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# The First Find of *Pseudosiderolites* Smout (Foraminifera) in the Upper Cretaceous of the Rostov Region

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**Abstract**—A taxonomic description of larger foraminifers of the genus *Pseudosiderolites*, from Upper Cretaceous beds in the Rostov Region that were previously assigned to the Paleogene, is provided for the first time. The beds with these foraminifers are dated as Maastrichtian. Species criteria and the taxonomic position of the genus *Pseudosiderolites* are discussed.

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*Key words*: Upper Cretaceous, Campanian, Maastrichtian, larger foraminifers, Sea of Azov Region.

## INTRODUCTION

The material studied comes from boreholes in the northern Sea of Azov Region (Rostov Region), which was transferred to me by T.E. Ulanovskaya in 2002 for determination of nummulitids. It was found that specimens of *Pseudosiderolites* from the Upper Cretaceous had been mistaken for Paleogene nummulitids. These foraminifers were found in borehole 200 and sample 1101/7 of an outcrop in the vicinity of Matveev Mound (Fig. 1).

*Pseudosiderolites* Smout is a larger foraminifer (LF) genus that was widespread in the Campanian–Early Maastrichtian of the central regions of the Tethys, including the northern and southern Mediterranean and southeastern Asia. In the northern peripheral regions of the Tethys (northern Peritethys), Upper Cretaceous LFs were represented by orbitoidids and siderolitines and were not diverse. They occur sporadically in a band extending from northern Europe to Central Asia. According to published data, the distribution of *Pseudosiderolites* in the Peritethys is restricted to the southern part of the Ukrainian Platform, the Mangyshlak Peninsula, and Tajikistan.

Cretaceous larger foraminifers found by D.I. Mushketov in 1907 in the Slavyanoserbskii District of the northern Donets Basin of the Ukrainian Platform were determined by Meffert (1931) as a new Oligocene nummulitid species, *Nummulites domgeri* Meff. Riabinin (1939) described and figured this species for the first time. Similar forms from the vicinity of Amvrosievka (southern Donets Basin) were subsequently determined as the Upper Eocene species *Pellatispira rutteni* Umbgr. (Nemkov, 1958). Zernetsky (1961) was the first to assign these LF to the Upper Cretaceous genus *Pseudosiderolites*; as a result, the age of the host rock was changed from the Late Eocene to the Early Maastrichtian. Upper Cretaceous LF of the northwestern Ukraine are very poorly understood. The genus *Siderolites*, which is closely related to *Pseudosiderolites*, was recorded in the Campanian of the vicinity of Lvov (Pasternak et al., 1987). A new *Siderolites* species without rays, *Siderolites krechovi* Terestschuk, was recorded in Opol'e (vicinity of the town of Zhuravno) (Terestschuk, 1961). Judging from available figures, this form is most similar to the genus *Pararotalia*. In addition to *Orbitoides*, the Upper Maastrichtian beds of the Sullu-Kapy section of the Mangyshlak Peninsula yielded small forms, which were determined as *Pseudosiderolites vidali* (Douv.), but were not described (Aschurov et al., 1987). The study of washed samples considered in this work has shown that they lack representatives of this genus. In the Campanian–Maastrichtian of the Tadjik Depression, the larger foraminifers *Orbitoides* and *Siderolites* are accompanied by rare small *Pseudosiderolites* (Aschurov, 1983, 1987; Dzhalilov et al., 1988).

In the southeastern Caucasus and Transcaucasia, which belong to the Mediterranean Paleobiogeographic Region of the Tethys (Grigoryan, 1986), *Pseudosiderolites vidali*, which was recorded in the Campanian–Maastrichtian of Azerbaijan (Glaessner, 1937) and in the Campanian of Armenia (Grigoryan, 1986), has not been studied in detail.

The significance of *Pseudosiderolites* for paleogeography and stratigraphy follows from the fact that it is confined to shallow-water conditions and shows a narrow stratigraphic range. In the rare Russian publications, little attention is paid to morphological characteristics of the test of this genus, and its taxonomic position and composition have been a subject of long discussion in the literature.

The purpose of the present study is the characteristics of representatives of *Pseudosiderolites*, which were

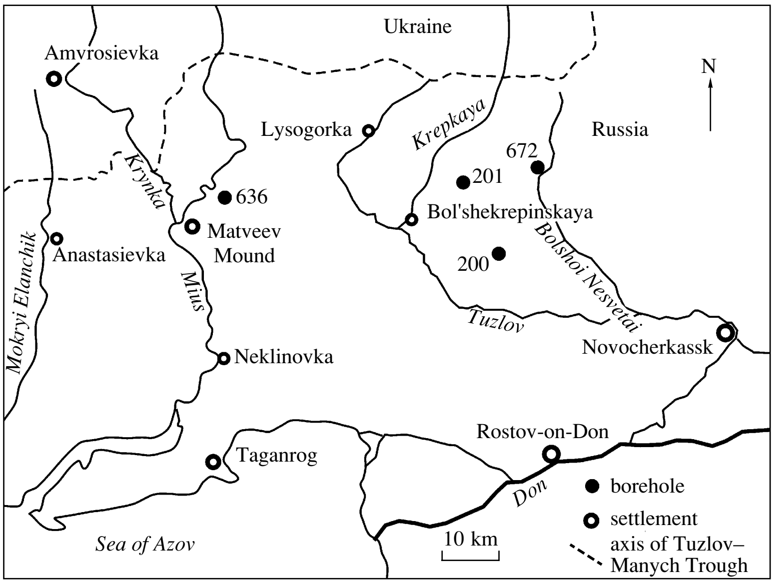



**Fig. 1.** The position of borehole 200 in the Rostov Region, Russia.

found for the first time in the Russian part of the southern Donets Basin, the analysis of species composition and taxonomic and stratigraphic position of this genus. Comparative analysis involves representatives of this genus from a quarry of State Farm no. 5, which is positioned northwest of the town of Amvrosievka (southern Donets Basin), and from the Khrestovaya gully in the northern Donets Basin (collected by G.I. Nemkov). A total of about 300 tests from 14 samples were analyzed. The biometric study of parameters of the internal structure of the test was performed in fine section in equatorial and axial sections. Statistical analysis of parameters was performed based on 112 tests (Tables 1, 2). These parameters are compared with published data on foraminifers from Spain, southern France, Switzerland, and Turkey (Tables 3, 4).

## STRATIGRAPHIC POSITION OF HORIZONS WITH *PSEUDOSIDEROLITES* IN THE UPPER CRETACEOUS OF THE DONETS BASIN

*Pseudosiderolites* from the Rostov Region are presently referred to the Upper Maastrichtian (Ulanovskaya, 2003) and, from the Ukrainian part of the Donets Basin, to the Lower Maastrichtian (Zernetsky, 1961).

**Ukrainian part of the Donets Basin.** The Upper Cretaceous strata are composed of carbonate terrigenous matter. LF, which are represented by the genera *Pseudosiderolites* Smout and *Lepidorbitoides* A. Silv., are confined to the upper part of the Cretaceous section and occur on both the northern (Lugansk Region) and southern (Donetsk Region) marginal areas of the Donets Basin. In the northern Donets Basin, the horizon with LF is in the basins of the Belaya (Khrestovaya and Sap'yanovay gullies, village of Beloe), Luganchik (near the village of Krasnoe), and Ol'khovaya (near the village of Menchikur) rivers and is assigned to the Menchikur beds (Savchinskaya, 1982; Naidin, 1986). More deepwater facies of these beds contain belemnoidean assemblages of the *Belemnitella langei najdini* Subzone of the Upper Campanian (Savchinskaya, 1974). In the shallow-water calciferous–glauconitic–sandy matter, LF co-occur with belemnoideans only in the localities on the Luganchik River (Savchinskaya, 1982). Smaller foraminifers from the *B. langei* Zone (Blank, 1974) and beds with LF (Zernetsky, 1961) are represented by species that occur from the Upper Campanian to the Lower Maastrichtian: *Globorotalites emdiensis* Vass., *Brotzenella taylorensis* (Garsey), *Neoflabellina reticulata* (Reuss), *Stensioina stellaria* (Vass.), and *Bolivina incrassata* Reuss. In the roof of the *B. langei* Zone near the village of Menchikur (Savchinskaya, 1982) and in the beds with LF from the vicinity of the village of Beloe (Nemkov and Zernetsky, 2007), the first rare *Belemnella lanceolata* (Schlot.); however, the Campanian–Maastrichtian boundary is marked by relatively frequent occurrence of these mollusks. In the Donetsk Region, Upper Cretaceous LF were recorded in quarries in the valley of the Krynka River (Savchinskaya, 1982). Near the town of Amvrosievka and the village of Uspenka, cement marls of the *B. mucronata mucronata* Zone are overlain by siliceous marls of the *B. langei* Zone. Northwest of Amvrosievka, these deposits become shallow-water and are represented by alternating marls, calcareous sandstones, and conglomerates with interbeds filled with LF tests. The correlation between these strata and the *B. langei* Zone is based on the presence of damaged rostra of the zonal species (Naidin, 1986), the Upper Campanian foraminifers *Cibicidoides voltzianus* (d'Orb.), and the sea urchin *Balanocidaris schlüteri* (Lamb.) (Savchinskaya, 1982). In LF assemblages of the Ukrainian Donets Basin, *Pseudosiderolites* co-occurs with orbitoid foraminifers, which Zernetsky assigned to the genus *Pseudorbitella* Hanz. (Nemkov and Zernetsky, 2007). I refer these forms to the genus *Lepidorbitoides* and believe that, in the shape of the nucleoconch and periembryonal chambers, they are similar to *L. campaniensis* van Gors. (Gorsel, 1975) from the biozone of the Upper Campanian–basal Maastrichtian. The Late Campanian age of the beds with *Pseudosiderolites* of the Donetsk and Lugansk regions is supported mostly by the confinement to the *B. langei* Zone and the absence of typical Maastrichtian foraminifers.

The texture of the member with *Pseudosiderolites* from the quarry of State Farm no. 5 (vicinity of Amvrosievka) is derived from the field description of D.P. Naidin. This 4–4.5-m-thick member overlies sandy marls and is composed of calcareous clays at the base, calcareous glauconitic sandstone and sand with a marl layer in the lower part, and with cherts in the upper part (12 layers). In addition to marls and cherts, each layer has abundant LF (mostly *Pseudosiderolites*) and less abundant smaller benthic foraminifers, sea urchins, and bryozoans. Nine washed samples from this section (collected by D.P. Naidina), with more than 1000 LF tests are housed in Vernadsky State Geological Museum of the Russian Academy of Sciences (GGM).

**Russian part of the southern Donets Basin (Rostov Region).** The region under study (basins of the Mius and Tuzlov rivers) is assigned based on its texture to the Tuzlov–Manych Trough of the Azov–Kuban Depression (Shvemberger, 1962). In the northern slope of the trough (north of the village of Lysogorki), the Upper Cretaceous section is terminated by cement marls of the *B. mucronata mucronata* Zone (Savchinskaya, 1974, 1982). To the south, within the closed areas of the trough, the Campanian–Maastrichtian beds are composed of relatively deepwater facies which lack LF (Titova, 1972). I have not found published data on foraminifers from shallow-water facies of the northern part of the trough near borehole 200. Shallow-water Cretaceous–Paleocene strata of the western part of the Tuzlov–Manych Trough are of interest. In this area, Anastasievka borehole (valley of the Mokryi Elanchik River) exposes sandy and coarse-detritus limestones at a depth of 100–130 m (Shamrai, 1964; Belyaeva, 1965). The lower part (130–112 m) contains a rotaliid assemblage dominated by *Discorbis binkhorsti* (Reuss) and *Cibicides clipeatus* Vass., which were established by Vasilenko (1961) as index taxa of the Danian. The middle part of limestones (112–103 m) has yielded Maastrichtian and Paleocene *Reusella minuta* Mars., *Bolivina (Grammostomum)* cf. *incrassata* Reuss, *Anomalina ekblomi* Brot., and *Reusella paleocenica* Brot. In the overlying beds, foraminifers of the Danian *Cibicides lectus* Zone (Shamrai, 1964) have been found. Belyaeva (1965) assigned the entire carbonate–sandy strata to the Danian Stage and indicated that it is of "transitional character" and contains an assemblage of forms varying in age. Since foraminifers of this assemblage were recorded in borehole 200 in a member with *Pseudosiderolites*, Ulanovskaya initially referred it to the Paleocene.

Ulanovskaya (2003) described three limestone members in borehole 200, which are presently dated as Late Maastrichtian. *Pseudosiderolites* is only recorded in the first member of detritus limestone (400–500 m of depth). The underlying limestones contain the zonal Campanian species *Cibicidoides aktulagayensis* (Vass.) and Upper Maastrichtian *Brotzenella praeacuta* (Vass.) (Olfer'ev and Alekseev, 2003). The first member with *Pseudosiderolites* has yielded Upper Maastrichtian *Brotzenella praeacuta* (Vass.), *Anomalina ekblomi* (Brot.), Campanian–Maastrichtian *Cibicides spiropunctatus* Gall. et Mor., and Maastrichtian–Paleogene *Discorbis binkhorsti* (Reuss). In the second calciferous–gaize member (at a depth of 282–400 m), Campanian *Cibicidoides aktulagayensis* (Vass.) and *Brotzenella taylorensis* (Garsey) along with Upper Maastrichtian *B. praeacuta* (Vass.), Upper Campanian–Maastrichtian *Bolivina incrassata* Reuss, and Upper Maastrichtian–Paleocene *Anomalina danica* (Brot.) and *A. mantaensis* Gall. et Morr. were recorded. The first and second members have yielded plankton foraminifers, which indicate Upper Cretaceous age of the beds. These members extend to the north and west and are present in boreholes 201, 672, and 636; however, LF are absent from these localities. To the west, *Pseudosiderolites* was recorded on the Gruzkoi Elanchik River (personal communication, B.F. Zernetsky). Thus, at present it is very difficult to establish the exact position of the beds with *Pseudosiderolites* in borehole 200 based on the accompanying assemblage of smaller foraminifers. However, the fact that each member contains Upper Maastrichtian foraminifers suggests that beds with LF should be assigned to the Maastrichtian. It is evident that closely situated regions of the Donets Basin have two horizons with LF, which differ in the composition of assemblages, thickness, and possibly in geological age. In the Rostov Region, LF are represented by relatively infrequent *Pseudosiderolites* of one morphotype. In the Lugansk and Donetsk regions, LF are represented by *Pseudosiderolites* and *Orbitoides*, which are frequently rock-building and display various morphotypes.

## MORPHOLOGY OF THE *PSEUDOSIDEROLITES* TEST

The morphology of *Pseudosiderolites* has been investigated using the material from Aquitania, northern Spain, and Turkey (Arni, 1932; Pfender, 1934; Gorsel, 1974; Wannier, 1980, 1983; Neumann, 1985). Even Arni (1932) examined in detail the test structure, including the shape and arrangement of canals; and Wannier (1980) developed this model. In Russian works, the test of *Pseudosiderolites* was described by

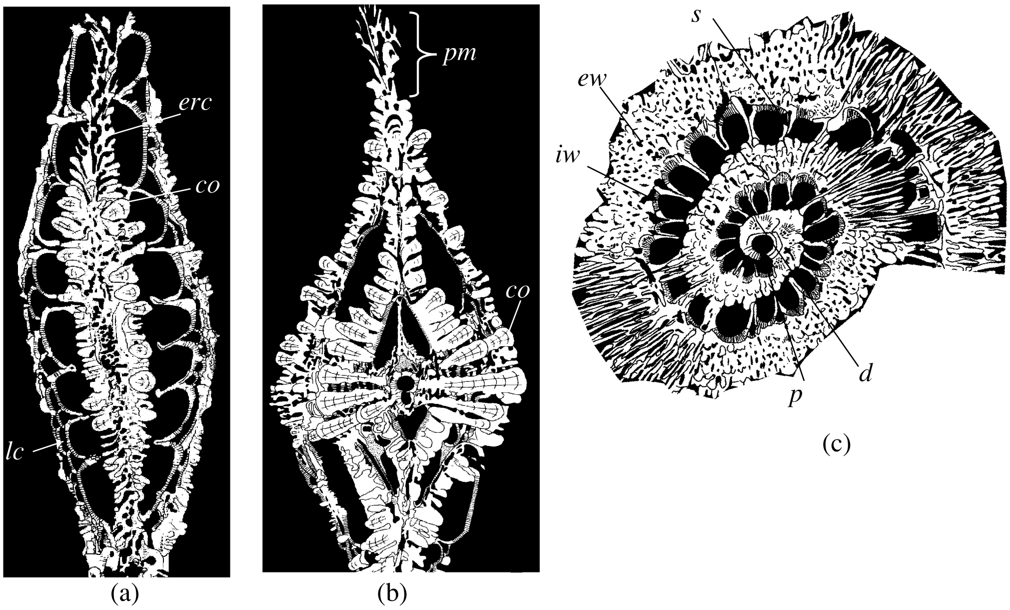



**Fig. 2.** Test structure in *Pseudosiderolites vidali* (Douv): (a) tangential, (b) axial, and (c) equatorial sections (after Wannier, 1980); (a, c) ×25 and (b) ×20. Designations: (*erc*) equatorial radial canals; (*co*) columella; (*lc*) lateral chambers; (*pm*) flange; (*p*) protoconch; (*d*) deuteroconch; (*s*) septum; (*ew*) external wall; and (*iw*) internal wall.

Zernetsky (1961) and Aschurov (1983). In addition, Zernetsky (1983) provided photographs of pores in the wall of *Pseudosiderolites* from Amvrosievka.

**Test morphology.** The genus *Pseudosiderolites* comprises pierced canal-bearing foraminifers 2–6 mm in diameter, with spiral–plane or weakly trochoid involute coiling, large tubercles (pustules / granules) on septal sutures, and low, irregularly shaped lateral chambers located in the peripheral part of the last whorls. The embryonic apparatus (nucleoconch) is double-chambered. The test is basically bilaterally symmetrical, lenticular, ranging from flattened to convex, biconical, with a rounded or sharp margin. However, the external bilateral symmetry is false in the case of the trochoid arrangement of chambers of the first whorl (Pl. 3, fig. 8), which is characteristic of Calcarinidae. The margin of flattened tests usually has a nonpierced flange, which resembles a crest in the axial section and reflects in the test sculpture the nonpierced peripheral part of the wall. Sometimes, the test margin is rough, with denticles and even small spines (Gorsel, 1974; Wannier, 1980). The tubercles are the ends of columellae, which develop at the points of crossing of the septa and lateral wall and are positioned on straight or curved radial lines. At the center of the test, tubercles are largest, densely spaced; in its middle part, they are uniform in size, regularly arranged, becoming small and irregularly distributed at the margin.

**Wall structure.** The wall is vitreous, complex, doubled. The internal (primary or chamber) wall is thin (20–30 μm), bilamellar, porous in the lateral and upper parts of chambers. The external (secondary, additional, or spiral) wall is several times as thick as the internal wall and has radial (lateral and equatorial) canals. Its structure differs in the peripheral and lateral parts of the test, which are frequently referred to in the literature as the peripheral and lateral walls. In the peripheral part, the wall is nonporous, forms the flange ("crest"), which is homologous to the spiral ridge of nummulitids and pierced by a bunch of equatorial radial canals (Figs. 2, 3; Pl. 2, fig. 1; Pl. 3, figs. 11, 12). In the equatorial plane, it is rapidly thickened from 40 μm in the first whorl to 400 μm in the second and third whorls (Fig. 2c, Pl. 2, fig. 1). The lateral external wall is thinner (less than 150 μm), porous (Pl. 3, fig. 13), pierced by the lateral radial canals, and has an additional frame composed of columellae. The external wall appears in the area of the deuteroconch (Fig. 2c; Pl. 2, figs. 5, 7; Pl. 3, fig. 12) or the first postembryonic chamber (Pl. 2, fig. 9). In embryonic chambers (protoconch and deuteroconch), the wall, in addition to the lamellar radial layer, has an internal, very thin (about 10 μm) layer, with vitreous granular (probably microgranular) microstructure. This layer is clearly visible between the protoconch and deuteroconch, where the radial layer is absent (Pl. 2, fig. 5). In the postembryonic chambers, it is also absent. A similar microgranular–lamellar wall combined with the absence of the lamellar structure between the protoconch and deuteroconch is recorded in the embryonic chambers of *Orbitoides* (Hofker, 1967). However, they differ from rotaloid foraminifers in the succeeding chambers with a microgranular–lamellar wall. The septa are nonporous, consist of two plates of the internal wall, the proximal septal face and distal septal flap of bilamellar structure, which are fused in the lower part and diverge in the upper part of the septa, forming

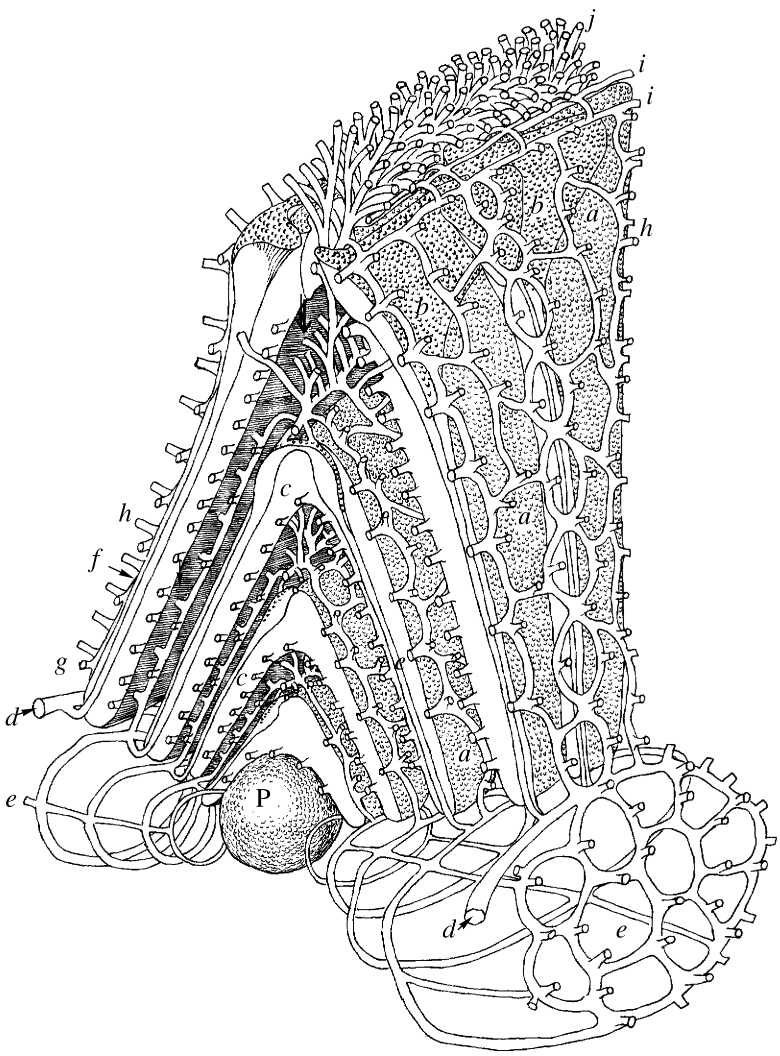



**Fig. 3.** Model of the test and canal system in *Pseudosiderolites vidali* (Douv.), ×50 (after Wannier, 1980). Designations: (*a*) lateral porous surface of the chamber; (*b*) lateral chamber; (*c*) foramen (aperture); (*d*) spiral canal; (*e*) umbilical vertical canal; (*f*) intraseptal lateral canal; (*g*) net of lateral canals; (*h*) lateral radial canal; (*i*) peripheral spiral canal; (*j*) equatorial radial canal; (*P*) protoconch; and (pointer) communication between chamber and canals.

the intraseptal space (Figs. 2a, 2c; Pl. 2, fig. 1; Pl. 3, figs. 1, 12). In the lateral part of the test, this space and adjacent areas are covered by a thin, porous wall; as a result, the lateral chambers are formed. They appear in the second and third whorls at the periphery of the test (Fig. 2a; Pl. 2, fig. 14; Pl. 3, figs. 10, 11). In the numerous rows of the test of orbitoid foraminifers, the growth of the lateral chambers is alternating, more regular, begins in the first whorl and proceeds through a system of stolons. The columellae develop independently in each whorl and are fused in consecutive whorls only at the center of the test (Fig. 2b; Pl. 2, fig. 12; Pl. 3, fig. 10). Like in *Siderolites*, they are pierced by pores (Pl. 2, fig. 16) and possibly by canals.

The main canals begin from between the primary and secondary walls and include: spiral canals, connected in consecutive whorls by a vertical umbilical canal; the tangential enveloping canal system of the lateral wall; the intraseptal lateral canals, peripheral spiral canals, and equatorial radial canals (Fig. 3; Pl. 2, fig 1; Pl. 3, figs. 1, 2, 12). The umbilical canals are connected with the peripheral spiral canals through the lateral and septal canal system. In consecutive whorls, the radial equatorial canals are connected (Figs. 2a, 2b, 3; Pl. 3, fig. 11). A characteristic feature of *Pseudosiderolites* (and *Siderolites*) is the short lateral radial canals, which deviate from the network of enveloping canals and due to the large diameter (up to 25 μm, that is, from two to four times as large as usual pores) are distinctly visible on the test surface (Pl. 2, figs. 1–3, 15, 16; Pl. 3, figs. 4, 13). The main aperture is simple, rounded, positioned in the equatorial plane at the base of the septum of the first postembryonic chamber; succeeding chambers have many supplementary openings (foramina), which are arranged in a single series and pass into the area of the lateral continuation of the septa (Fig. 3).

**Dimorphism and microspherical generation.** In *Pseudosiderolites*, dimorphism is poorly pronounced. Microspherical generation is very infrequent and, according to Gorsel (1974), differs from the megaspherical generation in the smaller size of embryonic chambers, which are at most 30 μm in diameter, the greater average number of whorls of the spiral, and in the higher whorl expansion rate.

## TAXONOMIC POSITION OF THE GENUS *PSEUDOSIDEROLITES*

The genus *Pseudosiderolites* was established by Smout (1955), and the type species *Siderolites vidali* was described by Douville (1906) from the Maastrichtian (at present Campanian) of Catalonia. The author of the genus assigned it to the family Miscellaneidae Sigal based on the similarity in the wall structure and coiling pattern. A more thorough study of the test structure of *Miscellanea* (Leppig, 1988) and *Pseudosiderolites* has shown significant distinctions in the structure of their canals and aperture. *Miscellanea* differs from *Pseudosiderolites* in the absence of the lateral canal system, the thicker peripheral spiral canals continuing the intraseptal canals (as in nummulitids), the shorter equatorial radial canals, the presence of the lateral sutural canals of the septa, the intraseptal canals developed not only in the lateral part of the septa, but also in the central part (as in nummulitids), and in the simple, slitlike interchamber aperture. Earlier Arni (1932) analyzed large rotaliids with a double wall, a well-developed system of radial and peripheral canals, and a similar shape of the test, taking into consideration the genera *Arnaudiella* Douv., *Pellatispira* Bous., *Miscellanea* Pfen., and *Siderolites* Lam. with rays and without rays (*S. vidali* Douv. and *S. heracleae* Arni). It was indicated that, in canal structure, *Siderolites heracleae* Arni is most similar to *S. calcitrapoides*, which Arni referred to Calcarinidae. In Russian works, *Siderolites* (Kacharava, 1959; Terestschuk, 1961) and *Pseudosiderolites* (Dzhalilov et al., 1988) were included in the family Nummulitidae (because of similar coiling pattern and arrangement of chambers) or in the family Miscellaneidae (Zernetsky, 1961).

The majority of researchers assign the genus *Pseudosiderolites* to the subfamily Siderolitinae Sigal of the family Calcarinidae Schwager based on an identical system of canals and apertures (Wannier, 1980, 1983; Andreieff and Neumann, 1983; etc.). It remains uncertain why Loeblich and Tappan (1988) included *Pseudosiderolites* in the family Lepidorbitoididae Vaug. This probably resulted from the presence of lateral chambers in *Pseudosiderolites* and the assumption that it is phylogenetically related not only to *Siderolites* but also to the *Helicorbitoides–Lepidorbitoides* lineage (Gorsel, 1974). However, the lateral chambers of *Pseudosiderolites* are poorly developed, the equatorial chambers at all growth stages are positioned only spirally, while Loeblich and Tappan themselves marked the absence of canals in all orbitoid foraminifers. Thus, the position of *Pseudosiderolites*, along with the genera *Arnaudiella, Siderolites*, and *Praesiderolites*, in the subfamily Siderolitinae of the modern foraminifer system seems most reasonable.

## VARIABILITY, TAXONOMIC STRUCTURE, AND SPECIES CRITERIA IN THE GENUS *PSEUDOSIDEROLITES*

Opinions differ as to the validity and composition of the genus *Pseudosiderolites* and establishment of its species. The author of the genus (Smout, 1955) included the type species and *P. heracleae* (Arni) in this genus. The majority of researchers believe that the main criteria for the establishment of species, varieties, and races of *Pseudosiderolites* are the size and shape of the test. Small forms were designated *P. vidali* race *minor* (Douville, 1910), inflated forms and (or) forms with a more rounded margin were *P. heracleae* (Arni, 1932) or *P. muschketovi* (Zernetsky, 1961). Gorsel (1974) performed the first quantitative analysis of inner parameters of the test of *Pseudosiderolites* from the type region, Aquitania, Switzerland, and Austria. He proposed that the species *P. vidali* comprised all species and forms of this genus described by that time and genera with similar structures of the test and wall (such as *Sulcoperculina* aff. *cubensis* (Palm.)), which occurred from the Upper Santonian to the bottom of the Maastrichtian. The analysis of the size of the test and embryonic chambers showed the absence in *Pseudosiderolites* of normal evolutionary trends in the change of these parameters, which usually increase in the course of phylogeny. Based on this, Gorsel (1974) considered this genus to be monotypic and comprise various phylogenetic groups. In essence the same group was established by Wannier (1980, 1983), who united all small (Santonian–Campanian) forms of *Pseudosiderolites* sensu Gorsel in a new genus, *Praesiderolites* Wannier. The major differences of *Praesiderolites* from *Pseudosiderolites* are the weak development of the equatorial radial canals and the absence of lateral radial canals and lateral chambers. In addition, *Praesiderolites* is distinguished by the presence of a narrow, thickened flange and denticles; based on this, Wannier (1983) regarded this group as direct ancestors of *Siderolites*. The genus *Praesiderolites* was thought to include not only the smallest Santonian forms, which were described as *Sulcoperculina* aff. *cubensis* (Palm.) (Hottinger, 1966), but also larger Campanian forms, described previously as *Pseudosiderolites vidali.* Since the test and nucleoconch increased in size during phylogenetic development of *Praesiderolites*, Wannier (1983) recognized three species. At the same time, Wannier retained only one species *P. vidali* (Douv.) in the genus *Pseudosiderolites*, which occurred throughout the Upper Campa-

**Table 1.** Statistical analysis of the structural parameters of the test of *Pseudosiderolites vidali muschketovi* Zernetsky

| Species, genus | Sample no. | $N_p$ | $P$, μm | | | $D_p$, mm | | $T_p$, mm | |
|---|---|---|---|---|---|---|---|---|---|
| | | | range | mean | s.e. | range | mean | range | mean |
| *Pseudosiderolites vidali mushketovi* Zernetsky, Rostov Region, borehole 200 | 200/468 | 8 | 75–150 | 99.3 | 8.2 | 1.7–2.2 | 1.95 | 1.0–1.1 | 1.04 |
| | 200/475 | 9 | 75–120 | 95.0 | 4.9 | 1.35–2.0 | 1.73 | 0.7–1.0 | 0.86 |
| | 200/481 | 8 | 70–140 | 101.2 | 8.2 | 1.6–2.1 | 1.84 | 0.9–1.0 | 0.96 |
| | 1101/7 | 3 | 70–100 | 87.5 | 6.3 | 1.4–1.9 | 1.63 | 0.8–1.2 | 1.0 |
| | 200/468–481, 1101/7 | 26 | 70–150 | 95.8 | 3.1 | 1.35–2.2 | 1.79 | 0.7–1.1 | 0.96 |
| *Pseudosiderolites vidali mushketovi* Zernetsky, vicinity of Amvrosievka | Am17 | 10 | 70–150 | 111.0 | 7.3 | 2.3–3.5 | 2.9 | 1.3–2.0 | 1.3 |
| | Am16 | 10 | 75–150 | 111.0 | 6.6 | 1.7–3.0 | 2.51 | 1.0–1.8 | 1.51 |
| | Am15 | 7 | 75–125 | 107.1 | 6.4 | 2.3–3.2 | 2.6 | 1.5–1.8 | 1.71 |
| | Am14 | 8 | 75–130 | 96.2 | 6.0 | 2.0–4.0 | 2.75 | 1.2–2.0 | 1.52 |
| | Am13 | 10 | 70–150 | 112.0 | 7.0 | 2.5–3.2 | 2.85 | 1.5–2.0 | 1.7 |
| | Am12 | 6 | 75–125 | 101.7 | 6.7 | 2.2–3.0 | 2.4 | 1.4–1.5 | 1.48 |
| | Am11 | 8 | 75–100 | 89.3 | 4.0 | 1.5–2.3 | 2.1 | 1.0–1.5 | 1.3 |
| | Am5 | 13 | 75–150 | 111.5 | 6.7 | 2.0–3.5 | 2.88 | 1.1–2.0 | 1.67 |
| | Am3 | 12 | 70–150 | 102.9 | 7.8 | 2.0–3.3 | 2.73 | 1.1–2.0 | 1.57 |
| | Am3–17 | 84 | 70–150 | 104.7 | 2.6 | 1.7–4.0 | 2.63 | 1.0–2.0 | 1.53 |

Note: ($N_p$) number of tests measured; ($P$) internal transverse diameter of the protoconch; ($D_p$) test diameter; ($T_p$) test thickness; (range) range of variation; (mean) average value; (s.e.) standard error

nian; *P. heracleae* (Arni) was regarded as a junior synonym of *P. vidali*.

Neumann (1985) developed an essentially different concept of the position and composition of this genus. She assigned both pseudosiderolites and praesiderolites to the genus *Siderolites*; however, among Campanian forms, in addition to *Siderolites vidali*, the species *S. praevidali* Andr. et Neum. was recognized (Andreieff and Neumann, 1983). This species included *Siderolites* with a small nucleoconch (48–70 μm) and small test (1–1.8 mm), narrow thick flange, and a few whorls and septa, which occurred from the Lower Campanian to the Upper Campanian. After the establishment of the genus *Praesiderolites*, it became evident that Campanian species of this genus are synonyms of *S. praevidali* Andr. et Neum. The wall structure of *S. praevidali* has not been described in detail; however, a thorough description of the flange shows that transition from *S. praevidali* to *S. vidali* was accompanied not only by an increase in width of this structure but also by the appearance of the lateral radial canals, which are a generic character of *Praesiderolites*. Because of not only quantitative but also qualitative differences between *S. vidali* and *S. praevidali*, I assign the second species to the genus *Praesiderolites*.

In the Maastrichtian of the Tadjik Depression, Aschurov (1983; 1987) established three *Pseudosiderolites* species, *P. darwasensis* Asch., *P. djalilovi* Asch., and *P. akjarensis* Asch. Judging from the figures, it is possible to refer the first and second species, the tests of which are about 2 mm in diameter, to *Pseudosiderolites* or *Praesiderolites*. Since important generic characters, such as lateral radial canals and lateral chambers are absent from the descriptions of these species, it is difficult to determine their taxonomic position more precisely. Subsequently, Aschurov (1990) transferred these species to a new genus, *Nemkovites* Aschurov, and included *Pseudosiderolites* (*P. muschketovi* Zernetsky) and *Siderolites* (*S. nummulitispira* (Osimo)) in this

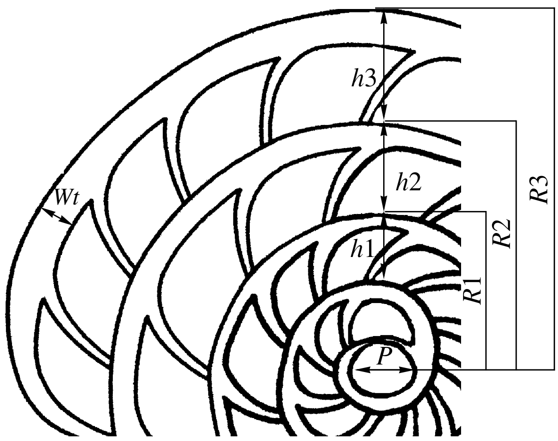



**Fig. 4.** Measurements in the test of *Pseudosiderolites* (generation A). Designations: ($P$) internal transverse diameter of the protoconch, ($h1$, $h2$, $h3$) height of whorls, ($R1$, $R2$, $R3$) external radii of whorls, and ($Wt$) wall thickness.

**Table 2.** Statistical analysis of the structural parameters of the test of *Pseudosiderolites vidali muschketovi* Zernetsky

| Species, genus | Sample no. | $N_p$ | $\bar{N}_c$ | | | $R_2$, mm | | $R_3$, mm | $\bar{T}_c$, mm | $\bar{A}2$, $\bar{A}3$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | range | mean | | | |
| *Pseudosiderolites vidali muschketovi* Zernetsky, Rostov Region, borehole 200 | 200/468 | 8 | 9.8 | 20.7 | | 1.0–1.2 | 1.06 | | 0.25 | 1.52 |
| | 200/475 | 9 | 10.8 | 20.8 | | 0.85–1.25 | 0.97 | | 0.21 | 1.75 |
| | 200/481 | 8 | 10.5 | 20.3 | | 0.9–1.3 | 1.09 | | 0.27 | 1.19 |
| | 1101/7 | 3 | 8.6 | 16.3 | | 0.75–0.8 | 0.77 | | 0.18 | 1.54 |
| | 200/468–481, 1101/7 | 26 | 9.9 | 19.5 | | 0.75–1.3 | 0.97 | | 0.23 | 1.50 |
| *Pseudosiderolites vidali muschketovi* Zernetsky, vicinity of Amvrosievka | Am17 | 10 | 10.1 | 18.0 | | 1.1–1.5 | 1.26 | | 0.40 | 1.78 |
| | Am17 | 1 | | | 30.0 | | | 1.75 | | 1.5, 1.6 |
| | Am16 | 10 | 9.5 | 17.7 | | 1.0–1.5 | 1.30 | | 0.39 | 1.41 |
| | Am15 | 7 | 10.1 | 18.5 | | 1.2–1.6 | 1.40 | | 0.41 | 1.50 |
| | Am15 | 1 | | | 25.0 | | | 2.1 | | 1.2, 1.2 |
| | Am14 | 8 | 10.2 | 17.0 | | 0.8–1.7 | 1.28 | | 0.33 | 1.62 |
| | Am14 | 1 | | | 22.0 | | | 2.0 | | 2.5, 1.3 |
| | Am13 | 10 | 10.7 | 18.5 | | 1.0–1.6 | 1.30 | | 0.38 | 1.19 |
| | Am13 | 1 | | | 24.0 | | | 1.8 | | 1.5, 1.7 |
| | Am12 | 6 | 10.6 | 17.6 | | 1.1–1.2 | 1.18 | | 0.30 | 1.13 |
| | Am11 | 8 | 8.6 | 16.7 | | 0.9–1.25 | 1.04 | | 0.26 | 1.15 |
| | Am11 | 1 | | | 24.0 | | | 1.5 | | 1.2, 0.9 |
| | Am5 | 13 | 10.8 | 19.3 | | 1.0–1.6 | 1.43 | | 0.41 | 1.37 |
| | Am3 | 12 | 10.0 | 17.9 | | 0.8–1.35 | 1.12 | | 0.42 | 1.64 |
| | Am3 | 3 | | | 27.3 | | | 1.65 | | 1.5, 1.4 |
| | Am3–17 | 84 | 10.0 | 17.9 | 25.4 | 0.8–1.7 | 1.26 | 1.8 | 0.37 | 1.42, 1.35 |

Note: ($N_p$) number of tests measured; ($\bar{N}_c$) average number of septa per whorl; ($R_2$) radius of the second whorl; ($R_3$) radius of the third whorl; ($\bar{T}_c$) average thickness of the wall in the equatorial section in the second whorl; ($\bar{A}2$ and $\bar{A}3$) average whorl expansion rate in the second and third whorls.

**Table 3.** Statistical analysis of the structural parameters of the test of *Pseudosiderolites vidali* (Douv.) and closely related species and genera based on published data

| Species, genus | Reference | $N_p$ | $P$, µm | | | $D_p$, mm | | $T_p$, mm |
|---|---|---|---|---|---|---|---|---|
| | | | range | mean | s.e. | range | mean | range mean |
| *P. vidali* (Douv.), topotype | Wannier, 1980 | 1 | | 100.0 | | | 3.7 | 1.7 |
| *P. vidali* (Douv.), Catalonia | Wannier, 1983 | 43 | 80–150 | 106.0 | 2.2 | ?–6.0 | | |
| *P. vidali* (Douv.), Switzerland | Wannier, 1983 | 27 | 64–122 | 90.3 | 1.3 | | | |
| *P. vidali* (Douv.), Austria | Gorsel, 1974 | 10 | | 99.4 | | | | |
| *P. heracleae* (Arni), Turkey | Arni, 1932 | 4 | 75–120 | 102.2 | 9.6 | | | |
| | | 13 | | | | 2.4–3.95 | 2.95 | 1.1–1.2 |
| *P. mushketovi* Zernetsky, holotype (?) | Zernetsky, 1961 | 1 | | 157.0 | | | 2.7 | |
| | | ? | | | | 1.4–3.9 | | ?–1.8 |
| *Praesiderolites* Wannier, Catalonia | Wannier, 1983 | 36 | 40–70 | 50.0 | 1.2 | 0.95–1.67 | | 0.48–0.84 |
| *S. praevidali* Andr. et Neum., southern France | Andreieff and Neumann, 1983 | ? | 48–70 | | | 1.0–1.8 | | 0.52–0.72 |

Note: ($N_p$) number of tests measured; ($P$) internal transverse diameter of the protoconch; ($D_p$) test diameter; ($T_p$) test thickness; (range) range of variation; (mean) average value; (s.e.) standard error.

**Table 4.** Statistical analysis of the structural parameters of the test of *Pseudosiderolites vidali* (Douv.) and closely related species and genera based on published data

| Species, genus | Reference | $N_p$ | $\bar{N}_c$ | | | $R_2$, mm mean | $R_3$, mm | $\bar{T}_c$, mm |
|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | | | |
| *P. vidali* (Douv), topotype | Wannier, 1980 | 1 | 8.0 | 18.0 | 25.0 | 1.15 | 1.94 | 0.44 |
| *P. vidali* (Douv.), Catalonia | Wannier, 1983 | 43 | 10.3 | 16.6 | 25.4 | 1.34 | | |
| *P. vidali* (Douv.), Austria | Gorsel, 1974 | 10 | 8.6 | 15.0 | 18.0 | | | |
| *P. heracleae* (Arni), Turkey | Arni, 1932 | 13 | 8.1 | 16.0 | 27.8 | | | |
| *P. mushketovi* Zernetsky, holotype (?), topotypes | Zernetsky, 1961 | ? | 10.0 | 14.0 | 30.0 | | | |
| *Praesiderolites* Wannier, Catalonia | Wannier, 1983 | 36 | 7.5 | 13.0 | 19.7 | 0.66 | | 0.1 |
| *S. praevidali* Andr. et Neum., southern France | Andreieff and Neumann, 1983 | | | 10.0 –14.0 | | | | 0.1 |

Note: ($N_p$) number of tests measured; ($\bar{N}_c$) average number of septa per whorl; ($R_2$) radius of the second whorl; ($R_3$) radius of the third whorl; ($\bar{T}_c$) average thickness of the wall in the equatorial section in the second whorl.

genus. The test of *Pseudosiderolites akjarensis* Asch. is very small (0.2 mm) and, hence, it probably belongs to the genus *Pararotalia*.

Zernetsky (1961) described a new species, *Pseudosiderolites muschketovi* from the Donetsk and Lugansk regions. In his opinion, this species differs from *P. vidali* in the more compressed spiral, lower chambers, and more convex tests and from *P. heracleae*, in the larger nucleoconch, wide chambers, and large tubercles.

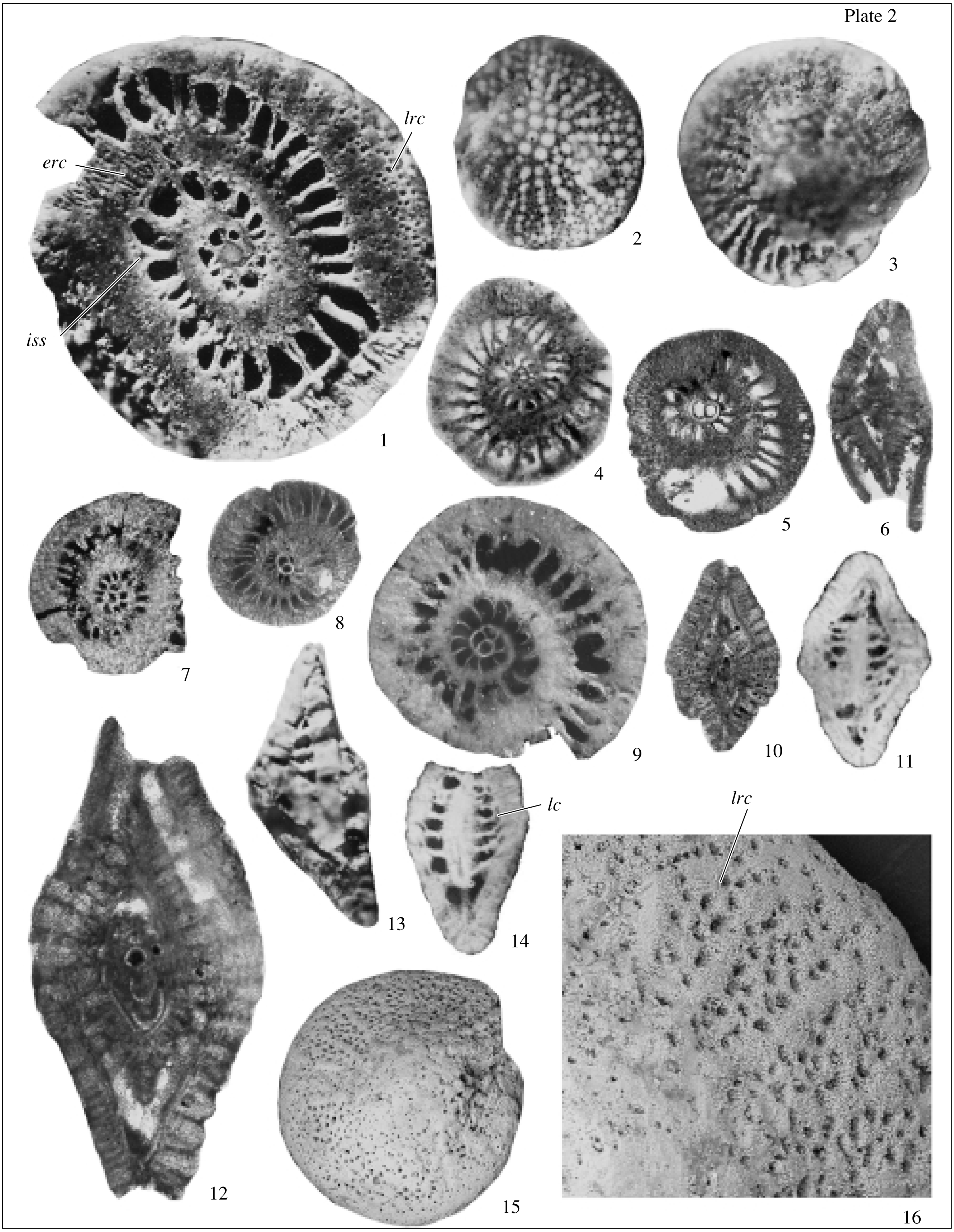
Based on statistical analysis (Tables 1–4), test characteristics of *Pseudosiderolites* that were taken by different researchers for species criteria are considered below. The test measurements are shown in Fig. 4. The specimens studied come from borehole 200, the sample numbers are 200/468, 475, and 481, corresponding to the depths of samples; nos. Am 3, 5, 11, 12, 13, 14, 15, 16, and 17 designate samples from layers 3–14 of the quarry of the town of Amvrosievka (sample numbers increase from below upwards).

**Test size and shape.** The largest *P. vidali* are found in Austria and Spain; medium-sized forms are characteristic of northern Aquitania, Turkey, and Ukraine; and the smallest come from the Rostov Region. The test size depends directly on the number of whorls and, since it is not correlated with the shape of the spiral or the nucleoconch size, it should not be taken for a species criterion. Two major morphotypes (convex and flattened tests) are recognized; they usually co-occur in different regions at one stratigraphic level. Neumann (1985) recognized three morphotypes within flattened lenticular tests: (1) bilaterally symmetrical, with a well-pronounced flange and undulating margin; (2) asymmetrical, with an even margin; and (3) symmetrical, with an even margin; the convex (biconical) forms are represented by one morphotype, with a symmetrical test. In the upper part of the Campanian, she recognized only two morphotypes, biconical test and lenticular test, with an undulating margin. The forms from the upper part of the Campanian of the Ukrainian Donets Basin display all the morphotypes listed. They are similar in the shape of the spiral and the nucleoconch size.

**Test sculpture.** Sculptural elements of the test are the flange and tubercles. The presence of a well-pronounced flange on the test margin is probably connected with a tendency towards the formation of denticles or spines and has a certain taxonomic value. In particular, a flange with denticles is characteristic of the majority of *Praesiderolites*. At the same time, despite the presence of the flange, denticles and spines are less frequent in *P. vidali* of Western Europe. In the forms from the Ukrainian part of the Donets Basin, the flange is wide (Pl. 3, fig. 4), and denticles (Pl. 3, fig. 7) infrequently occur in large tests; in all tests from the Rostov Region, the flange is not developed, and the test margin is rounded, without denticles. The arrangement of tubercles depends on the shape of the septal sutures and the presence of the flange, where they are usually absent, and varies even within one population. Small forms usually have smaller tubercles.

**Nucleoconch size.** The internal diameter of embryonic chambers (protoconch and deuteroconch) of *Pseudosiderolites* ranges from 70 to 150 μm and is independent of their stratigraphic or geographical position (Tables 1, 3) and of the test shape. The protoconch size weakly correlates, if at all, with the test size. The greatest average size of the protoconch is characteristic of tests from Catalonia and Ukraine, while the smallest average size is recorded in Switzerland.

**The spiral shape** is characterized quantitatively by the whorl expansion rate (the height ratio of each subsequent whorl to the first) or the radius of whorls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(Tables 2, 4) and was taken by Zernetsky for a species criterion. Note that the spiral shape is a stable species character in many spiral–plane forms (for example, in nummulitids), which is frequently connected with the test shape. *Pseudosiderolites* under study do not show this dependence, the spiral shape is sometimes identical in different morphotypes and varies in the same morphotype (Table 2). The spiral shape of the first two whorls is similar in *P. vidali* from Catalonia (whorl expansion rate is 1.4–2.5) and *Pseudosiderolites* from the Donets Basin (whorl expansion rate is 0.9–2.9) and differs slightly in the third. In the third whorl of forms from Amvrosievka, the expansion rate decreases or remains constant (Table 2); this is connected with the fact that this is the last whorl with a thinner wall. In large *P. vidali* from Catalonia with four whorls, the expansion rate in the third whorl slightly increases to 1.1–1.4. Small forms at different levels show both dense and loose spirals (Table 2, samples Am11 and 1101/7).

**The shape of chambers** was regarded by Zernetsky (1961) as a species character. He indicated that, in *P. muschketovi*, the chambers are lower than in *P. vidali* and wider than in *P. heracleae.* The absolute height of chambers varies within one whorl; however, the average value remains the same in these species. As the whorl expansion rate is almost the same, the shape of chambers ranges from isometric to high rectangular, depending on the wall thickness and the density of septa.

In *Pseudosiderolites*, as in other taxa with spiral–plane coiling, species could have been established primarily based on the directional (in time or space) changes in the size of nucleoconch and whorl expansion rate and in the shape of the chambers and test margin in the case that they were correlated. However, representatives of this genus show neither correlation between these characters nor regular changes. The ranges of variation of the nucleoconch size and whorl expansion rate in *P. vidali* from the Mediterranean and *Pseudosiderolites* from the Donets Basin are identical (Tables 1–4). The high similarity of quantitative parameters of the internal test structure of *Pseudosiderolites* from the Mediterranean and Donets Basin suggests that the last should be assigned to the species *P. vidali.* The population of this species from the Donets Basin includes two major morphotypes, (a) large flattened, with a well-pronounced flange, sometimes with denticles, undulating or even margin, thick wall, and relatively wide chambers; and (b) regularly convex, large or small, without flange, with a rounded margin, relatively narrow chambers, and thinner spiral wall. The first morphotype is only recorded in the Ukrainian part of the Donets Basin and represents typical *P. vidali.* The second morphotype prevails in assemblages of the Ukrainian Donets Basin. Since Zernetsky (1961) described large representatives of this morphotype as *P. muschketovi*, they are established here as the subspecies *P. vidali muschketovi* Zernetsky. Small forms of this morphotype are characterized by the thinnest wall and narrow chambers; they are infrequent in assemblages of the Ukrainian Donets Basin, while, in the Rostov Region, this is the only morphotype of *Pseudosiderolites*. It is possible that these forms belong to the other subspecies; however, this statement requires additional material from other districts of the Rostov Region.

The nominal subspecies *P. vidali vidali* and *P. vidali muschketovi* Zernetsky are described below. The material is housed in Vernadsky State Geological Museum of the Russian Academy of Sciences, Moscow (GGM), collection no. BP94.

## SYSTEMATIC PALEONTOLOGY

### Family Calcarinidae Schwager, 1876

### Subfamily Siderolitinae Sigal, 1952

### Genus *Pseudosiderolites* Smout, 1955

#### *Pseudosiderolites vidali vidali* (Douville, 1906)

Plate 2, figs. 4 and 7

*Siderolites vidali*: Douville, 1906, pp. 598, 599, pl. XVIII, fig. 9.

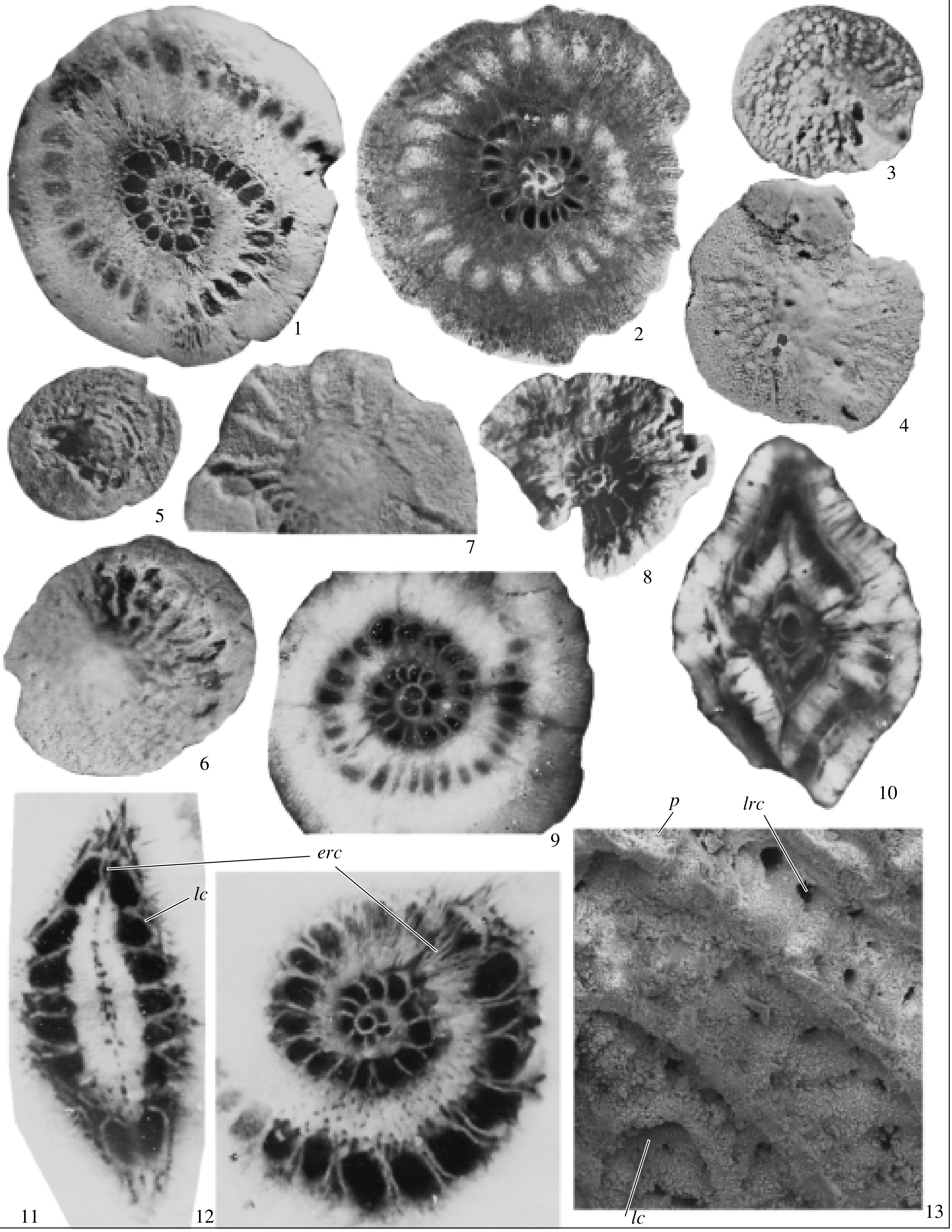
*Pseudosiderolites vidali*: de Castro, 1990, pp. 83, 84, pls. 26–29 (synonyms).

D e s c r i p t i o n. The tests are medium-sized or large, lenticular flattened or convex at the center, bilaterally symmetrical or asymmetrical, covered with large tubercles, with undulating or even margin, and usually with a wide flange. The test consists of 2.5–4 whorls of the spiral, 25–70 chambers. The chambers are rectangular, isometric or high; the protoconch is rounded, the deuteroconch is nodular. The microspherical generation differs from the megaspherical generation in the smaller nucleoconch, larger number (4–4.5) of whorls, and in the higher whorl expansion rate.

E x p l a n a t i o n o f P l a t e 2

**Figs. 1–16.** *Pseudosiderolites vidali muschketovi* Zernetsky, generation A; specimens figured come from the following localities: (1–8, 10–16) of the Tuzlov River Basin, borehole 200: (1–4, 11, 15, 16) borehole 200, depth of 468 m, sample 200/468: (1) specimen BP-9450, subequatorial section, ×40; (2) specimen BP-9451, surface (Canada balsam), ×20; (3) specimen BP-9452, surface, ×20; (4) specimen BP-9453, equatorial section (fine section), ×20; (11) specimen BP-9459, tangential section (fine section), ×25; (15, 16) specimen BP-9463, surface (SEM): (15) ×30 and (16) ×100; (5–8, 12) borehole 200, depth of 475 m, sample 200/475: (5, 7, 8) equatorial sections (fine sections), ×20, specimens: (5) BP-9454a, (7) BP-9456, (8) BP-9454b; (6) specimen BP-9455, tangential section (fine section), ×20; (12) specimen BP-9460, axial section (fine section), ×40; (10, 13, 14) borehole 200, depth of 481 m, sample 200/481: (10) specimen BP-9458, axial section (fine section), ×20; (13) specimen BP-9461, split close to the axial section, ×20; (14) specimen BP-9462, tangential section (fine section), ×25; and (9) vicinity of Matveev Mound, Mius River Basin, sample 1101/7, specimen BP-9457, equatorial section, in reflected light (fine section), ×30. Designations: (*erc*) equatorial radial canals, (*iss*) intraseptal space, (*lc*) lateral chambers, and (*lrc*) lateral radial canals.

Plate 3



M e a s u r e m e n t s. Test diameter, 2.5–6 mm; test thickness, 1.0–2.0 mm. Internal diameter of protoconch, 70–150 μm; internal diameter of deuteroconch of megaspherical and microspherical generations, 70–170 and 20–30 μm, respectively.

C o m p a r i s o n. See in the description of the subspecies *P. vidali muschketovi.*

O c c u r r e n c e. Upper part of the Lower Campanian–lower part of the Lower Maastrichtian of the following regions: Spain, Southern and Central France, Switzerland, Austria, Portugal, Italy, Slovenia, Greece, western Carpathians, Turkey, Iran, Iraq, Tunis, Egypt, and Ukraine.

**Subspecies *Pseudosiderolites vidali muschketovi* Zernetsky, 1961**

Plate 2, figs. 1–16; Plate 3, figs. 1–3, 5, 6, 8–13

*Pseudosiderolites muschketovi*: Zernetsky, 1961, p. 1365, pl. 1, figs. 1–4.

*Nemkovites muschketovi*: Aschurov, 1990, p. 213.

H o l o t y p e. IGN (Institute of Geological Sciences, National Academy of Sciences of Ukraine), no. 13/21; Donetsk Region, quarry of State Farm no. 5; Upper Campanian.

D e s c r i p t i o n. The microspherical generation has not been recorded. Megaspherical generation (A). *External structure.* The tests are medium-sized or small, bilaterally symmetrical or asymmetrical, lenticular, from strongly to poorly convex, sometimes, with a well-pronounced central inflation. The margin is rounded in the majority of tests, frequently undulating. Approximately 40% of tests are asymmetrical to a greater or lesser extent (Pl. 2, fig. 13). The projections of tubercles on the surface are in the shape of hemispheres or cylinders, sometimes with openings of canals at the center of tubercles. The test margin lacks a distinct flange in the sculpture and has foramina of the equatorial radial canals (Pl. 2, figs. 2, 3, 15, 16). The lateral radial canals open on the external and internal surfaces of the test (Pl. 2, figs. 1–3, 15, 16; Pl. 3, fig. 13).

*Internal structure.* The spiral is relatively loose, consists of 2–3.5 whorls; the chambers are usually high, quadrangular, sometimes isometric in the first whorl. The protoconch and deuteroconch are almost equal in size. The lateral and equatorial radial canals are large. The lateral chambers are low, better developed in large forms (Pl. 2, fig 14; Pl. 3, fig. 11).

M e a s u r e m e n t s. Test diameter, 1.35–4.0 mm; test thickness, 0.7–2.0 mm. Average ratio of diameter to thickness, 1.8. Diameter of tubercles, 100–150 μm at the center of test and 30–50 μm at margin. Internal diameter of the protoconch and deuteroconch, 70–150 μm. Two whorls of the spiral correspond to the radius of 0.75–1.7 mm; three whorls correspond to the radius of 1.5–2.1 mm. Number of septa in the first, second, and third whorl, 7–11, 15–22, and 22–30, respectively. Wall thickness in the equatorial plane, 0.15–0.35 mm in Rostov tests and 0.25–0.45 mm in Donetsk tests. Pore diameter, 2.5–4 μm; diameter of lateral and equatorial radial canals, 15–25 μm.

V a r i a b i l i t y. *Pseudosiderolites* from the Rostov Region slightly varies in test shape. The tests from the Donetsk and Lugansk regions vary considerably in shape and size. *P. vidali muschketovi* from the Rostov Region differ from specimens from the Donetsk and Lugansk regions in the smaller test, fewer number of whorls in the spiral, thinner wall, narrow chambers, on the average smaller nucleoconch, and more loosely arranged spiral.

C o m p a r i s o n. *P. vidali muschketovi* differs from *P. vidali vidali* in the absence or weak development of narrow flange, the more rounded margin of the test, in general narrower main chambers, and the less developed lateral chambers.

R e m a r k s. *P. vidali muschketovi* from the Donetsk and Lugansk regions is more similar to *P. vidali vidali* than to specimens from the Rostov Region. *Pseudosiderolites* of the Ukraine is most similar to *Pseudosiderolites* from Turkey and differs only in the test sculpture (the absence of wide flange). Apparently, the differences between subspecies of *P. vidali* follow from different natural conditions, since they do not show distinct patterns in time and space. In particular, all *P. vidali* of the Donets Basin are in the peripheral part of the range of this species; however, tests from the northern Donets Basin are much larger than tests from the Rostov Region. The smallest tests, with a rounded

E x p l a n a t i o n o f P l a t e 3

**Figs. 1–3, 5, 6, 8–13.** *Pseudosiderolites vidali muschketovi* Zernetsky, generation A; specimens figured come from the following localities: (1–3, 5, 6, 9, 11, 12) quarry of State Farm no. 5 (Amvrosievskii District): (1) specimen BP-9464 (sample Am5), subequatorial section, ×20; (2) specimen BP-9465 (sample Am3), equatorial section, ×20; (3) specimen BP-9466 (sample Am3), surface, ×20 (internal wall of the last whorl partially exposed); (5, 6) specimen BP-9468 (sample Am14): (5) surface of the flat side, ×10; (6) convex side of the test, ×15; (9) specimen BP-9474 (sample Am5), subequatorial section from the convex side of the test, ×20; (11) specimen BP-9472 (sample Am14), tangential section (fine section), ×40; (12) specimen BP-9471 (sample Am13), equatorial section, ×40 (equatorial radial canals and intraseptal cavity are seen); (8, 10) Khrestovaya gully (Belaya River Basin), sample 080: (8) specimen BP-9469, split in the equatorial plane, ×20 (trochoid coiling is seen); (10) specimen BP-9473, split of the test at the axial section (Canada balsam), ×30 (lateral chambers are exposed); and (13) Tuzlov River Basin, borehole 200, depth of 481 m, sample 200/481, specimen BP-9470, internal surface of the test (split), ×200 (lateral radial canals, pores, and lateral chamber are seen).

**Figs. 4 and 7.** *Pseudosiderolites vidali vidali* (Douville), generation A; Khrestovaya gully (Belaya River Basin), sample 080: (4) specimen BP-9467a, surface, ×15 (flange of the test is distinct); (7) specimen BP-9467b, surface, ×20 (well-developed denticles are seen at the margin of the test). Designations: (*erc*) equatorial radial canals, (*lc*) lateral chambers, (*lrc*) lateral radial canals, and (*p*) pore.

margin and poorly developed lateral chambers from the Rostov Region are similar to more primitive (ancient), relatively large forms from Spain, Austria, and Aquitania, although they show a higher stratigraphic position.

O c c u r r e n c e. Upper Cretaceous, Upper Campanian–Maastrichtian; Donetsk and Lugansk regions (vicinity of Lugansk, basins of the Belaya, Luganchik, and Ol'khovaya rivers; vicinity of the town of Amvrosievka, Krynka River Basin), Rostov Region (Tuzlov River Basin, vicinity of the Bol'shekrepinskaya station, Mius River Basin, vicinity of Matveev Mound).

M a t e r i a l. About 70 tests from the Rostov Region and more than 1000 tests from the Donetsk and Lugansk regions.

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