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A REVISION OF SOME GLANDULINE
NODOSARIIDAE (FORAMINIFERA)

(WITH ONE PLATE)

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In 1839 d'Orbigny described *Glandulina* as a subgenus of *Nodosaria* (type species *Nodosaria (Glandulina) laevigata* d'Orbigny, 1826). This type species has a biserial early chamber arrangement and, as was shown much later, also an internal tube connecting with the radial aperture.

For many years all uniserial forms with strongly overlapping chambers were placed in this genus. In 1929 Cushman proposed a new generic name, *Pseudoglandulina*, for the completely uniserial forms, leaving in *Glandulina* those species which, like the type species, have an early biserial chamber arrangement. Perhaps because the early stages are not always clearly visible, in recent years the generic names *Glandulina* and *Pseudoglandulina* have both been rather loosely applied, many completely uniserial forms being left in *Glandulina* and some with a biserial stage and internal tube were placed in *Pseudoglandulina*. Some authors even placed the species *laevigata*, the type of *Glandulina*, in *Pseudoglandulina*, although d'Orbigny's name had nearly a century's priority.

The type designated by Cushman for the genus *Pseudoglandulina* was *Nautilus comatus* Batsch, but as will be shown in the generic discussion that follows, this form is actually a *Nodosaria*; hence the name is a junior synonym. As a new name is therefore needed for the uniserial, rectilinear *Glandulina*-like species, one is here proposed.

Recently, Boomgaard (1949) proposed the name *Pseudonodosaria* for the rectilinear *Glandulina*-like species which show a tendency to become like *Nodosaria* in the adult, with inflated, less-embracing

chambers and constricted sutures. A description is here given of an American species we consider to belong to this genus.

During the course of these investigations we found specimens of a *Glandulina*-like form that differed from those mentioned above in having a uniserial chamber arrangement, but with a curved axis, somewhat as in *Marginulina* and with strongly embracing chambers. A new name has been here proposed to include this new species and some earlier described species formerly referred to *Glandulina*.

The three genera here considered should be classed with the Nodosariidae, as they have a hyaline calcareous wall and radial aperture and show neither a biserial early stage nor an internal siphon.

Unfortunately, it is impossible to determine from the literature to which of these genera each described species should be referred, as many writers have ignored the early portions of their species in both figures and descriptions and few have shown the internal characters. Many of the species must be critically re-examined to determine whether they should be placed in *Glandulina*, *Pseudonodosaria*, or in one of the two genera here named, *Rectoglandulina* or *Pandaglandulina*.

Family NODOSARIIDAE Schultze, 1854

Genus PSEUDOGLANDULINA Cushman, 1929, suppressed

Pseudoglandulina CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 5, p. 87, 1929.

Type species.—*Nautilus comatus* Batsch, 1791. Original designation.

Discussion.—Cushman (1929, p. 87) defined *Pseudoglandulina* as similar to *Nodosaria* but with embracing chambers, and as differing from *Glandulina* in lacking the early biserial "pyruline" stage. Cushman designated *Nautilus comatus* Batsch, 1791, as type species of *Pseudoglandulina*.

Batsch (1791, pl. 1, fig. 2a-d) originally figured two completely different types as *Nautilus comatus*. One of these was a typical *Nodosaria* (fig. 2a, b) and the other a *Glandulina* (fig. 2c, d). Apparently it was the latter form to which Cushman referred. However, Parker, Jones, and Brady (1865, p. 226) had earlier recognized these distinct differences in Batsch's figures, and they had already designated Batsch's fig. 2a, b, as *Nodosaria comata* (Batsch) (although stating that this was a "smallish specimen of *Nodosaria raphanus*"), and they referred Batsch's fig. 2c, d, to *Glandulina glans* d'Orbigny. Thus when Cushman designated *Nautilus comatus* Batsch

as type species of *Pseudoglandulina* he immediately, although unknowingly, created only a junior synonym of *Nodosaria*, for Parker, Jones, and Brady had selected the nodosarian form as the type of *comatus*. Even if the genus were based on the other form of Batsch (the one later referred to *Glandulina glans* d'Orbigny by Parker, Jones, and Brady), *Pseudoglandulina* would have no standing for it would then be a synonym of *Glandulina* as was shown by Selli (1947, p. 5, pl. 3, figs. 1-6). He showed *Glandulina glans* d'Orbigny to be a true *Glandulina* with internal tube and biserial early stage. Selli considered *G. glans* to be the type of *Pseudoglandulina* and therefore considered the latter to be a synonym of *Glandulina*. However, Parker, Jones, and Brady's assignation of the name *comatus* to the nodosarian form of Batsch precludes this later fixation by Selli.

Nevertheless, *Pseudoglandulina* has been recognized by many foraminiferal workers, although there has been much confusion between this genus and *Glandulina* d'Orbigny, 1826 (type species *G. laevigata* d'Orbigny). This confusion culminated in the referring of some specimens by Renz (1948, p. 154), and by Cushman and McCulloch, as late as 1950 (p. 325) to the combination "*Pseudoglandulina laevigata* (d'Orbigny)." The specimens of Cushman and McCulloch were typical *Glandulina* however, and they clearly showed the internal tube in their figures. Nevertheless, these authors had placed the type species of *Glandulina* (*laevigata*) in another genus (*Pseudoglandulina*), which is antedated by nearly a century. The type species of a genus could not in any legal way be placed in a later-named genus.

This unfortunate type citation places the genus *Pseudoglandulina* within the synonymy of *Nodosaria* and the name must therefore be suppressed. Furthermore, many specimens referred in the literature to *Pseudoglandulina* are obviously true *Glandulina* showing either a biserial base or internal tube or both, and many other references would seem to be better placed in *Nodosaria* or in *Pseudonodosaria* Boomgaard, 1949. Nevertheless, some species remain for which a name must be proposed, as they can not be placed in *Nodosaria*, or in *Glandulina* or *Pseudonodosaria*.

Genus RECTOGLANDULINA Loeblich and Tappan, new genus

Pseudoglandulina (part) CUSHMAN, 1929, and later authors.

Glandulina (part) of authors, not d'Orbigny, 1826.

Nodosaria (part) of authors, not Lamarck, 1812.

Type species.—*Rectoglandulina appressa* Loeblich and Tappan, new species.

Derivation.—*rectus* L. straight, upright + *glandula* L. dim. acorn (shaped). Gender feminine.

Diagnosis.—Test free, uniserial, with chambers increasing rapidly in diameter and strongly overlapping, sutures horizontal and parallel, never strongly depressed; wall calcareous; aperture terminal, radiate.

Remarks.—This genus differs from *Glandulina* d'Orbigny in lacking an early biserial stage, and from *Pseudonodosaria* Boomgaardt in having all chambers closely appressed and with the later chambers unseparated by constricted sutures as are found in *Pseudonodosaria*. It includes many of the species previously placed in *Pseudoglandulina* Cushman, 1929, but does not include the type species of *Pseudoglandulina*, *Nautilus comatus* Batsch, which has been shown to belong to the genus *Nodosaria* Lamarck, 1812.

RECTOGLANDULINA APPRESSA Loeblich and Tappan, new species

Plate 1, figures 1-4

Pseudoglandulina lagenoides (Olszewski) CUSHMAN and DEADERICK (not *Glandulina lagenoides* Olszewski, 1875), Journ. Pal., vol. 18, p. 334, pl. 51, figs. 14, 15, 1944.

Pseudoglandulina sp. PLUMMER, Univ. Texas Bull. 3101, p. 158, pl. 10, figs. 16, 17, 1931.

not *Pseudoglandulina lagenoides* (Olszewski) CUSHMAN and HEDBERG, Contr. Cushman Lab. Foram. Res., vol. 17, p. 89, pl. 21, fig. 34, 1941.—CUSHMAN and TODD, *ibid.*, vol. 19, p. 58, pl. 10, fig. 14, 1943.—CUSHMAN, *ibid.*, vol. 20, p. 8, pl. 2, fig. 4, 1944.—CUSHMAN, U. S. Geol. Surv. Prof. Paper 206, p. 76, pl. 27, fig. 29, 1946.

Test free, subfusiform, widest centrally, chambers uniserial, closely appressed, increasing rapidly in diameter from the pointed base, last chamber occupying one-half to three-fifths the length of the test, elongate turbinate in form; sutures distinct, horizontal, flush with the surface; wall calcareous, surface smooth; aperture terminal, radiate.

Length of holotype 0.44 mm., greatest breadth 0.23 mm. Other specimens range from 0.26 to 0.57 mm. in length.

Types and occurrence.—Holotype (U.S.N.M. P2010), figured paratypes (U.S.N.M. P2011a-c), and unfigured paratypes (U.S.N.M. P2012) all from the Ozan sand, 7.8 miles south of Nashville on State Highway 4, Hempstead County, Ark., Deaderick Collection. Unfigured paratypes (U.S.N.M. P2013) from the Annona chalk, 8.3 miles south of Mineral Springs on the road to Saratoga, 0.4 mile north of junction with Okay road, Howard County, Ark., Deaderick Collection. Unfigured paratypes (Cushman Coll. 41957 and 41958) from

north side of road, 2 miles east of Saratoga on road to Columbus, Ark., Deaderick Collection. Unfigured paratype (U.S.N.M. P2014) from the Corsicana marl, 2 miles south of Manda, Travis County, Tex. Unfigured paratype (U.S.N.M. P2015) from the Corsicana marl, on Mexia highway at forks of Wortham road, 2.8 miles ESE of Cooledge, Limestone County, Tex. Unfigured paratypes (U.S.N.M. P2016) from the Taylor marl, Colorado River, 1 mile NNE of Delvalle, Travis County, Tex.

Remarks.—Cushman and others had referred this species to *Pseudoglandulina lagenoides* (Olszewski) but had also included with it many varying forms, some fusiform, others subcylindrical, some with bluntly rounded base, others with pointed and even apiculate base. The present species differs from *Glandulina lagenoides* Olszewski in having much lower chambers and in the shape of the test. *G. lagenoides* has a strongly fusiform test in contrast to the subfusiform outline of *Rectoglandulina appressa*.

RECTOGLANDULINA OBESA Loeblich and Tappan, new species

Plate 1, figures 5a-6

Test free, robust, ovate in outline, widest slightly above the midline, base pointed, apertural end broadly rounded, chambers rectilinear, very strongly overlapping, final chamber occupying three-fifths the length of the test; sutures distinct, horizontal, flush, not constricted; wall calcareous, hyaline, surface smooth; aperture terminal, radiate.

Length of holotype 0.47 mm., greatest breadth 0.34 mm. Paratypes range from 0.36 to 0.68 mm. in length and from 0.21 to 0.36 mm. in breadth.

Types and occurrence.—Holotype (U.S.N.M. P2017), figured paratype (U.S.N.M. P2018), and unfigured paratypes (U.S.N.M. P2019) all from the Ozan sand, Murfreesboro road, 0.9 mile west of Wright's Store at junction of Okolona and Murfreesboro roads, Clark County, Ark., Deaderick Collection. Unfigured paratypes (U.S.N.M. P2020) from the Annona chalk in a natural erosion about one-half mile north of White Cliffs Post Office, Ark., Deaderick Collection.

Remarks.—This species somewhat resembles *Glandulina inflata* Bornemann from the Oligocene of Germany but differs in being smaller, in having a more broadly rounded upper surface, rather than a produced aperture, and a more rounded final chamber.

Genus **PSEUDONODOSARIA** Boomgaard, 1949

Pseudonodosaria BOOMGAART, Smaller Foraminifera from Bodjonegoro (Java), Thesis Univ. Utrecht, p. 81, 1949.

Type species.—*Glandulina discreta* Reuss, 1850. Original designation.

Test free, uniserial and rectilinear throughout, chambers embracing strongly in the early portion, later chambers inflated, less embracing and separated by constricted sutures; sutures horizontal; aperture terminal, radiate.

PSEUDONODOSARIA LARVA (Carsey)

Plate 1, figures 7-11

Nodosaria larva CARSEY, Univ. Texas Bull. 2612, p. 31, pl. 2, fig. 2, 1926.

Nodosaria radícula (Linné) PLUMMER (not *Nautilus radícula* Linné, 1758), Univ. Texas Bull. 3101, p. 155, pl. 11, fig. 2 (? fig. 1), 1931.

Pseudoglandulina manifesta (Reuss) CUSHMAN (not *Glandulina manifesta* Reuss, 1851), U. S. Geol. Survey Prof. Paper 206, p. 76, pl. 27, figs. 21-26 (not fig. 20), 1946.

Test free, elongate, base smooth and rounded, consisting of a rectilinear series of chambers, early ones closely appressed, strongly overlapping and subcylindrical, later chambers slightly inflated with a lesser amount of overlap and separated by slight constrictions, final chamber turbinate in form, somewhat produced to the aperture; sutures distinct, straight, horizontal, flush with the surface in the early portion, slightly constricted in the later portion where the chambers are more inflated; wall calcareous, hyaline, surface smooth; aperture terminal, radiate. Specimens range from 0.39 to 0.88 mm. in length and 0.18 to 0.26 mm. in width.

Types and occurrence.—Figured topotypes (U.S.N.M. P2021a-e) and unfigured topotypes (U.S.N.M. P2022) from basal Navarro strata exposed in a steep 80-foot exposure on the right bank of Onion Creek just east of the bridge on the Austin-Bastrop Highway, Travis County, Tex. Collected by A. R. Loeblich, Jr.

Remarks.—Plummer placed Carsey's species under the synonymy of *Nodosaria radícula* (Linné); Cushman considered it equivalent to *Pseudoglandulina manifesta* (Reuss). It differs from the former species in having a rounded, rather than an apiculate base, and in having closely appressed early chambers. It is also much smaller than the Recent species. It differs from Reuss's species in having a more rounded base and a much less flaring test and in the later chambers being more separated and sutures more constricted.

Genus PANDAGLANDULINA Loeblich and Tappan, new genus

Type species.—*Pandaglandulina dinapolii* Loeblich and Tappan, new species.

Derivation.—*pandus* L. bent, curved + *glandula* L. dim. acorn (shaped). Gender feminine.

Diagnosis.—Test free, like *Rectoglandulina* with chambers much overlapping, and all chambers uniserially arranged, but with a slightly arcuate axis, sutures very slightly radiate in the early portion, later ones horizontal, and may be very slightly depressed; wall calcareous, hyaline; aperture terminal, radiate.

Remarks.—This genus differs from *Rectoglandulina* Loeblich and Tappan, n. gen., in having a curved axis in the early portion, with the sutures somewhat radial, rather than horizontal and parallel. It differs from *Glandulina* d'Orbigny in being uniserial throughout, rather than biserial in the early portion, and in lacking an internal tube. It differs from *Pseudonodosaria* Boomgaardt in having a curved axis and in having closely appressed chambers throughout, and in lacking the constricted sutures of the later stage of *Pseudonodosaria*.

Glandulina laevigata var. *dentalinoides* Silvestri belongs to this genus and very probably also *Glandulina adunca* Costa and *Glandulina laevigata* var. *marginulinoides* Fornasini. In the latter two species nothing is known of their interior structures.

PANDAGLANDULINA DINAPOLII Loeblich and Tappan, new species

Plate I, figures 12-16

Test free, fusiform to elongate; chambers much embracing, uniserial but with a slightly curved axis; sutures straight, very slightly radial in the early portion, later nearly horizontal, flush with the surface or very slightly depressed in the later portion of the longer individuals; wall calcareous, hyaline, surface smooth; aperture terminal, radiate, slightly produced.

Length of holotype 0.83 mm., greatest breadth 0.39 mm. Other specimens range from 0.68 to 1.17 mm. in length.

Types and occurrence.—Holotype (U.S.N.M. P2023) and figured paratypes (U.S.N.M. P2024a-d) and unfigured paratypes (U.S.N.M. P2025) all from the Lower Pliocene blue clays, Ponticello di Savena, on right bank of the stream below the bridge near San Ruffillo, Province of Bologna, Italy. Collected by H. T. and A. R. Loeblich, Jr., 1954.

Remarks.—This species somewhat resembles the figures of *Glandulina laevigata* d'Orbigny var. *dentalinoides* Silvestri, 1903, from the

Miocene (Helvetian). Silvestri gave no magnification and no measurements of his figures and the comparative size of the two forms is not known. However, the present species has a more produced aperture. *Glandulina laevigata* d'Orbigny var. *marginulinoides* Fornasini, 1901, from the Pliocene of Siena is also similar, but has constricted sutures in the later portion, somewhat as in *Pseudonodosaria*. Whether this is a diagnostic character or merely represents an aberrant specimen is not known, but apparently only one specimen was found, which would suggest the latter possibility. *Glandulina adunca* Costa differs in being more slender with the early sutures nearly equidistant, and final chamber higher and more tapering.

This species is named in honor of Dr. Enrico di Napoli Alliata, of Rome, Italy, in recognition of his outstanding work on the Foraminifera of Italy.

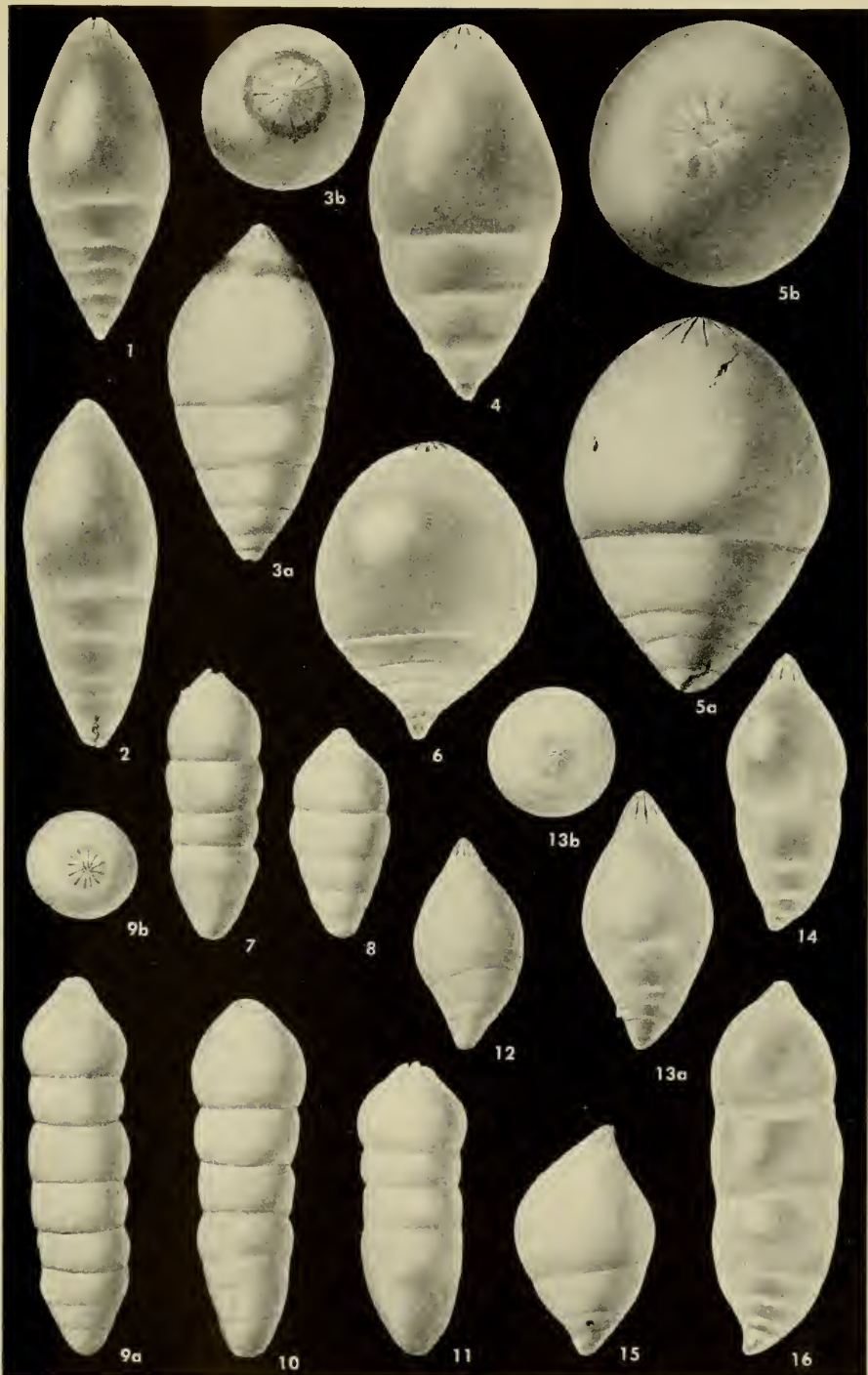
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EXPLANATION OF PLATE 1

Rectoglandulina, Pseudonodosaria, Pandaglandulina

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Rectoglandulina, Pseudonodosaria, Pandaglandulina
 (For explanation see page 9.)