eudes-Deslongchamps, 1877, pp. 19–20, pl. II, fig. 14; Zittel, 1927, text-fig. 403A [cop. Goldfuss, 1831]; (pars) Gerasimov, 1955, pp. 30–31, pl. X, figs. 1–12, 14–18 [non Fig. 13 = *Propomatoceros* sp. nov.]; non Pugaczewska, 1961, pl. II, fig. 7 [cf. *Propomatoceros barskovi* sp. nov.]; non *Serpula* aff. *limax*: Gerasimov, 1955, p. 31, pl. X, fig. 19 [= *Neovermilia* sp. nov.].

Serpula (*Dorsoserpula*) *limax*: Gerasimov et al., 1996, pl. 6, figs. 5–9.

Pomatoceros limax (*Serpentula*): Hecker and Ushakov, 1962, pl. V, fig. 3.

Serpula grandis: Goldfuss, 1831, p. 212, pl. LXVII, fig. 11; Deshayes in Lamarck, 1838, p. 627 [cop. Goldfuss, 1831]; (?) Roemer, 1836, p. 35; (?) Eudes-Deslongchamps, 1877, pp. 15–17, pl. II, figs. 25–28.

Serpula convoluta: Goldfuss, 1831, p. 213, pl. LXVII, fig. 14; Quenstedt, 1858, p. 392, pl. 53, figs. 12–14; Lahusen, 1883, p. 18; Zittel, 1927, text-fig. 403D (cop. Goldfuss, 1831).

Serpula plicatilis: (?) Trautschold, 1862, pl. IV, fig. 1.

Serpula segmentata: (?) Dumortier, 1874, p. 220, pl. XLVIII, figs. 5–7.

Serpula thermarum: Loriol, 1876, pp. 6–7, pl. I, fig. 1.

Serpula (*Tetraserpula*) *quinquangularis*: (pars) Sazonova and Sazonov, 1967, pl. LII, fig. 2, pl. LVII, fig. 1, pl. LVIII, fig. 1.

Serpula (*Dorsoserpula*) sp.: (?) Palmer and Fursich, 1974, pl. 77, fig. 3.

H o l o t y p e. Not designated. The type series comes from the Jurassic (Callovian?) of Germany.

D e s c r i p t i o n. The tube is large, varying in cross section from triangular at the initial stage to rounded-triangular with a trend toward pentagonal, rounded-pentagonal, and (where not attached to a substrate) circular. The median dorsal keel, which runs along the entire length of the tube, is high at the early stages, of medium size and usually undulating at the middle stages, and low and relatively small at the later stages.

The peristomes, which, as a rule, are universally present, are irregular and show morphology typical of most members of the genus. The surface is smooth, the growth lines are usually well-defined along the entire length of the tube. The paired lateral sutures are present, the median suture is occasionally well-defined, and the ventral suture may be visible in the peristomial region.

The attachment structures consist of tubules with widely spaced irregular transverse elements.

The tube is three-layered, with a thin milk-white intermediate layer clearly visible only in large specimens. The tube thickness in large specimens is approximately one-seventh to one-eighth of the tube diameter.

M e a s u r e m e n t s in mm. Specimen no. 5071/22: aperture diameter 2.1, estimated length 40 (atypical, slowly increasing); specimen no. 5071/30: aperture diameter 5.5, length 65–75; specimen no. 5071/34: aperture diameter 3.3, length 37.

C o m p a r i s o n. This species differs from the most closely related species, *P. sulcatus*, in the smooth surface of the tube; from *P. conformis*, in the more rounded cross section and less consistent appearance of the keel; from *P. limatus* and *P. nodulosus*, in the irregularly arranged peristomes; from *P. gibbosus*, in the absence of regularly arranged swellings on the tubes; and from *P. davidsoni* and *P. sublimax*, in the absence of paired lateral keels.

R e m a r k s. The species names *Serpula lumbricalis* L. and *Serpulites lumbricalis* Schlotheim are homonyms according to Art. 20 of the International Code of Zoological Nomenclature; however, in 1800 the first of these species was transferred to the genus *Vermetus* (Mollusca, Gastropoda), and since that time *Serpula lumbricalis* L. has not been used as a valid name; thus, according to Art. 23.9.5 the species name established by Schlotheim should be maintained.

Gerasimov (1955) correctly noted that the spiral forms described in Goldfuss's paper under the name *Serpula convoluta* are identical with *Serpula limax*. The presence of a continuous series of transitional forms shows that the differences in the type of coiling are caused by differences in the environment, most likely in the nature of the substrate. Facultative tightly coiled spiral tubes are also known in other serpulid species.

The surface of many tubes is covered with numerous pores that are arranged in an almost regular pattern and are surrounded by protuberances. Such formations, which occur on the tubes of serpulids from the Bajocian to Tertiary time, are remains of colonies of the symbiotic hydroid *Protulophila gestroi* Rovereto, 1904 (Scrutton, 1975), the network of stolons of this hydroid was immured in the tubes of worms during its lifetime, and the zooids were arranged on the apertural margin following the growth of the tube.

In our material most colonies of this symbiont have been encountered on tubes of one species, *P. lumbricalis*, and only one colony has been found on *Tetraserpula tetragona.* The invasion of the symbiont occurs at different growth stages of the tube and is usually accompanied by the following changes: a decrease in the growth rate of the tube (in terms of the growth rate of diameter per unit length) and the abrupt transition of the tube to a pentagonal cross section with sharp edges.

O c c u r r e n c e. Middle Jurassic, Europe.

M a t e r i a l. Hundreds of specimens in varying states of preservation, coming from concretions, belemnite rostra, and shells of oysters.

Propomatoceros barskovi **Ippolitov, sp. nov.**

Plate 12, figs. 4, 5, 9a, 9b

Serpula limax: (?) Pugaczewska, 1961, pl. II, fig. 7.

E t y m o l o g y. In honor of I. S. Barskov.

H o l o t y p e. PIN, no. 5071/41; Moscow Region, Kolomna district, locality Peski I, Upper Callovian, *lamberti* Zone.

D e s c r i p t i o n. The tube is of medium size, slowly increasing. The initial portion of the tube is rounded in cross section, 1.5–2 cm long, with the lateral folds located considerably lower than the easily observable median keel and barely protruding above the surface, subsequently the tube is almost quadrangular (the median keel forms a barely visible fold, a fifth angle of the cross section). The lateral walls are almost vertical and run parallel to each other along their entire length.

The median keel is shaped like a low costa along its entire length. The peristomes are widely and irregularly spaced, at the initial stages they have a winglike shape typical of *Propomatoceros*; at the middle stages they are shaped like elongated swellings on the lateral folds that give rise to dorsolateral keels that extend anteriorly and gradually thin out, usually to complete disappearance, within 3–4 mm; at the later stages they are absent. The apertural margin is almost straight, with a poorly developed median denticle and the bases of the walls not projecting anteriorly.

Although the tubular attachment structures are not developed, their positions are marked by the portions of the intermediate layer that are thickened up to be split, as in typical representatives of the genus.

At the later stages the thickness of the walls is about one-sixth of the tube diameter. Macroscopically the tube is three-layered, with semitransparent outer and inner layers of consistent thickness and a milk-white opaque intermediate layer.

M e a s u r e m e n t s in mm. Specimen no. 5071/41 (holotype): aperture diameter 2.0, length 35.

C o m p a r i s o n. This species differs from *P. keepingi* (Ware, 1975) from the Aptian of Great Britain in the thicker tube and in the presence of distinctive peristomes. It differs from all known species of the Jurassic *Propomatoceros* in the nearly tetragonal shape of the cross section, morphology of peristomes at the middle stages, and in the underdevelopment of tubular structures. It differs from *P. lumbricalis*, with which it cooccurs, in the rounded-quadrangular section, low median keel without undulations, flanks not protruding forward, and in the small denticle on the aperture.

Remarks. This species convergently resembles "*Serpula*" *quadrilatera* Goldfuss, 1831; the latter differs from our species in the size that is half as much, in the absence of a well-defined median keel, and in the sharply quadrangular cross section persisting along the entire length of the tube.

In all our specimens the tube is cream to yellow, a color not characteristic of other serpulids.

A number of structural features clearly distinguish the tube of the species described (see Comparison) from that of the other members of the genus. *P. barskovi* may be regarded either as a primitive member of *Propomatoceros* or as a highly specialized species. The latter view is supported by the fact that the unique characters appear at the later ontogenetic stages, whereas at the early stages the species is almost indistinguishable from the other *Propomatoceros*. The absence of tubular structures may be treated as a primitive character: however, it is more probable that this is a secondary ecological adaptation.

Occurrence. Type locality and, probably, the Upper Callovian of Poland.

Material. Seven almost completely preserved specimens, about 20 juvenile forms; two on belemnite rostra; all the others come from the condensation horizon.

Genus *Spiraserpula* Regenhardt, 1961

Spiraserpula: Regenhardt, 1961, p. 41; Kaever, 1974, p. 97; Lommerzheim, 1979, pp. 141–142; Pillai, 1993, pp. 72–73; Pillai, ten Hove, 1994, pp. 41–46.

Cementula (pars): Jäger, 1983 p. 46; 1993, pp. 81–84 [=*Cementula* Regenhardt, 1961 + *Spiraserpula* Regenhardt, 1961].

Type species. *Spiraserpula spiraserpula* Regenhardt, 1961; Germany, Campanian.

Diagnosis. Tubes solitary, predominantly attached to substrate along their entire length, very long (6–10 cm) and slender (no more than 2 mm in diameter), triangular or rounded-triangular in cross section, with keel or fold on dorsal side forming prominent denticle over aperture.

Tube consists of alternating straightened segments and regular flat spirals of three to seven whorls. Spirals without consistent direction of coiling, frequently forming cascades of several spirals with same coiling direction stacked on top of one another. Umbilicus at center of spiral segments frequently with unclosed gap. Spirals tightly coiled, frequently cemented together.

Internal longitudinal tube sculpture (ITS, in terms of Pillai, 1993) may present inside tube.

Species composition. It is possible that *S.* (?) *complanata* (Goldfuss, 1831) and *S.* (?) *circinnalis* (Muenster in Goldfuss, 1831) from the Lower Jurassic of Germany are the oldest members of the genus.

Middle–Late Jurassic forms: the species described below and, perhaps, *S. spirolinites* (Muenster in Goldfuss, 1831) (Germany; Middle Jurassic) and *S. subfilaria* (Eudes-Deslongchamps, 1877) (Europe, Middle Jurassic).

Cretaceous species: *S. spiraserpula* Regenhardt, 1961 (northern Germany, central European Russia, Kazakhstan; Middle Santonian–Upper Campanian, ?Maastrichtian), *S. versipellis* Regenhardt, 1961 (northern Germany; Lower Maastrichtian), *S. adunca* Regenhardt, 1961 (The Netherlands; Upper Maastrichtian), and *S. subdivita* Regenhardt, 1961 (Belgium, The Netherlands; Upper Maastrichtian–Danian Stage of the Paleogene).

Another six species, described by Regenhardt (1961) and Pasternak (1973), are of questionable species status.

Recent species: 19 (see Pillai and ten Hove, 1994) (tropical and subtropical regions of the world's oceans).

Comparison. This genus differs from the genera *Rotularia* Defrance, 1826, *Cementula* Regenhardt, 1961, *Laqueoserpula* Lommerzheim, 1979, *Conorca* Regenhardt, 1961, *Ortoconorca* Jaeger, 1983, and *Protectoconorca* Jaeger, 1983 in the absence of 3-D spiral coiling and in the presence of several spirals within one tube.

Remarks. I exclude *S. mikesia*, described by Ziegler (Ziegler and Michalik, 1980) from the Rhaetian deposits of the western Carpathians, from the species composition of the genus because of its uncertain generic affiliation. Jäger (1993, p. 83) pointed out unpublished data on finds of tubes from the Lower Pliensbachian of France and Germany that perhaps belong to the genus.

All the above species have a close resemblance in tube appearance, irrespective of the presence or absence of ITS. Pillai and Hove (1994) proposed the presence/absence of internal tube structures as the only criterion for distinguishing the genera *Spiraserpula* and *Cementula*. Like Jäger (1993, p. 83), I also believe that this criterion is not fully satisfactory. In my opinion, this differentiating character will cause *Cementula* to become a collective group that includes the Upper Cretaceous *C. sphaerica* Nielsen, 1931, Jurassic species with all the characters of *Spiraserpula* but without ITS, a number of independent Triassic and Jurassic lineages, and also the aberrant species of *Spiraserpula* that have lost ITS (some species of *Spiraserpula* show a tendency toward the reduction of ITS).

On this basis, I propose that the species with and without ITS should be distinguished in the future at the rank of subgenera within *Spiraserpula*. Thus I place some forms with morphology typical of *Spiraserpula* but without ITS (e.g., *S. applanata* Regenhardt, 1961) that previously Jäger (1993) transferred to the genus *Cementula* into *Spiraserpula*.

The Middle–Late Jurassic species, recorded from deposits of Europe, including the Russian Platform, *S. spirolinites* and *S. oligospiralis* sp. nov., the most ancient unquestionable species of the genus with the typical characters of the tube of *Spiraserpula*, have no ITS.

Spiraserpula oligospiralis **Ippolitov, sp. nov.**

Plate 12, figs. 10, 11

Serpula spirolinites: Gerasimov, 1955, pl. IX, fig. 21.

Serpula (*Dorsoserpula*) *spirolinites*: Gerasimov et al., 1996, pl. 6, fig. 10.

Cementula spirolinites: Radwanska, 2004, p. 39, pl. 2, figs. 6–8.

E t y m o l o g y. From the Latin *oligospiralis* (with few spirals).

H o l o t y p e. PIN, no. 5071/50, Moscow Region, Kolomna district, locality Peski I; Upper Callovian, Upper *Q. lamberti* Zone.

D e s c r i p t i o n. The cross section of the tubes varies from rounded-triangular with a well-developed median keel to almost circular with a barely visible fold; the cyclic alternation of these stages in ontogeny is usually easily observable within long fragments. The diameter of the tube increases at a relatively rapid rate during the early growth stages, subsequently the rate gradually decreases almost to zero.

The tube curves gently. The spiral segments are widely spaced, consisting of three to five contiguous whorls with an open umbilicus, and provide sites for the displacement of the median fold toward the outer side of the spiral.

The peristomes are clear-cut, widely spaced, irregular, most pronounced on the lateral surfaces of the tube, and thus may assume the form of paired triangular "ears" on the lateral sides. The growth lines are visible at the later stages. The degree to which the apertural denticle extends forward increases with age, and the degree to which the bases of the lateral surfaces protrude remains almost invariable.

The tube thickness is approximately one-fifth to one-sixth of the tube diameter on the upper side, it significantly increases on the lateral and lower sides of the tube. ITS is absent.

M e a s u r e m e n t s in mm. Specimen no. 5071/50 (holotype): aperture diameter 1.2, length about 85; specimen no. 5071/49 (paratype): aperture diameter 1, length about 50.

C o m p a r i s o n. This species differs from *S. spirolinites* in the median keel not being consistent along its entire length, in the initial stage not being spiral, and in the presence of peristomes. It differs from *S.* (?) *complanata* and *S.* (?) *circinnalis* in the larger size, uncertain position of spiral segments in ontogeny, and in the presence of peristomes. It differs from *S. filaria* in the nonspiral initial stage and in the presence of a fold or keel on the upper side of the tube. It differs from *S. subdivita* in the small number of spiral segments.

O c c u r r e n c e. Upper Callovian–Upper Oxfordian, Poland, Russian Platform.

M a t e r i a l. Eight specimens: five almost completely preserved specimens (only the earliest stages are absent) and three poorly preserved fragments.

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