LOWER BASHKIRIAN FUSULINOIDEANS FROM THE UPPER PART OF THE TAGNANA FORMATION (CARBONIFEROUS, NW ALGERIA)

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ABSTRACT

The upper member of the Tagnana Formation of the Djebel Béchar Group (informally the Tagnana-3 or Tagnana III member) yielded fusulinoideans and other related foraminifers of the genera *Pseudoendothyra* (rare), *Pseudostaaffella* (*Semistaaffella*) (rare), *Millerella*, *Pseudonovella*, *Plectostaaffella*, *Eostaaffella* and *Mediocris*. The presence of *Eostaaffella* (rare) and *Endostaaffella* is doubtful. The difference between *Millerella* and *Eostaaffella* cannot be adequately defined by evolute versus involute coiling. *Pseudonovella* Kireeva, 1949 is redefined to include *Seminovella* Rauzer-Chernousova, 1951.

The foraminifers are from two samples, one from close to the top and the other from near the base of the Tagnana III Member. Conodonts from the same samples, in comparison with the fusulinoidean foraminifera indicate similar or slightly younger ages; combined evidence from conodonts and foraminifera shows that the Tagnana-III Member at its upper boundary is Askynbashky or Akavassky (probably late Akavassky), while its lower boundary is Akavassky or Siuransky (probably late Siuransky) in age.

Keywords: Fusulinoideans, taxonomy, biostratigraphy, Carboniferous, Lower Bashkiran, Tagnana Formation, Algeria.

RESUMEN


Los foraminíferos hallados proceden de dos muestras, una de ellas cercana a la base y la otra próxima al techo del Miembro Tagnana-III. Los conodontes procedentes de las mismas muestras señalan edades similares o ligeramente más jóvenes que las proporcionadas por los fusulinoideos. Combinando datos de ambos grupos se obtiene que el techo del Miembro Tagnana-III es Askynbashky o Akavassky (probablemente Akavassky superior), mientras que la base de dicha unidad es Akavassky o Siuransky (probablemente Siuransky superior).

Palabras clave: Fusulinoideos, taxonomía, bioestratigrafía, Carbonífero, Bashkiriense Inferior, Formación Tagnana, Argelia.
INTRODUCTION

The present paper describes early Bashkirian, mainly fusulinoidean foraminifera from the upper part of the Tagnana Formation near Béchar (NW Algeria) (Fig. 1), and is one of a number of reports that started with the description of an early Moscovian fusulinoidean fauna from the Kenadza Formation, followed by similar studies of the earliest Moscovian and late Bashkirian Oued el Hamar Formation and the late and early Bashkirian Hassi Kerma Formation (van Ginkel, 1986a, 1986b, 1989, 1992).

The upper part of the Tagnana Formation is also informally known as the Tagnana-III Member. The investigated sequence (about 65 m thick) consists mainly of shales, alternating with up to 7 m thick and sometimes oolitic limestone beds, and is underlain by the Tagnana-II Member. The Tagnana-II Member is a prominent limestone cliff (about 50 m thick). The Tagnana-I Member (approximately 150 m thick) at the base of the formation resembles the Tagnana-III Member, but is reported to be more arenaceous. This lower member contains the Mid-Carboniferous boundary [= first appearance of Declinognathodus noduliferus near the top of unit E of Lemosquet (Weyant, 1982)] (Fig. 2).

The Tagnana Formation underlies the Hassi Kerma Formation and the latter is overlain by the Oued el Hamar Formation. The Tagnana, Hassi Kerma, and Oued el Hamar formations together form the Djebel Béchar Group (Pareyn, 1961). A detailed description of the sequence comprising these three formations was presented by Legrand-Blain (1967).

The sequence between the Mid-Carboniferous boundary and the base of the Djéniène Limestone (=Niveau D) at the top of the Oued el Hamar Formation appears to be a complete (Bogdanovsky-Asatausky) succession of Bashkirian rocks. However, more detailed studies have shown that sedimentation during this interval was not continuous (Lemosquet and Pareyn, 1975).

For a general description of the Carboniferous succession in NW Algeria, including the Béchar area, the studies of Pareyn (1961) and Lemosquet and Pareyn (1985) may be consulted.

LOCATION OF SAMPLES

The sampled sequence is exposed in a section east-southeast of Béchar, north of Mouizeb el Atehaa, close to section A (Fig. 1; Legrand-Blain, 1967, fig. 1).

The present account considers foraminifera (mainly fusulinoideans) and conodonts from two sampling stations.
DISCUSSION OF THE STRATIGRAPHIC POSITION OF SAMPLES 13 AND SA 11

Initially, we considered the alternation of shale and, often oolitic, limestone of about 65 m thickness underlain by the Tagnana-II Member to represent the Tagnana-III Member (Fig. 3, Appendix). At present this seems somewhat dubious. The uncertainty arose when age estimates based on forams and conodonts of the present section appeared to differ from those based on ammonoids found in a typical section of the Tagnana-III Member (e.g. section B of Legrand-Blain, 1967, fig. 1, p. 302). The analysis of the ammonoid distribution of the Tagnana-III Member by Manger et al. (1985) who report Cancelloceras only from the upper part of Tagnana III, combined with Popov’s ammonoid records of the Donets Basin showing the appearance of Cancelloceras cancellatum (together with other species of this genus) from the E8 Limestone (Popov, 1979, fig. 1, p. 27), leads to the conclusion that the stratigraphic level of the Tagnana-III Member corresponds to the middle or lower part of the C1-5 (E) suite (not above the E7 Limestone), comparable to the Siuransky (Ural Mountains), the Seslavinsky (Central Asia), or the Krasnopolysky (Moscow Basin). A similar conclusion follows from the correlation of Carboniferous stratigraphic units of the Donets Basin and North Africa (Aisenverg et al., 1979, fig. 1.; Semichatova et al., 1979, fig. 2). Preliminary results of foraminiferal studies from several sections from the Béchar and Abadla Basins by Sebbar (1997) show, in her figure 3, a correlation of the upper part of the Tagnana Formation with strata below the Pseudosaffellia antiqua Zone of the former USSR, below Zone 21 of Mamet, and below Zone C9 of Conil. Sebbar’s correlations agree with the aforementioned correlations. However, the foraminifera and conodonts of the present paper point to a correlation with the Upper E (E8-E9) or F1 limestones of the Donets Basin. Probably, only the basal strata of the Tagnana III Member can be correlated with the E7 limestone or the upper part of the Siuransky (Fig. 4).

If we stick to our initial opinion, that in the present section the succession (35-65 m) overlying the Tagnana-

II Member represents the Tagnana-III member, this would imply that ammonoids indicate a slightly older age for the Tagnana-III member than foraminifera and conodonts. An alternative interpretation is that in the present section this basal sequence does not belong to the Tagnana-III Member, but to the lowermost part of the Hassi Kerma Formation. The hiatus at the base of the present sequence (Fig. 3) might then involve most or all of the Tagnana-III Member. On the other hand, the lithological succession of the Tagnana-III Member of the nearby section A (Fig. 1b; Legrand-Blain, 1967, fig. 1) compares rather closely with the present sequence.

DIFFICULTIES REGARDING IDENTIFICATION

Mainly during the second half of the last century, hundreds of new, notably Eurasian, eostaffellids and primitive ozawainellids were described; see Maslo and Vachard (1997) for complete lists of species. Discrimination between species was based on very small
differences which do not allow for much variation within a species. However, the written descriptions of new species suggested considerable variability and overlap with other species. Lamentably, the impression of conspicuous variability was generally not confirmed by a sufficient number of illustrations of specimens accompanying the descriptions; in quite a number of cases not more than three specimens were shown. Generally all specimens were axial sections with little attention paid to sagittal sections. The lack of knowledge on the degree of variability of a species in a sample and consequently the number of species it contains, may generally have impeded proper identifications. More illustrations of paratypes of a new species might have facilitated subsequent identifications, and could have improved the understanding of relationships with other species.

These difficulties also complicated the present studies on the Algerian eostaffellids (in particular with regard to the genera Eostaffella and Millerella), which seldom resulted in unambiguous identifications; uncertainties remained at species and genus level. Actually, some of the groups of specimens considered distinct from each other may be conspecific. A more profound analysis using more material could have shown the coalescing of groups which at the present stage appear to be still separated. Investigations into this latter problem ended prematurely when the sampling material had been exhausted. The foraminiferal identifications from the two samples SA 13 and SA 11 are based on 157 slides of fairly rich limestone and are listed on p. 42 and p. 43 respectively.

As mentioned above, the distinction between the genera Millerella Thompson, 1942 and Eostaffella Rauzer-Chernousova, 1948b was another problem.

According to descriptions of the type species Millerella marblensis Thompson and Eostaffella parastruveli (Rauzer-Chernousova), the features by which these species can be distinguished are:

Millerella marblensis

(a) Coiling is evolute in the outer (two) whorl(s); specimens may become uncoiled in the adult stage.
(b) Chomata are discontinuous (after Moore, 1964).
(c) Spirotheca consists of three layers: upper tectorium, tectum, and a clear layer below the tectum.
(d) A tunnel, typical for fusulinids, is present (after Moore, 1964).

Eostaffella parastruveli

(a) Coiling is usually accepted as being involute.
(b) Secondary deposits are in the form of pseudochomata (Rauzer-Chernousova, 1948b); this suggests a weaker development of these deposits, by comparison with Millerella marblensis.
(c) Wall dark, finely granular, undifferentiated or composed of a thin tectum and inner and outer tectoria (Rauzer-Chernousova, 1948b).
(d) A [primary] aperture is present (Armstrong and Mamet, 1977). The assignment by Armstrong and Mamet of the genera Millerella and Eostaffella to different families (Ozawainellidae and Eostaffellidae, respectively) was probably based on this difference.

However, none of the differences “a” to “c” suffice to distinguish between Eostaffella and Millerella or lead to the establishment of a natural classification:

(a) Coiling
The slightly oblique section of the type specimen of Eostaffella parastruveli does not permit to conclude that
the final whorl is involute. However, even if fully involute coiling could be confirmed, Eurasian Lower Carboniferous (partially) evolve species should preferably be assigned to *Eostaffella*, because they are probably not closely related to typical *Millerella*.

(b) Chomata

The species groups of *Eostaffella ikensis* Vissarionova, 1948, and *Eostaffella mirifica* Brazhnikova in Brazhnikova et al., 1967, are considered typical *Eostaffella*. However, species of these groups show usually ribbon-like chomata (low and relatively wide), that are different from the pseudochomata of the type species of *Eostaffella*.

(c) Wall structure

A three-layered wall comparable to that of the type species of *Millerella* has usually been recorded as well for species which on the basis of their involute coiling were assigned to *Eostaffella*. Moreover, “the holotype of *Eostaffella parastrupei* shows a differentiated wall”... and “preservation (or lack thereof) may prevent recognition of layering in some species” (Dr. P. Brenckle, written communication).

(d) Aperture

A fundamental distinction between *Eostaffella* and *Millerella* on the basis of aperture versus tunnel is perhaps possible. However, it is not yet clear which of the involute species usually assigned to *Eostaffella* have indeed a primary aperture. Bashkirian or Moscovian *Eostaffella* showing well-established chomata resembling *Ozawaionella* have more likely a tunnel.

Figure 4. Upper and lower Tagnana-III beds at sampling localities SA 13 and SA 11 correlated with East European and Central Asian (bio)stratigraphic units. Correlations are based on foraminifera and conodonts. Full-drawn lines represent the most likely correlations, dashed lines the extreme possibilities. Stratigraphic data regarding the lowermost Bashkirian are partly based on Nemyrovska (1999, fig. 36).

Today, a generic diagnosis of *Eostaffella* and *Millerella* (as based on their type species) briefly summing up their characteristics — and (implicitly) their differences — cannot be easily established. Neither of the three characters, a-e, can be applied separately for the definition of the two genera if the resulting classification should correspond to accepted phylogenetic relationships. Nevertheless, these and other characters (i.e. shape of test, septal count/shape, degree of skewness of coiling) could be used in different combinations. Various specific combinations, each defining related groups of species, might together be sufficient to discriminate between the two genera. It may be also useful to consider the introduction of a new genus for most of the species included in *Zellerinella* Mamen, 1971 (see Armstrong and Mamen, 1977). Unfortunately, the genus *Zellerinella* is not generally accepted because of the apparently close similarity between the type species of *Zellerinella* and that of *Endostaffella* (Brenckle and Groves, 1981; Rich, 1986). Another possibility might be to reintroduce *Paramillerella* Thompson, 1951 (see Anisgard and Campau, 1963, and Brenckle and Groves, 1981; the latter paper suggests a relationship between *Endostaffella* and *Paramillerella*).

The present account deals with species of the groups of *Eostaffella pseudostrupei* (Rauzer-Chernousova and Belyaev, 1936), and *Eostaffella chomatifera* Kireeva, 1951. In this and my previous papers on Algerian fusulinoideans, these species were not included in *Eostaffella* because they seem to be only remotely related
to the typical (Upper Viséan-Serpukhovian) species of *Eostaffella*. Provisionally, they are assigned to *Millerella* for reasons of priority. Actually, these species may be closer to the type species *Millerella? advena* Thompson, 1944 of *Paramillerella*. Typical and/or toptotypical material of this species should be restudied. That applies to *Eostaffella parastruves* as well.

**MAIN ASPECTS OF THE DESCRIBED FORAMINIFERA**

The foraminifera from the upper part of the Tagnana Formation are of Lower Bashkirian age, and especially similar to foraminifera from the Donets Basin found in the upper part of the E suite. The forms that prevail near the top of the Tagnana III Member (sample SA 13) are species of the group of *Millerella acutissima* (Kireeva, 1949), whereas towards the base of this member (sample SA 11) the most common forms belong to the group of *Millerella pseudostruves* (Rauzer-Chernoussova and Belyaev, 1936). These forms are found together with species of the group of *Millerella chomatifera* (Kireeva, 1951). (*Millerella* close to the type species *Millerella marblensis* Thompson, 1942, have not been found, neither in the Tagnana Formation nor in the other formations of the Djebel Béchar Limestone Group). Typical species of the genus *Plectostaffella* such as *Plectostaffella jakhenensis* (Reitlinger, 1971) do not occur above the lower part of the Tagnana III Member, whereas species close to *Plectostaffella varvariensis* (Brazhnikova and Potievskia, 1948) are present not only at the base of the Tagnana III Member but are also found in the lower part of the overlying Hassi Kerma Formation. A few forms from samples SA 13 and SA 11 have been assigned to *Pseudonovella* although they resemble not only *Pseudonovella ex gr. carbonica* (Grozdilova and Lebedeva, 1950), but also *Millerella ex gr. pseudostruves* and *Millerella grozdilovae* (Maslo and Vachard, 1997). Typical *Eostaffella*, well-known from Upper Viséan and Serpukhovian strata, are either absent (SA 13) or fairly rare (SA 11). Two specimens from sample SA 11 were compared with *Eostaffellina libera* (Rumyantseva, 1970). A closely similar form occurs in the lower part of the Hassi Kerma Formation. However, both species clearly differ from typical Serpukhovian or Upper Viséan *Eostaffellina* and might not be congeneric with the earlier forms of *Eostaffellina*. Equally dubious is the presence of *Endostaffella* in the Tagnana III Member (SA 11); the specimens could be descendants from typical Viséan and Serpukhovian species, but the possibility that they represent young individuals of *Millerella ex gr. pseudostruves* seems more likely. *Pseudostaffella antiqua* (Duketkich, 1934) was expected to be present, because its occurrence in the Tagnana III Member had been established already by Lys (cf. Lys 1976, 1979, 1985). Yet, the genus *Pseudostaffella* is apparently absent at sample SA 11, whereas locality SA 13 yielded only a single specimen of the primitive form *Pseudostaffella (Semitastaffella) variabilis* Reitlinger, 1961.

**BIOSTRATIGRAPHY**

**CORRELATIONS BY FORAMINIFERA AND CONODONTS FROM SAMPLE SA 13**

**Foraminifera**

Sample SA 13 yielded eight fusulinoidean species: *Pseudostaffella (Semistaffella) cf. variabilis* Reitlinger, 1961, *Pseudonovella* spp., *Millerella* spp. cf. *M. paracarbonica* Manukalova et al., 1969, *Millerella ex gr. acutissima* (Kireeva, 1949), *Millerella ex gr. chomatifera* (Kireeva, 1951), and *Mediocirres breviscula* (Ganelina, 1951). These species have been compared with similar species from the Donets Basin mainly after data of Manukalova et al. (1969) and Vachard and Maslo (1996). Examination of the distribution of Donets Basin fusulinoidean species in a succession of biozones shows that seven Algerian species from SA 13 are close to or conspecific with species that occur in the C2b-a Zone. Higher and lower biozones share progressively fewer species with the SA 13 assemblage. A more precise comparison of the stratigraphic ranges of Donets species close to or conspecific with species of the SA 13 assemblage indicates the upper part of the C2b-a Zone (Table 1, Fig. 4).

The oldest possible stratigraphic level of SA 13, on the basis of the presence of *Pseudostaffella (Semistaffella) variabilis*, is the E5 Limestone (C1n-e Zone) (see Vachard and Maslo, 1996). It is important to note that *Pseudostaffella (Pseudostaffella) antiqua* (Duketkich, 1934) has not been found in sample SA 13. The absence of *Pseudostaffella (Pseudostaffella)* at SA 13 is either fortuitous or points to a zone lower than the C2b-a Zone (lower part). However, this species was reported to be present in this part of the Tagnana Formation by Lys (1976, 1979, 1985). Its presence clearly distinguishes the C2b-a Zone (lower part) from assemblages of lower zones. The upper part of the Tagnana Formation, according to Mamet et al. (1995, fig. 5), corresponds to Mamet’s Zone 21 and Comif’s Zone Cf 9. This agrees with the results of Lys mentioned above.

Considering all fusulinoidean evidence, the equivalent stratigraphic level of sample SA 13 in the Donets Basin is estimated to be not below the E8 Limestone [(C1-5E) suite] and not above the F1 Limestone [C2-1 (F) suite].

**Conodonts**

A preliminary investigation of conodonts by van den Boogard yielded the following species: *Idiognathoides sinatus*, *Idiognathoides corrigatus*, *Idiognathoides macer*, and *Declinognathodus lateralis*. It was concluded that the conodonts from sample SA 13 indicate the *Idiognathoides sinatus* Zone, and that the assemblage may occur in the Krasnopolyansky and the Severokeltmensky of the Moscow Basin (Dr. M. van den Boogard, written communication, early 1990’s).

The *Idiognathoides sinatus* Zone in the Donets Basin
Table 1. Foraminiferal content of sample SA 13 (seven species) compared with a succession of biozones in the Donets Basin. + = the number of species that occur more likely in a zone below the biozone considered. - = the number of species that occurring more likely in a zone above the biozone considered. o = the number of species that do not occur more likely in higher or lower biozones than the biozone considered; this includes, as a special case, an occurrence restricted to the biozone.

<table>
<thead>
<tr>
<th>Biozone</th>
<th>+</th>
<th>-</th>
<th>o</th>
<th>n=7</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2b-b</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C2b-a (upper part)</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C2b-a (lower part)</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Foraminiferal content of sample SA 11 (nineteen species) compared with a succession of biozones in the Donets Basin. Explanation of symbols as in Table 1.

<table>
<thead>
<tr>
<th>Biozone</th>
<th>+</th>
<th>-</th>
<th>o</th>
<th>n=19</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2b-b</td>
<td>17</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>C2b-a (upper part)</td>
<td>14</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>C2b-a (lower part)</td>
<td>9</td>
<td>3</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>C1n-e</td>
<td>2</td>
<td>12</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>


Comparison with the Donets Basin

Mainly after data provided by Manukalova et al. (1969) and Vachard and Maslo (1996).

Of the nineteen species from sample SA 11 that may also occur in the Donets Basin, twelve to seventeen are close (or conspecific) to some species occurring in the biozones C1n-e, C2b-a (lower part), C2b-a (upper part), or C2b-b. This corresponds to the fusulinoides found in the C1-5 (E), C2-1 (F) and C2-1 (G) suites. This high number of shared similar species drops rapidly for higher and lower biozones (i.e., seven in C1n-d Zone and four in C2b-c Zone). A closer examination of the distribution of species from the Donets Basin close to species of the SA 11 assemblage, indicates rather the C1-5 (E) suite [either Zone C1n-e or Zone C2b-a Zone (lower part)] for the SA 11 assemblage (Table 2, Fig. 4).

Zone C2b-a (lower part) typically contains Pseudostaffella (Pseudostaffella) antiqua which belongs to the more evolved part of the assemblage of species from this zone. However, neither this species nor species of Pseudostaffella (Semistaffella) were found in sample SA 11. In view of the absence of these more evolved species, the stratigraphic level indicated by sample SA 11 is estimated to be below the Mandykinskaya group of the Donets Basin [the latter are a group of very persistent limestones comprising the interval E9-F1(1)], which may correspond to a level low in the Severokeltmensky Horizon of the Moscow Basin. Correlation with a high level of the Krasnopolyansky is also possible.

Comparison with the Urals and Central Asia


A comparison of fusulinoids from sample SA 11 with corresponding assemblages from the Urals (southern part, west slope), and Central Asia (Tien-Shan Mountains) shows that out of a total of twenty-three
species from SA 11, a vast majority (seventeen to twenty-one) are conspecific or closely similar to some Asian or Uralian species occurring in the zones of *Pseudostaffella antiqua*, *Semistaffella variabilis*, *Plectostaffella sselavica* and *Plectostaffella bogdanovkensis* (Akavassky-Bogdanovsky). This high number of conspecific or close forms decreases to eleven to thirteen in the overlying *Pseudostaffella praegorskyi* Zone (Askynbusky) and the underlying zones of *Plectostaffella poschovae* and *Eosignoimla explicata* (Ustesrabskaya). A closer examination of the stratigraphic ranges of the Bashkirian, Ural, and Asian species that are similar to the identified Algerian forms indicates the *Plectostaffella sselavica* and *Semistaffella variabilis* zones (Table 3, Fig. 4).

Results may be summarized as follows. Comparison of the assemblage from SA 11 with the Donets fusulnoids points to the C1-5 (E) suite (not above the E8 Limestone), whereas a comparison with Bashkirian, S Ural, and Central Asia indicates the Siuransky Horizon.

**Conodonts**

Sample SA 11 contains the following species: *Declinognathodus noduliferus*, *Declinognathodus lateralis*, and *Idiognathoides aff. corrugatus*. This assemblage possibly indicates the *Declinognathodus noduliferus* Zone. However, one of the species present is reminiscent of *Idiognathodus corrugatus*. The present association probably points to a low level in the zone which overlies the *Declinognathodus noduliferus* Zone. Age: Krasnopolyansky or Severokelmsky” (Dr. M. van den Boogard, written communication, early 1990's).

Recently, the same collection was investigated again by Nemyrovska who identified *Declinognathodus lateralis*, *Declinognathodus noduliferus*, *Declinognathodus lateralis* (=> *Decl. pseudolateralis*), *Idiognathoides corrugatus*, *Hindeodus minatus*, and *Aethohtaxis* sp. (AI elem.), and concluded as follows: “this association of species belongs to the *Idiognathodus corrugatus* Zone and indicates the upper E Formation (Donets Basin) and uppermost part of the Krasnopolyansky or Severokelmsky (Moscow Basin)” (Dr. T.I. Nemyrovska, written communication, 1998).

**Correlations with the Donets Basin, Moscow Basin, Urals and Central Asia (summarized)**

*Foraminifera*: High level in E Suite of Donets Basin, about E7 or E8 Limestone (= upper Krasnopolyansky or lower Severokelmsky of Moscow Basin).

Siuransky/Seslavincky of Ural/Central Asia (= middle to upper Krasnopolyansky of Moscow Basin).

**Conodonts**: Krasnopolyansky or Severokelmsky (van den Boogard).

Upper E Suite (Donets Basin), or uppermost Krasnopolyansky to Severokelmsky (Moscow Basin) (Nemyrovskaya).

**DESCRIPTION OF SPECIES**

Abbreviations used in the tables of measurements:

No.wh.= Number of whorls; D(0) = Diameter of proloculum; D(2), D(3) = Diameter second and third whorl of test respectively; D = Diameter of test; L/D= Length/Diameter ratio of test; F.r. = Form ratio of test, and R.v. = Radius vector of test; W.th. = wall thickness of test; m= mean; s= standard deviation; n= number of measurements.

Measurements of D(0), D(2), D(3), D, R.v., and W.th. are in microns.

*Pseudoendothrya* Mikhailov, 1939

**Type species**: *Fusulinella struvi* von Möller, 1879.

*Pseudoendothrya ex gr. struvi* (von Möller, 1879)

**Sample**: SA 11.

**Measurements**:

<table>
<thead>
<tr>
<th>Specimen</th>
<th>No.wh.</th>
<th>D(0)</th>
<th>D</th>
<th>L/D</th>
<th>W.th.</th>
<th>R.v.</th>
<th>F.r.</th>
</tr>
</thead>
<tbody>
<tr>
<td>21(7)(ax.)</td>
<td>4 or 4.5</td>
<td>536</td>
<td>0.53</td>
<td>14</td>
<td>284</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>29(7)(sag.)</td>
<td>4.5 or 5</td>
<td>588</td>
<td>17</td>
<td>312</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of septa of the three last whorls (counting from the antetheca of the ultimate whorl) is 19, 17, 13 respectively.

**Description**

- Shape thickly lenticular to subhomboidal; lateral sides straight or slightly convex; periphery of inner whorls probably arched, and in outer whorl bluntly pointed to arched. Chomata seem to be weakly developed. Tunnel is wide. Indistinct mural pores can be observed in outer whorls. Straight or somewhat curved septa are perpendicular to the wall or slightly forward inclined.

**Comparisons**

If indeed the two specimens are adults, they represent a small species resembling *Pseudoendothrya struvi*, *P.
Figure 5. a. *Pseudostaffella* (*Semistaffella*) cf. *variabilis* Reitlinger, 1961 specimen 13/8(1); b. *Pseudonovella* sp. 1, specimen 13/54; c. *Pseudonovella* sp. 2, specimen 13/55(1); d-i. *Millerella* sp. 1 aff. *M. paracarbonica* Manukalova et al., 1969, specimens d. 13/18(1), e. 13/75, f. 13/49, g. 13/72, h. 13/59(2), i. 13/47(1); j-p. *Millerella* sp. 2 aff. *M. paracarbonica* Manukalova et al., 1969, specimens j. 13/28(1), k. 13/63(3), l. 13/11(1), m. 13/82, n. 13/63(2), o. 13/69(1), p. 13/6(1); q. *Mediocricris breviscula* (Ganelina, 1951), specimen 13/5(4); r-s. *Pseudoendothrya* ex gr. *struvi* (von Möller, 1879), specimens r. 11/21(7), s. 11/29(7). Axial sections x160, sagittal section x100. Specimens a-q: SA 13; r, s: SA 11.

*struvi* suppressa (Shlykova, 1951), *P. afflientia* (Durkina, 1959), and *P. intermedia* (Shlykova, 1951). These species have been described from much older (= Viséan) strata than the Tagnana-III beds. Somewhat similar is also *Pseudoendothrya opinata* (Grozdilova and Lebedeva, 1954) from the Bashkirian. The aforementioned species usually show a diaphanotheca, not observed in the present specimens, perhaps due to alteration of the wall.
Pseudostaffella Thompson, 1942

**Type species:** Pseudostaffella needhami Thompson, 1942.

Pseudostaffella (Semistaffella) Reitlinger, 1971

**Type species:** Pseudostaffella variabilis Reitlinger, 1961.

Pseudostaffella (Semistaffella) cf. variabilis

Reitlinger, 1961

Fig. 5 a

**Sample:** SA 13.

**Measurements:**
8(1) 3.5-4 - - 285 0.83 13 160 0.73

**Comparisons**

The Algerian specimen resembles the holotype (the only illustrated specimen) of Pseudostaffella (Semistaffella) variabilis. Very similar is also Pseudostaffella (Semistaffella) minuta Sada, 1975, which in comparison with Pseudostaffella (Semistaffella) variabilis has more volutions (up to four versus up to three) and a smaller L/D ratio (0.7-0.8 versus 0.8-1.0). Both species may be slightly larger than the Algerian species. The similarity between Pseudostaffella (Semistaffella) minuta and Pseudostaffella (Semistaffella) variabilis — Groves (1988) considers them conspecific—makes it difficult to decide to which species the Algerian specimen should be assigned: Pseudostaffella (Semistaffella) variabilis is preferred here for reasons of priority. Pseudostaffella (Semistaffella) variabilis from the Bashkirian stratotype (cf. Groves, 1988, fig. 4, figs. 17.22-17.29) differs from the Algerian form by its oval/nautiloid shape (smaller L/D ratio) and greater shell diameter. Less similar is Eoastaffella protvae (Rauzer-Chernousova, 1948a), which differs in the more primitive character of its chomata and slightly greater shell diameter.

**Pseudonovella** Kireeva, 1949, emend. here

1949 Novella (Pseudonovella) Kireeva, 27.
1951 Eoastaffella (Seminovella) Rauzer-Chernousova, 64-66.
1963 Millerella Thompson (part); Rozovskaya, 110.

**Type species:** Novella (Pseudonovella) irregularis Kireeva, 1949.

**Definition and relationship**

The differences between Seminovella Rauzer-Chernousova and Pseudonovella are not evident, and were not discussed when Seminovella was introduced. The synonymy of Pseudonovella and Seminovella was suggested earlier (van Ginkel, 1987, p. 206, foot-note). Pseudonovella is defined as typically comprising species of small or medium size, of discoidal shape, showing umbilical depressions and a broadly arched peripheral rim in the inner whorls, which usually becomes more pointed in outer whorls. There are at least two (partially) evolve inner whorls; outer whorl(s) often show a trend towards involute coiling.

Pseudonovella is related to Millerella but differs from Millerella in its evolve coiling in two or more initial whors and in its more embracing outer whorl(s), contrary to the usually involute inner whorls and the clearly evolve outer whorl(s) of Millerella. The genus Pseudonovella is also related to “Eoastaffella” ex gr. pseudostruwei (Rauzer-Chernousova and Belyaev, 1936) and “Eoastaffella” ex gr. mutabilis Rauzer-Chernousova, 1951 (e.g. “Eoastaffella” grozdilovae Maslo and Vachard, 1997). The prolongation of the initial evolve stage to later whorls eventually leads to species of Pseudonovella that are intermediate between this genus and the fully evolve Novella Grozdilova and Lebedeva, 1950.

**Stratigraphic range**


**Species content and subdivision in groups of species**

The species assigned to Pseudonovella (including Seminovella) are subdivided in five groups of similar species as follows:

1. Pseudonovella ex gr. carbonica (Grozdilova and Lebedeva, 1950):


Species small or of medium size. Inner whorls clearly evolve; outer whorl in contact or sometimes slightly evolve. Umbilical depressions conspicuous.

Bashkirian-Lower Permian.

2. Pseudonovella ex gr. elegantula (Rauzer-Chernousova, 1951):


Species small to fairly large. Often deep and wide umbilical depressions. Secondary deposits absent or more commonly in the form of pseudochonoma. These species differ from species of the carbonica group in the generally more widely arched periphery of the outer volutions. The outer volution is evolve, often showing wide semi-lunar chambers in axial section. In contrast, outer volutions in the carbonica species group are usually in contact.

Lower Bashkirian-Lower Moscovian.
Figure 6. Millerella ex gr. acutissima (Kireeva, 1949), specimens a, 13/24, b, 13/73, c, 13/71(2), d, 13/11(2), e, 13/80, f, 13/7(1), g, 13/15(1), h, 13/51, i, 13/79, j, 13/52(2), k, 13/48, l, 13/83, m, 13/71(1), n, 13/52(1), o, 13/65(1), p, 13/39, q, 13/55(2), r, 13/66, s, 3/11(3). Axial sections. All x160 (SA 13).

3. Pseudonovella ex gr. monstrosa Kireeva, 1949;
Novella (Pseudonovella) monstrosa, Millerella minuta
Sheng, 1958, Eostaffella compressa Brusnikaova, 1951,
E. depressa Putrya, 1956, and Millerella (M.) carbonifera
Rozovskaya, 1975.
Species are extremely small. Few volutions.
Proloculum often large with respect to diameter of shell.
Upper Bashkirian-Moscovian; mainly Moscovian.
4. *Pseudonovella ex gr. sandersoni* (King, 1984):


Very slender species resembling *Pseudonovella irregularis* and *P. monstrosa* in their small size. Close to *Millerella*.

Upper Lower Bashkirian-basal Upper Bashkirian (Eurasia) and upper part Marble Falls Formation North America.


These species differ from *Pseudonovella ex gr. monstrosa* by their somewhat larger size and generally more pointed periphery in outer volutions.

Upper Bashkirian-Lower Permian.

*Pseudonovella* sp. 1

Fig. 5 b

Sample: SA 11.

Measurements:

Specimen No.wh. D(0) D(2) D(3) D L/D W.th R.v. Fr.
54 3 50 192 344 344 0.29 11 188 0.26

Comparisons

The single specimen present differs from *Pseudonovella aperta* (Grozdilova and Lebedeva, 1950) in its slightly more compressed shell, and more narrowly rounded or even subacute periphery. In this respect, *Pseudonovella irregularis* Kireeva, 1949, *Millerella grozdilovae* (Maslo and Vachard, 1997) (=*Eostaffella acuta* Grozdilova and Lebedeva, 1950), and a specimen assigned to *Eostaffella acuta* Grozdilova and Lebedeva, 1950, by Manukalova et al. (1969, pl. VIII, fig. 21, p. 115) are more similar than *Pseudonovella aperta*.

*Pseudonovella* sp. 2

Fig. 5 c

Sample: SA 13.

Measurements:

Specimen No.wh. D(0) D(2) D(3) D L/D W.th R.v. Fr.
55(1) 4.4-5 26 124 220 420 0.32 8 220 0.31

Comparisons

The specimen may belong to the group of *Pseudonovella carbonica* (Grozdilova and Lebedeva, 1950) and is somewhat similar to *Pseudonovella donetziana* (Potievskaya, 1964) and *Pseudonovella fragilis* (Vakarchuk in Brazhnikova et al., 1967). Another possibly related species is *Pseudonovella paraconcina* (Manukalova et al., 1969). Less similar is *Millerella prilikiensis* Vakarchuk in Brazhnikova et al., 1967, a species seemingly related to *Pseudonovella* as well as *Millerella*.

*Pseudonovella* sp. 3

Fig. 7 a–c

Sample: SA 11.

Measurements:

Specimen No.wh. D(0) D(2) D(3) D L/D W.th R.v. Fr.
52(3) 4.4-5 25 96 161 330 0.36 7 184 0.32
83(4) 3.5 34 124 218 292 0.43 8 168 0.38
58(7) 3.3-5 27 114 206 240 0.42 7 140 0.36

Comparisons

This small species may be assigned to the group of *Pseudonovella carbonica* (Grozdilova and Lebedeva, 1950) and is close to *Pseudonovella paraconcina* (Manukalova et al., 1969). The latter species has more whorls and a larger diameter. *Pseudonovella nataliae* (Maslo, 1993) shows a similar shape but is a much larger species. *Millerella grozdilovae* (Maslo and Vachard, 1997) has a relatively large proloculum, a slightly larger diameter of the test, and less pronounced umbilical depressions. *Millerella pseudostruweri var. losovskensis* (Manukalova et al., 1969) shows a more rounded periphery.

*Pseudonovella* sp. 4

Fig. 7 d–h

Sample: SA 11.

Measurements:

Specimen No.wh. D(0) D(2) D(3) D L/D W.th R.v. Fr.
33(2) 5.5-5 92 159 560 0.37 12 322 0.32
2(1) 4.5-5 27 122 206 518 0.47 11 286 0.43
4(1) 4.5-5 28 112 178 476 0.38 13 252 0.36
91(1) 4.5 30 108 188 440 0.36 10 248 0.32
58(6) 4.5 31 120 184 372 0.40 7 206 0.36

Comparisons

The somewhat similar *Pseudonovella elegantula* (Rauzer-Chernousova, 1951) shows more distinctly evolute initial whorls; its outer whorls are usually relatively lower and wider; quite similar is one of Rauzer-Chernousova’s paratypes (1951, pl. 2, fig. 8). Specimens identified as *Millerella aff. elegantula* (Rauzer-Chernousova) in Manukalova et al. (1969, pl. XI, figs. 17-19) may be close too; these specimens and the Algerian specimens in comparison with the type specimen of *Pseudonovella elegantula* show outer whorls that are relatively higher, more acute, and more embracing. *Pseudonovella nataliae* (Maslo, 1993) is larger, has fewer and wider volutions, and shows conspicuous umbilical depressions.

*Pseudonovella* sp. 5

Fig. 7 i–l

Sample: SA 11.
**Figure 7.** a-c. *Pseudonovella* sp. 3, specimens a. 11/52(3), b. 11/58(7), c. 11/83(4); d-h. *Pseudonovella* sp. 4, specimens d. 11/33(2), e. 11/41(1), f. 11/2(1), g. 11/58(6), h. 11/91(1); i-l. *Pseudonovella* sp. 5, specimens i. 11/23(1), j. 11/21(3), k. 11/69(1), l. 11/91(1); m-p. *Pseudonovella* sp. 6, specimens m. 11/69(2), n. 11/69(3), o. 11/56(2), p. 11/33(5). Axial sections. All x160 (SA 11).

**Measurements:**

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**Comparisons**

*Pseudonovella* sp. 5 is intermediate between *Millerella* of the *pseudostruvei* species group and *Pseudonovella*.

*Millerella concinna* Potievskaya, 1964 has deeper umbilical depressions, a smaller average diameter and
fewer volutions. *Millerella pseudostruwe* (Rauzer-Chernousova and Belyaev, 1936) shows inner volutions more clearly involute, and, on average, has a greater L/D ratio. *Millerella* (*Seminovella*) *elegantula* of Potievskaya (1964) has a smaller L/D ratio, more volutions, a smaller proloculum, and a larger maximum diameter. The adult stage of Potievskaya’s specimens shows more distinct involution in comparison with typical *Pseudonovella elegantula* (Rauzer-Chernousova, 1951), and in this respect the Algerian specimens are obviously closer to *Millerella* (*Seminovella*) *elegantula* of Potievskaya (1964). *Pseudonovella urtica* is less similar; like typical *Pseudonovella elegantula* and unlike *Pseudonovella* sp. 5, the holotype of this species shows clearly an evolute outer whorl.

*Pseudonovella* sp. 6  
Fig. 7 m-p

**Sample:** SA 11.

**Measurements:**

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**Table 4. Development of evolute versus involute coiling in 18 specimens of Pseudonovella spp. (sp. 1-6).** The three rows represent three classes expressing the amount of overlap between a whorl and its previous half-whorl as can be observed in axial sections. The three classes of the table are E (= coiling evolute), C (= opposite half whorls just in contact at the poles) and I (= coiling involute). The table columns list for consecutive whorls the percentage of specimens of *Pseudonovella* spp. showing evolute, just-in-contact, or involute coiling. The number of observations per whorl may be as high as the number of specimens available (here eighteen) but is usually lower. The succession of heavy-type numbers (highest percentages in the columns) show the general development of the type of coiling.

*Millerella*). The main difference with respect to *Millerella* is apparently the way of coiling which in the Algerian forms is dominantly evolute in inner whorls (Table 4).

*Millerella Thompson, 1942*

**Type species:** *Millerella marblensis* Thompson, 1942.

**Millerella sp. 1 aff. M. paracarbonica**  
*Manukalova et al., 1969*  
Fig. 5 d-i

**Sample:** SA 13.

**Measurements:**

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**Description**

Test small, slender discoidal; umbilical depressions shallow and wide. Periphery of the first whorl is flat or arched but tends to become more pointed with growth. The first one or two whorls are at a small or large angle to the subsequent two or three whorls; slight shifts may occur in the axis of coiling in outer whorls as well. The innermost two whorls of most specimens are evolute, whereas the outer two whorls are just in contact or slightly evolute. The wall of the outer whorls shows a tectum overlying a thicker more translucent layer. Secondary deposits are clearly present and form discontinuous chomata.
Adjacent to the septa, chomata take the form of low to moderately high chomata, that show a low or steep slope at the tunnel side. Chomata and tunnel are not, or only weakly, present roughly half-way between consecutive septa. Here, the secondary deposits usually form merely a thickened cap of tectorium that may take the form of “a shoulder” in axial section. The tunnel and chomata are discontinuous apparently. Millerella marbliensis Thompson, 1942 shows a similar morphology for tunnel and chomata (cf. Moore, 1964, p. 299).

Comparisons
The present species is probably related to Millerella paracarbonica Manukalova, et al., 1969 and Millerella extensa Marshall, 1969. The most similar of the two, Millerella paracarbonica, differs by showing deeper umbilical depressions, usually a more acute peripheral rim, a smaller proloculum, and a larger maximum number of whorls (up to five versus up to four in the Algerian species). The diameter of the fourth whorl of Millerella paracarbonica is smaller (220-300 versus 300-380 microns in the Algerian species) but the maximum shell diameter of Millerella paracarbonica is greater (420 versus 380 microns). The Algerian species resembles also Pseudonovella as well as species of the group of Millerella pseudostruwei (e.g. Millerella pseudostruwei).
var. losovskensis (Manukalova et al., 1969), M. amabilis (Grozdilova and Lebedeva, 1954).

**Millerella sp. 2 aff. M. paracarbonica**
Manukalova et al., 1969
Fig. 5 j-p

Sample: SA 13.

**Measurements:**

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<td>P</td>
<td></td>
<td>16</td>
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**Comparisons**

This species is very similar to **Millerella aff. paracarbonica** (species 1) described above. The main difference between the two is the larger size of the present form. Also similar is **Eostaffella acuta** Grozdilova and Lebedeva, 1950, in Manukalova et al., 1969, (cf. specimens 19, 20, and 23, pl. VIII, p. 115).

**Millerella ex gr. acutissima** (Kireeva, 1949)
Fig. 6 a-s

Sample: SA 13.

**Measurements:**

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**Description**

The test develops from discoidal in innermost whorls, through nautiliform/lenticular in middle whorls, to lenticular/discoidal in outer whorls. Outer whorls generally show shallow and wide umbilical depressions; the inner one to three whorls have parallel sides and umbilical depressions are absent. The periphery of the shell up to the fourth whorl becomes gradually more pointed. Thereafter, the trend is reversed. Percentages of angularity of the periphery from the first to the fifth whorl are shown in Table 5. Coiling is either planispiral or, more commonly, the first 1-1.5 whorls are at a slight angle (usually not exceeding 30 degrees) to the subsequent whorls. As shown in Table 6, coiling is mainly evolute in whorls 1 and 5, and just in contact in whorls 2 to 4. Wall structure is often obscure, especially in inner whorls; Overlying a thicker and more translucent layer, the tectum in the outer whorls is usually seen. Chomata are higher near the septa and may not always be continuous between consecutive septa; they extend over the equatorial plane, where a wide and shallow depression, barely indicating a tunnel, is often observed.

**Comparisons**

In comparison with the present form, **Millerella acutissima** has fewer volutions and is smaller in size; its umbilical depressions are very shallow, and secondary deposits are hardly developed. **Millerella paracarbonica** Manukalova et al., 1969 has slightly more volutions, a smaller proloculum, a slightly smaller shell diameter, and a smaller length/diameter ratio. **Millerella extensa** Marshall, 1969 conforms in shape and size, but differs in that it has an uncoiled final growth stage. The Algerian specimen 13/15(1) (Fig. 6 g) compares closely with a specimen identified as **Millerella marblenis** by Hoare and Sturgeon (1994, OSU 47727, fig. 3-27). Some specimens suggest a relationship with species of the group of **Millerella pseudostruvi** such as specimen 13/66 (Fig. 6 r) which may be compared with **Millerella angusta** (Kireeva, 1951). The evolute innermost whorls of specimen 13/51 (Fig. 6 h) indicate a possible relationship with **Pseudonovella**. An interesting form is also specimen 13/24 (Fig. 6 a), which would have certainly been assigned to **Millerella levencovica** (Manukalova et al., 1969), had it been an isolated specimen.

**Table 5. Development of the degree of angularity of the peripheral rim in Millerella ex gr. acutissima.** The six rows represent six classes of peripheral ranging from Straight/Flat (S) over Arched/Rounded (A), Bluntly pointed (Blp) to Pointed (P). The classes A(blp) and P(blp) are intermediate (cf. van Ginkel, 1965, p. 4). The table columns list for consecutive whorls (here: from 1st to 5th whorl) the percentages of specimens of **Millerella ex gr. acutissima** in this case) of different degrees of peripheral angularity corresponding to one of the six classes. The number of observations per whorl may be as high as the number of specimens involved (in this case nineteen), but is usually lower. The succession of heavy-type numbers (highest percentages in consecutive columns) shows the general development of the periphery of the shell.

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**Table 6. Development of evolute versus involute coiling in Millerella ex gr. acutissima** (explanation as in Table 4):
Figure 9. *Millerella angusta* (Kireeva, 1951), specimens a. 11/83(1), b. 11/1(1), c. 11/99(3), d. 11/64(2), e. 11/83(7), f. 11/4(4), g. 11/81(6), h. 11/78(2), i. 11/17(4), j. 11/56(1), k. 11/20(5), l. 11/21(9), m. 11/33(3), n. 11/33(4), o. 11/4(1), p. 11/29(2), q. 11/51(7), r. 11/20(6), s. 11/59(2). a-d. Form A; e-k. Form B; o, p. Form C; l-n, q-s. Form D. Axial sections. All x160 (SA 11).

Remarks

Table 7. Development of the degree of angularity of the peripheral rim in *Millerella cf. pseudostruvei* (explanation as in Table 5).

**Millerella cf. pseudostruvei**  
(Rauzer-Chernousova and Belyaev, 1936)  
Fig. 8 a-q

<table>
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Table 8. Development of evolute versus involute coiling in *Millerella cf. pseudostruvei* (explanation as in Table 4).

<table>
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<td>C</td>
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<td>29</td>
<td>50</td>
<td>76</td>
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</tbody>
</table>

Table 9. Development of the degree of angularity of the peripheral rim in *Millerella angusta* (explanation as in Table 5).

**Millerella angusta**  
(Kireeva, 1951)  
Fig. 9 a-s

<table>
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<td>A(blp)</td>
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<td>P(blp)</td>
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Table 10. Development of evolute versus involute coiling in *Millerella angusta* (explanation as in Table 4).

Sample: SA 11.

**Measurements:**

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<th>No.wh.</th>
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<th>D(2)</th>
<th>D(3)</th>
<th>D/L</th>
<th>W.th.</th>
<th>R.v.</th>
<th>F.r.</th>
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<tr>
<td>m</td>
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<td>27</td>
<td>111</td>
<td>192</td>
<td>363</td>
<td>0.49</td>
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<td>s</td>
<td>0.4</td>
<td>2.5</td>
<td>16</td>
<td>28</td>
<td>54</td>
<td>0.03</td>
<td>1.5</td>
</tr>
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<td>n=17</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Description**

Test is nautiliform; umbilical cavities are absent or well-developed. Peripheral rim is mainly arched in whors 1-3, and arched to bluntly pointed in whors 4-5 (Table 7).

Coiling is planispiral, or inner one to two whors are at a moderate angle to subsequent whors. Volutations are evolute (first whorl), in contact (second whorl), involute (third-fourth whors), in contact or involute (fifth whorl) (Table 8).

The wall consists of a tectum overlying a thicker, less dense, layer from whorl 1.5 onwards, and occasionally is single-layered throughout growth. Chomata are discontinuous, low or (closer to the septa) of medium height.

**Comparisons**

The Algerian species is close to *Millerella pseudostruvei*; the number of volutions and the shell diameter of *Millerella pseudostruvei* average slightly greater. Also *Eoostaffella pseudostruvei* of Bogush and Yuferev (1962, pl. VI, fig. 33) resembles several specimens of the present population. *Millerella postmosquensis* (Kireeva, 1951) has larger average values for proloculum and diameter at corresponding (inner) volutions. *Millerella cumberlandensis* (Rich, 1980), unlike some Algerian specimens, hardly shows umbilical depressions.

Sample: SA 11.

**Measurements:**

<table>
<thead>
<tr>
<th>No.wh.</th>
<th>D(0)</th>
<th>D(2)</th>
<th>D(3)</th>
<th>D/L</th>
<th>W.th.</th>
<th>R.v.</th>
<th>F.r.</th>
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<tr>
<td>m</td>
<td>4.1</td>
<td>27.5</td>
<td>114</td>
<td>192</td>
<td>363</td>
<td>0.42</td>
<td>9</td>
</tr>
<tr>
<td>s</td>
<td>0.4</td>
<td>5</td>
<td>18</td>
<td>30</td>
<td>66</td>
<td>0.05</td>
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<tr>
<td>n=22</td>
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<td></td>
</tr>
</tbody>
</table>

Form Fig. No.wh. D(0) D(2) D(3) D L/D W.th. R.v. F.r.  
A      A-D | 4.4  | 23  | 93  | 168 | 378 | 0.36 | 8    | 220  | 0.31 |
B      E-K | 4.1  | 27  | 114 | 197 | 373 | 0.41 | 9    | 212  | 0.36 |
C      O-P | 4.4  | 27  | 128 | 223 | 474 | 0.41 | 13   | 288  | 0.35 |
D      L-N-Q-S.3.8 | 31 | 121 | 215 | 319 | 0.45 | 9    | 180  | 0.40 |

**Description**

Test is discoidal to nautiliform; umbilical depressions are often absent in the inner three whors and shallow to deep in the outer whors. Peripheral rim is predominantly arched in whors 1-4 and usually arched to bluntly pointed in whorl 5 (Table 9).

Specimens show small shifts of the axis of coiling, notably in inner whors. Coiling is evolute or in contact (first whorl), in contact (second-fourth whors), and evolute (fifth whorl) (Table 10).

Except for the initial one or two whors which are single-layered, the spirotheca shows a tectum overlying a thicker,
less dense, layer. Occasionally, the spirotheca is single-layered throughout growth. Secondary deposits may be observed from whorl 1.5-2 onwards. Chomata are discontinuous, rather wide, low or moderately high, showing low or steep slopes at the tunnel side. About halfway between septa, secondary deposits form “shoulders”, and chomata and tunnel can hardly be distinguished as such.

The present material is quite variable. Several types (forms A to D) have been distinguished. Form B is intermediate with respect to the forms A and C. Form A is small, showing clearly evolute outer whorls and a subacute peripheral rim, whereas the larger Form C has better developed chomata. Form D includes specimens showing slightly fewer volutions and a slightly larger proloculum.

**Comparisons**

The present specimens are considered to belong to the species *Millerella angusta*, despite the slightly smaller proloculum, the smaller diameter per volution (from first to third whorl), the larger average L/D ratio, and the better developed chomata (form C) of the Algerian specimens. The Algerian specimens are intermediate in size between those from the Donets Basin described by Manukalova *et al.* (1969) and the much larger typical forms from the
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<tr>
<td>S</td>
<td>15</td>
<td>19</td>
<td>8</td>
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<tr>
<td>A</td>
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<td>25</td>
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<tr>
<td>A(blp)</td>
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<td>25</td>
<td>67</td>
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<td>Blp</td>
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<td>P(blp)</td>
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<tr>
<td>P</td>
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</table>

**Table 11.** Development of the degree of angularity of the peripheral rim in *Millerella yugorskensis* (explanation as in Table 5).

Urals. Very similar is *Millerella* sp. (Groves, 1984, pl. 7, figs. 7-12); the illustrations suggest that the main difference is the number of whors, being up to five for *Millerella* sp. and up to four and one half for the Algerian species. The form identified as *Eostaffella pseudostruvel* var. *elegantissima* (in: Manukalova et al., 1969, p.189, pl. IX, fig. 16; p.7, pl. XIII, fig. 13) differs from the Algerian species by its better developed chomata, slightly thicker sprotheca, slightly greater number of whors, and slightly smaller proloculum; it is very similar to the specimens here distinguished as Form C. Another related species may be *Millerella porcipinensis* Ross, 1967, which resembles in wall structure, development of chomata, and shell shape. It attains however, a much larger diameter (up to 700 microns).

*Millerella yugorskensis* (Solovieva, 1984)

**Sample:** SA 11.

**Measurements:**

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<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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<tr>
<td>m</td>
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<td>290</td>
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<td>163</td>
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<tr>
<td>s</td>
<td>0.25</td>
<td>2.6</td>
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<td>21</td>
<td>39</td>
<td>0.05</td>
<td>0.9</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Description**

Test is small, discoidal or plano-nautiliform. Umbilical depressions are absent or (rarely) moderately deep. Periphery develops from arched (first-third whorl), towards arched to bluntly pointed (fourth whorl). Percentages of angularity for whors 1-4 are shown in Table 11.

Specimens show skew coiling in the two first whors or (occasionally) throughout growth; others are planispiral. Volutions are predominantly evolute (first-second whorl), in contact (second-third whorl), or involute (fourth whorl) (Table 12).

A tectum can be distinguished in some or all volutions except the innermost one; occasionally the tectum appears to be absent throughout growth. These differences are probably caused by differences in preservation. Secondary deposits (in the form of discontinuous chomata) appear in the second-third whorl and are low or moderately high and relatively wide.

<table>
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<tr>
<td>E</td>
<td>68</td>
<td>44</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>32</td>
<td>44</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>I</td>
<td>12</td>
<td>38</td>
<td>50</td>
<td></td>
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**Table 12.** Development of evolute versus involute coiling in *Millerella yugorskensis* (explanation as in Table 4).

**Comparisons**

The species is a small member of the *Millerella pseudostruvel* species group. The specimens described by Solovieva show a slightly larger diameter. Other related but less similar forms are *Millerella pseudostruvel* forma *minima* (Kireeva, 1949) (cf. Manukalova et al., 1969, pl. VI, figs. 5-8) and *Millerella amabilis* (Grozdeva and Lebedeva, 1954). The present specimens usually show a slightly evolute first whorl. This partially evolute coiling of the first one or two whors points to a relationship with *Pseudonoella*.

**Millerella sp. 1** ex gr. *M. pseudostruvel* (Rauzer-Chernousova and Belyaev, 1936)

**Fig. 10 a-t**

**Sample:** SA 11.

**Measurements:**

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**Description**

Shell shape changes from nautiliform (first-third whors) to discolidal (fourth-fifth whors); the last whorl usually shows conspicuous umbilical cavities. The periphery is predominantly arched or flat (first-second whors), arched (third whorl) and arched to bluntly pointed (fourth whorl). Axis of coiling is not stable throughout growth but shifts are minimal; the first whorl, commonly, is at a slight angle to subsequent whors. Volutions are predominantly evolute in the first two whors and mainly in contact in the following whors. The wall shows a tectum overlying a thicker more translucent layer. Secondary deposits are quite variable, occasionally absent. Adjacent to the septa, low or moderately high and relatively wide chomata can usually be observed.

**Comparisons**

*Millerella pseudostruvel* shows a slightly wider arched peripheral rim in outer whors, and possibly shallower umbilical depressions. *Millerella bigemmicala* Igo, 1957 has slightly fewer volutions and a larger proloculum. The diameter of the fourth whorl is slightly greater and the sprotheca is slightly thicker. Secondary deposits may be better developed. Less similar is...
**Millerella postmosquensis acutiformis** (Kireeva, 1951) which shows fewer volutions, a larger proloculum, a larger diameter at corresponding volutions, a greater L/D ratio, and probably shallower umbilical depressions. Closely related is the species described below as *Millerella* ex gr. *pseudostruwei* sp. 2.

**Remarks**

Rauzer-Chernousova et al. (1951) introduced the species group of *Eostaffella pseudostruwei*. Despite the poor information on the leader of the group (the introduction in 1936 of *Staffella pseudostruwei* includes only one illustrated specimen) the following species are believed to be possible members:  

*Eostaffella postmosquensis* Kireeva, 1951, *E. akiyoshiensis* Sada, 1975, and *E. cumberlantensis* Rich,
Table 13. Development of the degree of angularity of the peripheral rim in *Millerella* sp. 2 ex gr. *pseudostruwei* (explanation as in Table 5).

1980 should perhaps be added here too. Yet Rauzer-Chernousova et al. (1951) assigned *E. postmosquensis* not to the species group of *E. pseudostruwei* but to the more primitive species group of *E. parva* (Müller, 1879). Subsequently, *Eostaffella parva* was designated as the type species of *Endostaffella* by Rozovskaya (1961). This suggests that *Eostaffella postmosquensis* and the other two similar species may have derived from *Endostaffella*. The *pseudostruwei* species group probably descended from *Endostaffella* as well.

*Millerella* sp. 2  ex gr. *M. pseudostruwei*  
(Rauzer-Chernousova and Belyaev, 1936)  
Fig. 11 a-g

Locality: SA 11.

Measurements:

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<tr>
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<td>62</td>
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<td>P(bl/p)</td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

Table 14. Development of evolute versus involute coiling in *Millerella* sp. 2 ex gr. *pseudostruwei* (explanation as in Table 4).

Evolute specimens as shown in the present material are apparently absent. *Millerella angusta* and *Millerella porcupinensis* Ross, 1967 have fewer whorls, a larger proloculum, and a larger diameter at corresponding whorls. *Eostaffella ex gr. mixta* of Manukalova et al. (1969, p.34, pl. X) is a more slender form (L/D ratio: 0.34–0.36 versus 0.40–0.47) and may have better developed secondary deposits. Similar are also the older *Millerella orbiculata* (Maslo, 1993) and *Millerella designata* Zeller, 1953. Both show umbilicate and slender inner whorls in contact at the poles, whereas the corresponding whorls of the Algerian specimens are rather nautiform and involute.

*Millerella* sp. 3  ex gr. *M. pseudostruwei*  
(Rauzer-Chernousova and Belyaev, 1936)  
Fig. 11 h-j

Sample: SA 11.

Measurements:

<table>
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<th>4</th>
<th>5</th>
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<td>E</td>
<td>25</td>
<td>16</td>
<td>16</td>
<td>42</td>
<td></td>
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<tr>
<td>C</td>
<td>62</td>
<td>42</td>
<td>7</td>
<td>16</td>
<td>42</td>
</tr>
<tr>
<td>I</td>
<td>13</td>
<td>42</td>
<td>93</td>
<td>68</td>
<td>16</td>
</tr>
</tbody>
</table>

Description

Inner volutions are nautiform or lenticular; outer whors dicoidal. The umbilical region in the inner whorls is usually flat, occasionally slightly umbotate; the outer volutions show shallow or deep umbilical depressions. The periphery is usually arched in the inner three and fifth volutions; the fourth volution shows a more pointed periphery (Table 13).

Coiling is planispiral, except for the first 0.5-1.5 whors, which usually are at an angle to subsequent whors. Slight axial shifts may occur throughout growth. Volutions are usually in contact in whors 1-2, mainly involute in whors 2-4, and mainly in contact or evolute in whorl 5 (Table 14).

The wall consists of a tectum overlying a thicker and more translucent layer; secondary deposits are present from whors 1.5-2.5 and take the form of low or moderately high and relatively wide, discontinuous, chomata which have steep slopes at the side of the tunnel (up to 90 degrees near the tunnel openings).

Comparisons

*Millerella pseudostruwei* (Rauzer-Chernousova and Belyaev, 1936) probably has a smaller average diameter;

*Millerella* ex gr. *chomatifer* (Kireeva, 1951)

Fig. 12 a-c

**Sample:** SA 11 and SA 13.

**Measurements:**

<table>
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<tr>
<th>Specimen</th>
<th>No.</th>
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<th>D(2)</th>
<th>D(3)</th>
<th>D</th>
<th>L/D</th>
<th>W.</th>
<th>th</th>
<th>R.</th>
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<th>Fr.</th>
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<tbody>
<tr>
<td>(SA 11)</td>
<td></td>
<td>24(4)</td>
<td>4.5</td>
<td>22</td>
<td>124</td>
<td>210</td>
<td>460</td>
<td>0.38</td>
<td>9</td>
<td>244</td>
<td>0.36</td>
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**Description**

Test lenticular, discoidal, or nautiliform. Axial region flat or slightly raised; umbilical depressions absent or
shallow. Lateral sides straight or convex. Peripheral rim of inner whorls flat or arched, and bluntly pointed or subacute in outer whorls. Axis of coiling in the first one or two whorls may be at a (small) angle to later whorls. First whorl can be evolute, subsequent whorls are in contact at the poles or involute, and the final whorl is sometimes evolute. Spirotheca shows tectum and a thicker, more translucent, lower layer. The chomata are of medium height and width.

**Comparisons**

Specimens resemble *Millerella chamotifera* (Kireeva, 1951) (= *Eoastaffella pseudostruvei* chamotifera Kireeva, 1951), *Millerella pseudostruvei* var. *elegantissima* (Manukalova et al., 1969), and *Millerella etoi* (Ota, 1971). Possibly conspecific is *Millerella pseudostruvei* var. *elegantissima*. However, the “variety” is not a valid category in zoological nomenclature since 1960 (ICZN, 1999, Art. 45.5; 45.6.3). *Millerella chamotifera* differs in shape: plano-nautiliform in *Millerella chamotifera* and more slender, lenticular, in the Algerian specimens. *Millerella etoi* has slightly fewer whorls, a larger proloculum, a larger diameter at corresponding whorls, and probably less developed chomata. Somewhat similar is also *Eoastaffella postmasquensis acutiformis* of Groves (1991).

**Remarks**


**Millerella cf. paraumbilicata**

*Manukalova et al., 1969*

**Fig. 12 d,e**

**Sample:** SA 11.

**Measurements:**

<table>
<thead>
<tr>
<th></th>
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<tr>
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<td>212</td>
<td>432</td>
<td>0.51</td>
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<td>248</td>
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**Comparisons**

Similar is *Millerella paraumbilicata* Manukalova et al., 1969 (cf. fig. 24, pl. XI, p. 121). The Algerian species is slightly larger and one of the two specimens [i.e. specimen 11/78(3)] differs in the more clearly evolute inner whorls. Another resembling form is *Eoastaffella?* sp. -*Millerella?* sp. of Gibshman and Akhmetshina (1990, pl. 3, figs. 17-19).

**Millerella aff. paraumbilicata**

*Manukalova et al., 1969*

**Fig. 12 f-h**

**Sample:** SA 11.

**Measurements:**

<table>
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<tr>
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<td>24(2)</td>
<td>4.55</td>
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<td>200</td>
<td>472</td>
<td>0.40</td>
<td>11</td>
<td>276</td>
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<td>49(1)</td>
<td>4.5</td>
<td>35</td>
<td>168</td>
<td>312</td>
<td>625</td>
<td>0.47</td>
<td>12</td>
<td>372</td>
</tr>
<tr>
<td>62(2)</td>
<td>3.5</td>
<td>30</td>
<td>160</td>
<td>312</td>
<td>420</td>
<td>0.49</td>
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<td>244</td>
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**Description**

Large shell in comparison with other fusulinoideans from the present locality. Whorls are thickly discoidal to lenticular; the ultimate discoidal whorl shows shallow (and wide) or deep umbilical depressions. The periphery is arched or (in middle whorls) arched to bluntly pointed. The first one or two whorls are at an angle to subsequent whorls. Adult specimens show outer whorls in contact or are slightly evolute. The spirotheca, except for the single-layered first whorl, consists of a tectum overlying a thicker, less dense, layer. The outer volutions show high, narrow, and, at the tunnel side, steep chomata; in the first whorls they are low and relatively wide.

**Comparisons**

This possibly new species is characterized by conspicuous —relatively high— chomata, loosely coiled volutions, a not entirely stable axis of coiling, and large size. *Millerella paraumbilicata* may be a related species, but is much smaller (up to 460 microns). *Millerella citata* (Bogush and Yuferov, 1962) could be related as well, but the one illustrated specimen of this species does not permit a detailed comparison. It probably has a larger proloculum and fewer volutions than the Algerian form.

**Plectostaffella Reitlinger, 1971**

**Type species:** *Eoastaffella? (Plectostaffella) jakhensis* Reitlinger, 1971.

**Plectostaffella aff. varvariensis**

*Brazhnikova and Potievskaja, 1948*

**Fig. 13 a-s**

**Sample:** SA 11.

**Measurements:**

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<td>25</td>
<td>101</td>
<td>176</td>
<td>325</td>
<td>0.43</td>
<td>8.5</td>
<td>185</td>
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<tr>
<td>s</td>
<td>0.4</td>
<td>2.5</td>
<td>10</td>
<td>20</td>
<td>47</td>
<td>0.05</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>n=24</td>
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<td>23</td>
<td>23</td>
<td>22</td>
<td>22</td>
<td>0.04</td>
<td>1</td>
<td>23</td>
</tr>
</tbody>
</table>

**Description**

Specimens are discoidal or nautiliform showing wide and shallow, occasionally deep, umbilical depressions. The periphery is flat or arched in the first whorl, mainly
arched in the second and third, bluntly pointed to arched in the fourth, and again arched in the fifth whorl. After the first one or one and one half whorls the axis of coiling may have shifted up to 90 degrees; these shifts are less conspicuous in subsequent whorls. Coiling is mainly evolute (first whorl), slightly evolute, in contact, or just involute (second-fourth whorls), and usually (slightly) evolute (fifth whorl). The spirotheca is undifferentiated in the inner one to two whorls, but in subsequent whorls it consists of a tectum overlying a more translucent and thicker layer. The discontinuous chomata are low or of medium height and relatively wide.

**Comparisons**

The Algerian species, in comparison with *Plectostaffella varvariensis*, has a smaller diameter at corresponding volutions, and a smaller number of volutions. The Algerian specimens that show a relatively stable axis of coiling are often similar to *Eostaffella varvariensis* var. *grandis* Brazhnikova ms. (Brazhnikova, 1951, p. 92, pl. I, figs. 7,8). Equally similar is *Eostaffella varvariensis* var. *umbonata* Brazhnikova and Potievskaya (see Wagner *et al.*, 1979). A description of this variety may have never been published. A related species could
be *Plectostaffella ispaica* Rumyantseva in Kulagina et al. (1992); especially the Algerian specimens 11/15(2) and 11/83(2) (Fig. 13 j.s) are similar. *Eostaffella evoluta* Rumyantseva, 1970 has less developed secondary deposits, fewer whorls, and a larger diameter at corresponding whorls.

Slender, partially evolute, specimens resemble also *Plectomillerella subacuta* Brazhnikova and Vdovenko, 1983.

Brazhnikova and Potievska (1948) noted the close similarity of their new species *Eostaffella varvariensis* to *Eostaffella pseudostrupei*. The similarity is indeed evident for the specimens of *Plectostaffella varvariensis* that show a relatively stable axis of coiling.

**Plectostaffella jakhensis** (Reitlinger,1971)

*Fig. 14 a-k*

**Sample:** SA 11.

**Measurements:**

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>m</td>
<td>4.0</td>
<td>30</td>
<td>123</td>
<td>208</td>
<td>373</td>
<td>0.59</td>
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<td>207</td>
<td>0.53</td>
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<tr>
<td>s</td>
<td>0.4</td>
<td>4.5</td>
<td>16</td>
<td>31</td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Description**

Test develops from discoidal in the inner one to two whorls, to nautiliform in the outer whorls. Umbilical
depressions are generally absent. The periphery changes from mainly arched in the inner three whorls, towards mainly arched to bluntly pointed (rarely pointed) in the outer two whorls. Considerable shifts in the axis of coiling (angles up to 90 degrees) can be observed throughout growth. The trend is towards involute coiling: the first whorl shows opposite half-whorls in contact, or, less commonly, this whorl is evolute; subsequent whorls are progressively more
involute, and the 4th and 5th whors are invariably involute. Except for the first whorl, which is undifferentiated, a tectum may be observed overlying a thicker more translucent layer; occasionally, the wall seems undifferentiated throughout growth. Secondary deposits can be absent up to whorl 2.5; subsequent whors show fairly well-developed chomata.

Comparisons
The specimens described by Manukalova et al. (1969) as Eostaffella parastrauvei Rauzer-Chernousova, 1948a, Eostaffella paraprotovae var. acuta var. nov., and Eostaffella aff. paraprotovae are quite close to the Algerian specimens. In the present work, as in Reitlinger (1971) and Groves (1988), they are assigned to Plectostaffella jakhensis. The similar Plectostaffella seslaveca (Rumyanseva, 1970) may have less massive chomata. Specimens from the lower part of the Hassi Kerma Formation identified as Eostaffella (Plectostaffella)? sp. (van Ginkel, 1992, sample SA 19, p. 257, fig. 13) are close too, but differ in showing conspicuous umbilical depressions and a more stable axis of coiling.

Plectostaffella? sp.
Fig. 15 a-c

Sample: SA 11.

Measurements:
62(1) 5 - 136 228 644 0.53 16 372 0.46
77(1) 4.5-5 39 143 228 584 0.48 14 310 0.45
22(1) 4-4.5 32 132 238 504 0.55 16 288 0.48

Description
The specimens are large in comparison with most other fusulinoidae specimens from the samples SA 13 and SA 11. The shell develops from discoidal in the inner two volutions to nautiliform or plano-nautiliform in subsequent whors. Umbilical depressions are shallow or absent. The periphery is arched in the inner 2.5-3.5 whors; arched or bluntly pointed in subsequent whors. The axis of coiling may shift throughout growth, but large shifts occur only in the inner whors; one specimen that has five whors is planispiral from whorl 2.5 onwards. Coiling is evolute or in contact (first whorl), in contact or involute (second-fourth whorl) and involute (third-fifth whorl). A tectum overlying a thicker, less dense, layer may be observed from the second whorl onwards. Adjacent to the septa, the chomata are of medium height and show fairly steep slopes at the side of the narrow tunnel; more to the center of chambers secondary deposits are less developed, and tunnel and chomata become less distinctive as such.

Comparisons
The assignment of this form to Plectostaffella is questionable because it has a relatively stable axis of coiling. However, shape and development of chomata are reminiscent of Plectostaffella jakhensis. Somewhat similar species are Plectostaffella sp. nov. (Rumyanseva in Kulagina et al., 1992, pl. X, fig. 7) and Eostaffella parastrauvei of Rumyanseva (1970, pl. VI, fig. 18). Eostaffella parastrauvei (Rauzer-Chernousova, 1948b) differs by its slightly larger diameter [D=(400)600-1000 versus 500-650 microns] and less-developed secondary deposits.

Eostaffellina Reitlinger, 1963

Type species: Eostaffella protovae Rauzer-Chernousova, 1948a.

Eostaffellina cf. libera (Rumyanseva, 1970)
Fig. 15 d, e

Sample: SA 11.

Measurements:
4(3) 4-4.5 38 138 235 476 0.71 15 272 0.62
38 4-4.5 138 233 548 0.55 18 340 0.45

Description
Test thickly nautiliform; lateral sides curved; umbilical depressions absent. Periphery arched, or, in the final whorl, arched to bluntly pointed. The inner one to two whors are at an angle to subsequent whors. Coiling is involute, except for the inner whors, which, in one of the two specimens, may be evolute. The wall is either undifferentiated, or, more rarely, a tectum overlying a thicker layer can be distinguished. The chomata are discontinuous, low or (adjacent to the tunnel openings of the septa) moderately high.

Comparisons
The two Algerian specimens are intermediate between the Bashkirian forms Eostaffella (Eostaffellina) libera Rumyanseva, 1970 and Eostaffella paraprotovae var. grandis Manukalova et al., 1969; they differ from both species in that the Algerian specimens have flat or slightly raised axial areas and no umbilical depressions. The lower part of the Hassi Kerma Formation, at sampling station SA 17, contains the similar Eostaffella (Eostaffellina) sp. (van Ginkel, 1992, cf. specimen SA17/16, fig. 13/12).

Eostaffella Rauzer-Chernousova, 1948b

Type species: Staffella (Eostaffella) parastrauvei Rauzer-Chernousova, 1948b.

Eostaffella ex gr. parastrauvei
(Rauzer-Chernousova, 1948b)
Fig. 15 f-g

Sample: SA 11.
Measurements:
Specimen No.wh. D(0) D(2) D(3) D L/DW.th. R.v. F.r.
5(1) 4.5  120 212 506 0.51 12 296 0.43
36(1) 4.5  39 128 232 488 0.47 14 280 0.41

Description
Test nautiliform; umbilical depressions absent, or shallow and narrow. Peripheral rim arched in the inner two whors, and arched to pointed in the outer whors. The first whors show slight shifts in the axis of coiling; later whors are planispiral. Volutions are in contact in the inner two whors, involute or in contact in the outer whors. Spiretecta single-layered in the inner two whors and with tectum and a lower, less dense layer, in outer whors. Discontinuous(? ) chomata are present in the outer three whors; they are low or of medium height and not sharply delimited at the side of the relatively wide tunnel (low slopes at the tunnel side). Somewhat denser areas occur near the poles (reminiscent of Mediocriis).

Comparisons
The two Algerian specimens are quite similar to Eostaffella ex gr. radiata (Brady, 1876) emend. Armstrong and Mamet (1977; pl. 35, figs. 5, 7). The radiata group of Armstrong and Mamet includes Eostaffella mosquensis Vissarianova, 1948. The type specimen of Eostaffella mosquensis in comparison with the Algerian specimens is smaller, more tightly coiled, and has slightly more (five) volutions. Other differences may be the even less developed secondary deposits and the absence of a clear tunnel in Eostaffella mosquensis. In view of the sometimes acute peripheral rim and the distinct secondary deposits of the Algerian specimens, the relationship with Eostaffella mosquensis attenuata Ganelina, 1951 (pl. 2, fig. 7) and E. mosquensis sublata Ganelina, 1951 (pl. 2, fig. 10) may be closer. Two specimens identified as Eostaffella mosquensis by Matsusue (1992, figs. 3/18, 3/19) are similar too; they probably have a larger diameter at corresponding volutions and less developed secondary deposits. Other related forms may be Eostaffella kamerai (Igo, 1957), which shares the small and dense deposits in the polar regions, and Eostaffella chusovensis Kireeva, 1951.

Eostaffella aff. chusovensis Kireeva, 1951
Fig. 16 a-m

Sample: SA 11.

Measurements:

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<th>3</th>
<th>4</th>
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<td>A</td>
<td>48</td>
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<td>58</td>
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<td>24</td>
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<td>50</td>
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<td>Blp</td>
<td>3</td>
<td>18</td>
<td>14</td>
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<td></td>
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Table 15. Development of the degree of angularity of the peripheral rim in Eostaffella aff. chusovensis (explanation as in Table 5).

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<th>4</th>
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<tr>
<td>I</td>
<td>13</td>
<td>50</td>
<td>79</td>
<td>73</td>
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</table>

Table 16. Development of evolute versus involute coiling in Eostaffella aff. chusovensis (explanation as in Table 4).

Coiling is either planispiral or, more commonly, the axis of coiling is not entirely stable. Some specimens show clearly an angular shift of the axis between first and second whors; others show conspicuous axial shifts in the adult stage. The spiral develops from mainly evolute (first whorl), in contact (second whorl), to mainly involute (third-fifth whors) (Table 16). From whorl 1.5 onwards, the wall contains a tectum, overlying a thicker and more translucent layer. A few specimens show an undifferentiated wall throughout growth. Discontinuous chomata are either low and relatively wide, or, close to the tunnel openings, of medium height.

Comparisons
The Algerian species resembles Millerella chomatifera (Kireeva, 1951) and Eostaffella chusovensis. The former has better developed chomata and a more stable axis of coiling, Eostaffella chusovensis is seemingly closer to the Algerian species than Millerella chomatifera, but the number of whors of Eostaffella chusovensis is lower, the proloculum larger, the diameter at corresponding whors greater, and the chomata seem less developed. Very similar is also a relatively slender specimen of Eostaffella chusovensis illustrated by Manukalova et al. (1969, pl. X, fig. 4).

Endostaffella Rozovskaya, 1961

Type species: Endothyra parva von Möller, 1879.

Endostaffella sp.
Fig. 15 h-v

Sample: SA 11.
Figure 16. *Eostaffella aff. chusovensis* Kireeva, 1951, specimens a. 11/6(2), b. 11/75(3), c. 11/59(1), d. 11/18(2), e. 11/15(1), f. 11/91(13), g. 11/42(1), h. 11/91(2), i. 11/73(2), j. 11/28, k. 11/15(4), l. 11/65(1), m. 11/6(1). Axial sections. All x160 (SA 11).

**Measurements:**

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<th>D(2)</th>
<th>D(3)</th>
<th>D</th>
<th>L/D</th>
<th>W. th.</th>
<th>R.v.</th>
<th>F.r.</th>
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<td>119</td>
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<td>17</td>
<td>0.05</td>
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</table>

**Description**

Specimens are short discoidal and generally slightly
umbilicate. The peripheral rim is arched throughout growth or, in outer whorls, arched to bluntly pointed. About one-third of the specimens of at least two and one half whorls are planispiral; others show a conspicuous angular shift (up to 90 degrees) of the axis of coiling between whorls 1 and 2, or its position oscillates throughout growth. The (sagittal) first whorl of axial sections usually has five bulbous chambers and septa at an angle roughly perpendicular to the spirotheca. The first whorl is generally evolute; subsequent whorls are usually in contact. Half the specimens with about three volutions have an undifferentiated spirotheca; the others show a tectum in the ultimate volution. Secondary deposits, if present, are very weak and observed only in the outer one or two whorls; they may be low and wide pseudochomata. In nearly half of the specimens that have at least two and a half whorls, secondary deposits are absent.

Comparisons

Very similar, possibly conspecific, is Eostaffella prisca var. minor Saurin, 1970. Closely related forms are perhaps Plectogyra bradyi (Mikhailov, 1939) forma minima Manukalova et al., 1969, and Eostaffella (Eostaffella) asymmetrica Potievskaya, 1974. These species have been described from Lower Bashkirian strata from Laos/N Vietnam and Ukraine respectively. Eostaffella (E.) asymmetrica differs in its smaller L/D ratio (0.40-0.46 versus 0.38-0.61).

Remarks

The wall of Endostaffella has been reported to be undifferentiated, but in some species (e.g. Endostaffella delicata Rozovskaya, 1963) a tectum is apparently present. The presence of secondary deposits and a tectum in a substantial number of the Algerian specimens may point to a highly evolved member of the genus. On the other hand, these specimens may not be Endostaffella at all, but juveniles of Plectostaffella aff. variairesis or Millerella ex gr. pseudostruvel which are also present in the sample.

Mediocris Rozovskaya, 1961

Type species: Eostaffella mediocriis Vissarianova, 1948.

Mediocris breviscula (Ganelina, 1951)

Fig. 5 q, 12 i-n

Sample: SA 13, specimen 3(4); SA 11, 8 specimens.

Measurements:

<table>
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<th>No.w. D(0) D(2) D(3) D L/D W.th. R.v. F.r. Spec.</th>
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<tr>
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</tr>
<tr>
<td>s</td>
<td>0.4 5.5 27 31 0.04 0.9 20 0.04</td>
</tr>
<tr>
<td>n=8</td>
<td>2</td>
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</table>

Comparisons

The species from SA 11 has been assigned to Mediocris breviscula, despite its smaller maximum values for diameter and number of whorls, and the slightly smaller average length/diameter ratio. In comparison with the closely related Mediocris evolutis Rozovskaya, 1963, the Algerian specimen has fewer whorls, and also the outer whorl is less evolute. The single specimen from SA 13 resembles the smaller specimens of both Mediocris evolutis and M. breviscula.

ACKNOWLEDGEMENTS

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Popov, A.V. 1979. Carboniferous ammonoids of the Donets


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Manuscrito recibido: 30 de marzo, 2001
Manuscrito aceptado: 3 de diciembre, 2001

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**APPENDIX**

**Lithology of Hassi Kerma Formation (from sampling locality SA 17 downward) and Tagnana-III Member.**

<table>
<thead>
<tr>
<th>Locality</th>
<th>Thickness (m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA 17</td>
<td>Two banks of well-layered grey limestone (abundant débris of recrystallized algae)</td>
</tr>
<tr>
<td></td>
<td>Poorly exposed sequence; includes oolitic limestone and some friable sandstone</td>
</tr>
<tr>
<td></td>
<td>Dark grey limestone</td>
</tr>
<tr>
<td></td>
<td>Poorly exposed sequence; contains sandstone, quartzitic sandstone and thin beds of fossiliferous limestone</td>
</tr>
<tr>
<td></td>
<td>Yellow-greenish weathering, fossiliferous oolitic limestone</td>
</tr>
<tr>
<td></td>
<td>Poorly exposed sequence; probably mainly cross-beded sandstone</td>
</tr>
</tbody>
</table>

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Cross-bedded sandstone showing a limestone-breccia at its base

**Inferred upper boundary of Tagnana-III**

Dark grey limestone

**SA 13**
Poorly exposed sequence; includes shale occasionally with silicified mollusks, and thin beds of oolitic limestone

Grey limestone with *Syringopora*

Poorly exposed sequence including shale and thin layers of oolitic limestone

Yellow-brown weathering dolostone

Quartzitic sandstone alternating with grey and yellow-greenish oolitic limestone

**SA 11**
Massive limestone, possibly comparable with *calcaire massif gris en gros blocs* (Legrand-Blain, 1967, p. 304)

Friable or quartzitic sandstone

Fossiliferous (brachiopods) calcareous shale

**Unconformable contact?**

High limestone cliff (probably Tagnana-II Member)