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 foraminifera of the genera *Pseudoendothyra* (rare), *Pseudostaffella (Semistaffella)* (rare), *Millerella*, *Pseudonovella*, *Plectostaffella*, *Eostaffella* and *Mediocris*. The presence of *Eostaffellina* (rare) and *Endostaffella* is doubtful. The difference between *Millerella* and *Eostaffella* cannot be adequately defined by evolute versus involute coiling. *Pseudonovella* Kireeva, 1949 is redefined to include *Seminovella* Rauzer-Chernousova, 1951.

The foraminifera 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 Bashkirian, Tagnana Formation, Algeria.

RESUMEN

El miembro superior de la Formación Tagnana (Grupo Djebel Béchar, NO de Argelia), denominado informalmente Miembro Tagnana-3 o Tagnana-III, ha proporcionado foraminíferos, especialmente fusulinoideos, pertenecientes a los géneros *Pseudoendothyra* (escaso), *Pseudostaffella (Semistaffella)* (escaso), *Millerella*, *Pseudonovella*, *Plectostaffella*, *Eostaffella* y *Mediocris*. La presencia de *Eostaffellina* (escaso) y de *Endostaffella* es dudosa. En este trabajo se discuten las diferencias entre los géneros *Millerella* y *Eostaffella*, cuya separación no puede establecerse de manera adecuada sobre la base del carácter evoluto o involuto del arrollamiento del caparazón. Además, se redefine el género *Pseudonovella* Kireeva, 1949, incluyendo en él a *Seminovella* Rauzer-Chernousova, 1951.

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 conodontos 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.

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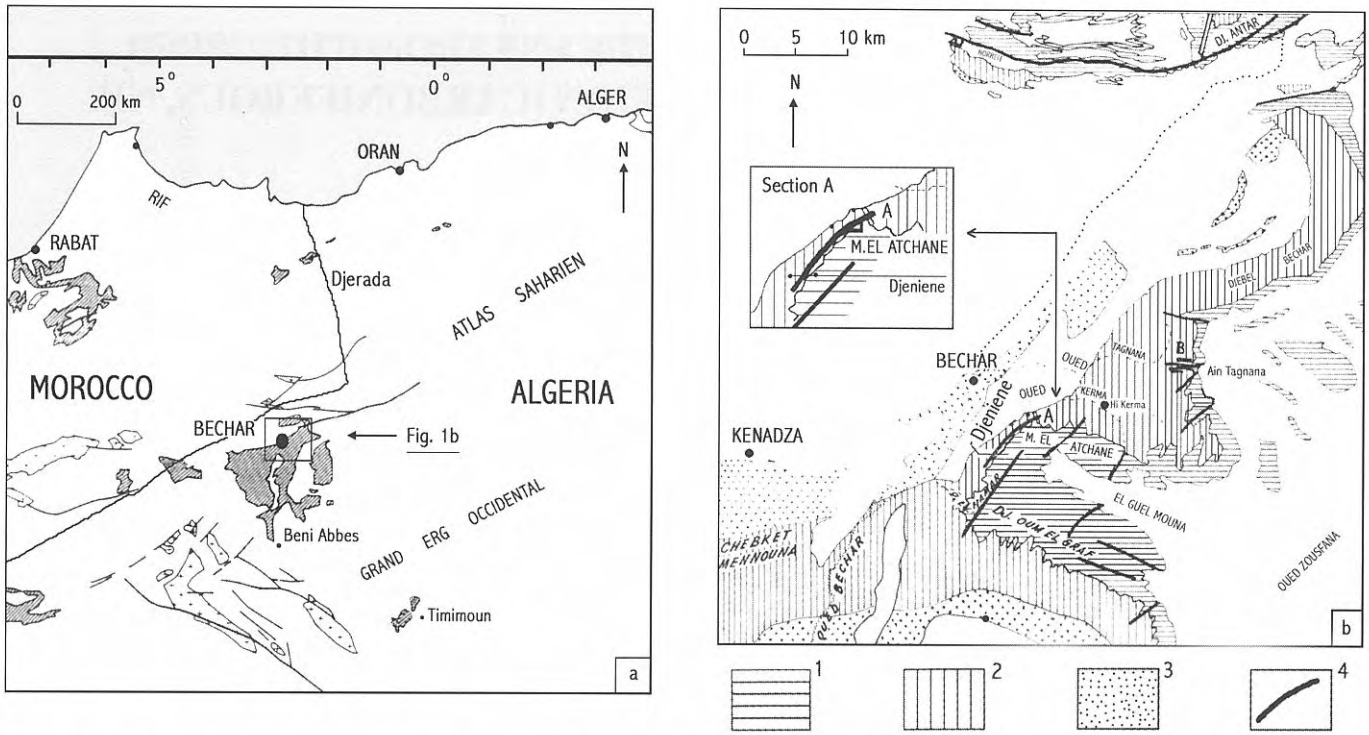

Figure 1. Geographical and stratigraphical location of the sampled section. **a** Modified after figure 2 of Legrand-Blain, 1986. Sketch-map showing the Carboniferous (striped area) in the Béchar Basin. The rectangle, enlarged in figure 1b, refers to the Carboniferous in the vicinity of Béchar city. **b** Modified after figure 1 of Legrand-Blain, 1967. Map showing section A of Legrand-Blain (see also inset) in the Djebel Béchar Group (2). Section A is close to the sampled section of the present paper.
1 = Zousfana Group (underlies the Djebel Béchar Group); 2 = Djebel Béchar Group (includes the Tagnana Formation); 3 = Kenadza Formation and the Béchar Basin coal measures (overlies the Djebel Béchar Group); 4 = Major faults.

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 Atchane, close to section A (Fig. 1; Legrand-Blain, 1967, fig. 1).

The present account considers foraminifera (mainly fusulinoideans) and conodonts from two sampling stations

located 3-8 m (sample SA 11) and 50-55 m (sample SA 13) above the top of the Tagnana-II Member (Fig. 3, Appendix). In addition to SA numbers, the section in Figure 3 shows also DZ and ML numbers, which refer to samples containing brachiopods. The ML numbers refer to the collections from corresponding sites in section A of Dr. M. Legrand-Blain and the DZ numbers (of the present section) to collections of Dr. C.F. Winkler Prins. The stratigraphic position of the DZ sites, which often correspond to ML sites in the A section, helped to verify the precise positions of the present and previous foraminiferal SA sampling stations.

The brachiopods and foraminifera from the DZ and SA sampling stations were collected in 1973 and are kept at the Leiden National Museum of Natural History (The Netherlands).

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 E 7 Limestone), comparable to the Siuransky (Ural Mountains), the Seslavinsky (Central Asia), or the Krasnopolyansky (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 *Pseudostaffella antiqua* Zone of the former USSR, below Zone 21 of Mamet, and below Zone Cf9 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 (55-65 m) overlying the Tagnana-

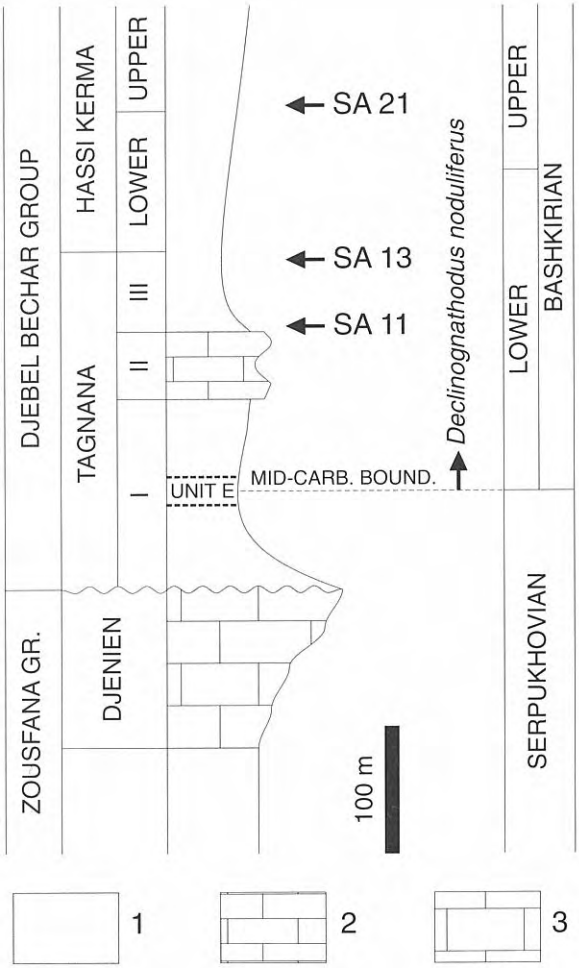

Figure 2. Stratigraphic position of the Tagnana Formation (including the sampls SA 13 and SA 11 in the Tagnana-III member).
1 = Alternation of carbonates and siliceous clastics; 2 = Carbonates; 3 = Mainly reefal and peri-reefal carbonates.

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

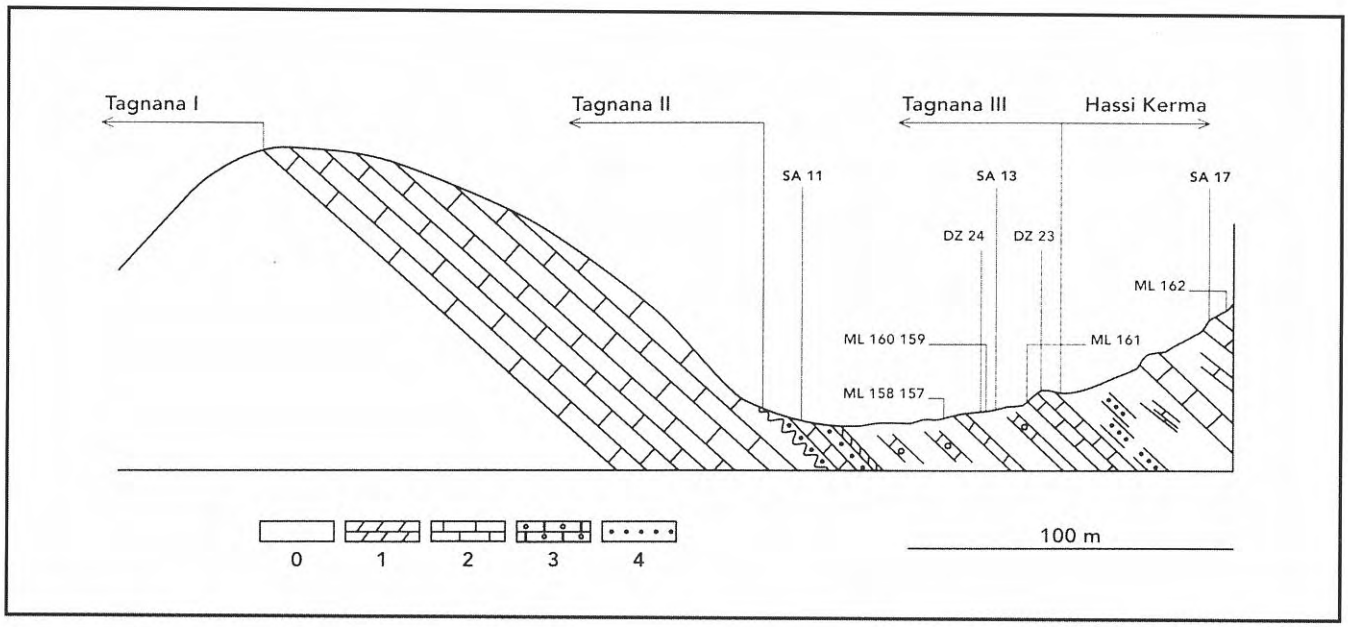

Figure 3. Position of samples SA 13 and SA 11 in the upper member (Tagnana-III) of the Tagnana Formation in the measured stratigraphic section. 0= Poorly exposed (mainly shale); 1= Dolostone 2= Limestone; 3= Oolitic limestone; 4= Sandstone and quarzitic sandstone.

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 parastruvei* (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 parastruvei

(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 parastruvei* does not permit to conclude that

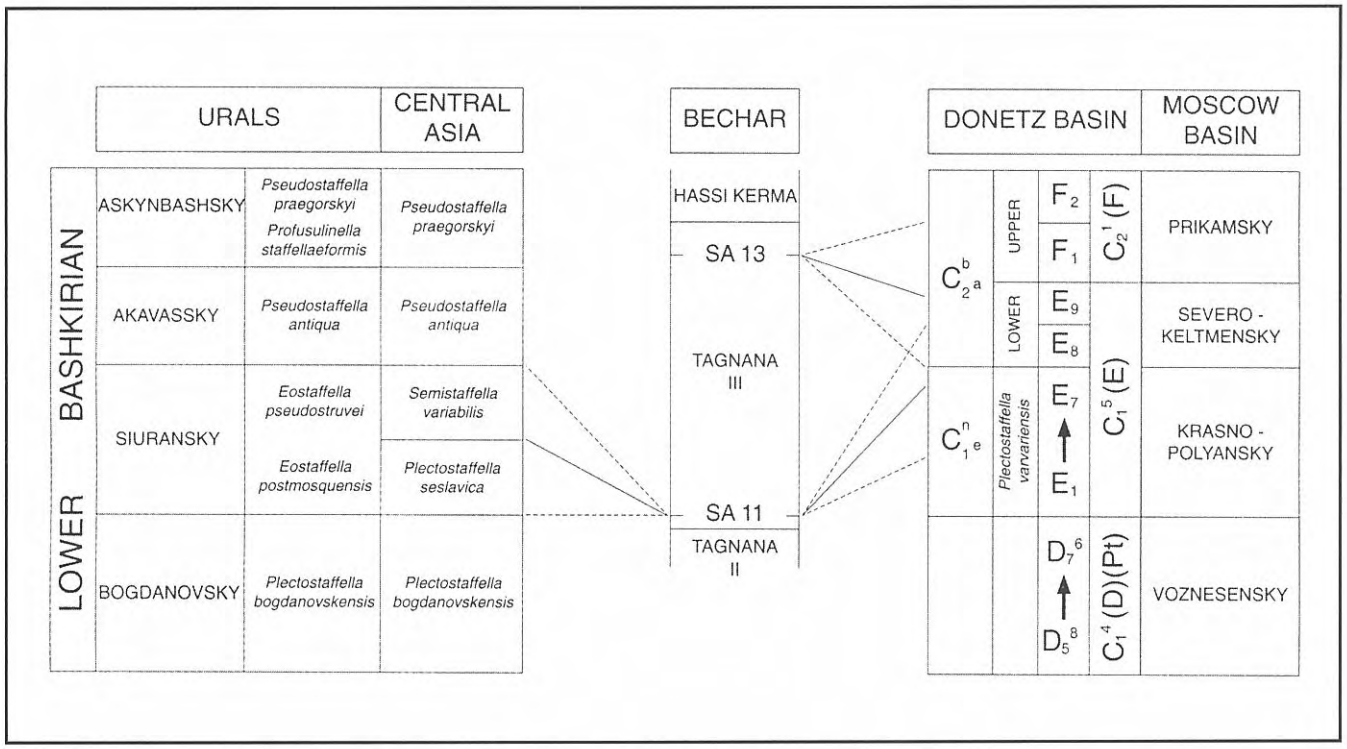

Figure 4. Upper and lower Tagnana-III beds at sampling localities SA 13 and SA 11 correlated with East European and Central Asean (bio)stratigraphic units. Correlations are based on foraminifera and conodonts. Full-drawn lines represent the most likely correlations, dashed lines the extreme possibilities.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

the final whorl is involute. However, even if fully involute coiling could be confirmed, Eurasian Lower Carboniferous (partially) evolute 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 parastruvei* 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 *Ozawainella* have more likely a tunnel.

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-c, 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* Mamet, 1981 (see Armstrong and Mamet, 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 pseudostruvei* (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 topotypical material of this species should be restudied. That applies to *Eostaffella parastruvei* 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 pseudostruvei* (Rauzer-Chernousova 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 jakhensis* (Reitlinger, 1971) do not occur above the lower part of the Tagnana III Member, whereas species close to *Plectostaffella varvariensis* (Brazhnikova and Potievska, 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. *pseudostruvei* 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. *pseudostruvei* seems more likely. *Pseudostaffella antiqua* (Dutkevitch, 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 (Semistaffella) 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 *Mediocris 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* (Dutkevich, 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 Conil'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 [(C1-5 (E) suite] and not above the F1 Limestone [C2-1 (F) suite].

Conodonts

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

The *Idiognathoides sinuatus* Zone in the Donets Basin

Biozone	+	–	o	n=7
C2b-b	5	1	1	
C2b-a(upper part)	3	3	1	
C2b-a(lower part)	0	5	2	

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 occur 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.

extends from the E1 Limestone up to and including the F1/1 Limestone. (Nemyrovskaya, 1982, fig. 1).

Recent re-examination of the same collection by Nemyrovska resulted in the following identifications: *Declinognathodus lateralis*, *Declinognathodus lateralis*(-> *Decl. pseudolateralis*), *Idiognathoides sinuatus*, *Idiognathoides corrugatus*, *Idiognathoides sulcatus parvus*, *Idiognathoides macer*(?), *Idiognathodus* sp. (early form, resembles *Streptognathodus nodosus* of Higgins, 1975), *Aethotaxis advena* (A1a+ A1b elem. + A2). This assemblage indicates either the uppermost part of the C1-5 (E) suite or some level of the C2-1 (F) suite of the Donets Basin (Dr. T.I. Nemyrovska, written communication, 1998).

Correlations with the Donets/Moscow Basins (summarized)

Foraminifera: E8-F1 Limestone Formations of Donets Basin.
Conodonts: Krasnopolyansky or Severokeltmensky (M. van den Boogaard).
E9 or F Limestones (upper part Severokeltmensky or Prikamsky) (T.I. Nemyrovska).

CORRELATIONS BY FORAMINIFERA AND CONODONTS FROM SAMPLE SA 11

Foraminifera

The fusulinoideans (and a few other foraminifera) from sample SA 11 have been compared with similar species from the Donets Basin, Urals and Central Asia. The sampling locality yielded the following species. *Pseudoendothyra* ex gr. *struvii* (von Möller, 1879), *Pseudonovella* spp., *Millerella* cf. *pseudostruvei* (Rauzer-Chernousova and Belyaev, 1936), *Millerella angusta* (Kireeva, 1951), *Millerella yugorskensis* (Solovieva, 1984), *Millerella* spp. ex gr. *Millerella pseudostruvei*, *Millerella* ex gr. *chomatifera* (Kireeva, 1951), *Millerella* cf. *paraumbilicata* Manukalova *et al.*, 1969, *Millerella* aff. *paraumbilicata*, *Plectostaffella* aff. *varvariensis* (Brazhnikova and Potievska, 1948), *Plectostaffella jakhensis* (Reitlinger, 1971), *Plectostaffella*? sp., *Eostaffellina* cf. *libera* (Rumyantseva, 1970), *Eostaffella* ex gr. *parastruvei* (Rauzer-Chernousova, 1948b), *Eostaffella* aff. *chusovensis* Kireeva, 1951, *Endostaffella*? sp., *Mediocris breviscula* (Ganelina, 1951), *Eolasiodiscus* aff. *donbassicus* Reitlinger, 1956 [single specimen: 11/36(5)].

Biozone	+	–	o	n=19
C2b-b	17	0	2	
C2b-a (upper part)	14	2	3	
C2b-a (lower part)	9	3	7	
C1n-e	2	12	5	

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.

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 fusulinoideans 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 Mandrykinskaya 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

Mainly after data of Sinitsyna and Sinitsyn (1987), Groves (1988), and Kulagina *et al.* (1992).

A comparison of fusulinoideans 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

"Horizon"	Biozone*	+	–	o	n=23
Akavassky	*Ps. antiqua*	16	2	5	
Siuransky	*Semist. variabilis*	8	5	10	
Siuransky	*Plect. seslavica*	4	8	11	
Bogdanovsky	*Plect. bogdanovkensis* (Upper subzone)	0	11	12	
Bogdanovsky	*Plect. bogdanovkensis* (Lower subzone)	0	18	5	

Table 3. Foraminiferal content of sample SA 11 (twenty-three species) compared with a succession of biozones in Central Asia. Explanation of symbols as in Table 1. * Biozones for Southern Urals and Central Asia after Kulagina *et al.*, 1992.

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 seslavica* and *Plectostaffella bogdanovkensis* (Akavassky-Bogdanovsky). This high number of conspecific or close forms decreases to eleven to thirteen in the overlying *Pseudostaffella praegorskyi* Zone (Askynbashky) and the underlying zones of *Plectostaffella posochovae* and *Eosigmoilina explicata* (Ustsarbaisky). 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 seslavica* and *Semistaffella variabilis* zones (Table 3, Fig. 4).

Results may be summarized as follows. Comparison of the assemblage from SA 11 with the Donets fusulinoideans points to the C1-5 (E) suite (not above the E8 Limestone), whereas a comparison with Bashkiria, S Urals, 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 Severokeltmensky" (Dr. M. van den Boogaard, 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 minutus*, and *Aethotaxis* sp. (A1 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 Severokeltmensky (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 Severokeltmensky of Moscow Basin).

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

Conodonts: Krasnopolyansky or Severokeltmensky (van den Boogaard).

Upper E Suite (Donets Basin), or uppermost Krasnopolyansky to Severokeltmensky (Moscow Basin) (Nemyrovska).

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.

Pseudoendothyra Mikhailov, 1939

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

Pseudoendothyra ex gr. *struvii* (von Möller, 1879)
Fig. 5 r,s

Sample: SA 11.

Measurements:

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

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 subrhomboidal; 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 forwardly inclined.

Comparisons

If indeed the two specimens are adults, they represent a small species resembling *Pseudoendothyra struvii*, *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**. *Mediocris breviscula* (Ganelina, 1951), specimen 13/3(4); **r,s**. *Pseudoendothyra* ex gr. *struvii* (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.

struvii 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 *Pseudoendothyra 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:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
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 *Eostaffellina 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 *Eostaffella (Seminovella)* Rauzer-Chernousova, 64-66.
1963 *Millerella* Thompson (part); Rozovskaya, 110.
1963 *Pseudonovella* Kir.; Rozovskaya, 111-112.

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 synonomy 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) evolute inner whorls; outer whorl(s) often show a trend towards involute coiling.

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

Stratigraphic range

Bashkirian-Lower Permian. Notably Upper Bashkirian-Lower Moscovian.

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):

Millerella vivax Solovieva, 1991, *M. symmetrica* Manukalova *et al.*, 1969, *Eostaffella (Millerella) carbonica*, *E. (Seminovella) keltmensis* Rauzer-Chernousova, 1951, *Millerella (Seminovella) fragilis* Vakarchuk *in* Brazhnikova *et al.*, 1967, *M. (S.) donetziana* Potievskaya, 1964, *M. paraconcinna* Manukalova *et al.*, 1969, *Eostaffella dolixa* Manukalova, 1950, and *E. lativoluta* Reitlinger, 1961.

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

Bashkirian-Lower Permian.

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

Novella? *aperta* Grozdilova and Lebedeva, 1950, *Eostaffella (Millerella) variabilis* Rauzer-Chernousova, 1951, *Millerella nataliae* Maslo, 1993, *Eostaffella (Seminovella) elegantula*, and *E. (Millerella) uralica* Kireeva, 1951.

Species small to fairly large. Often deep and wide umbilical depressions. Secondary deposits absent or more commonly in the form of pseudochomata. These species differ from species of the *carbonica* group in the generally more widely arched periphery of the outer volutions. The outer volution is evolute, 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.

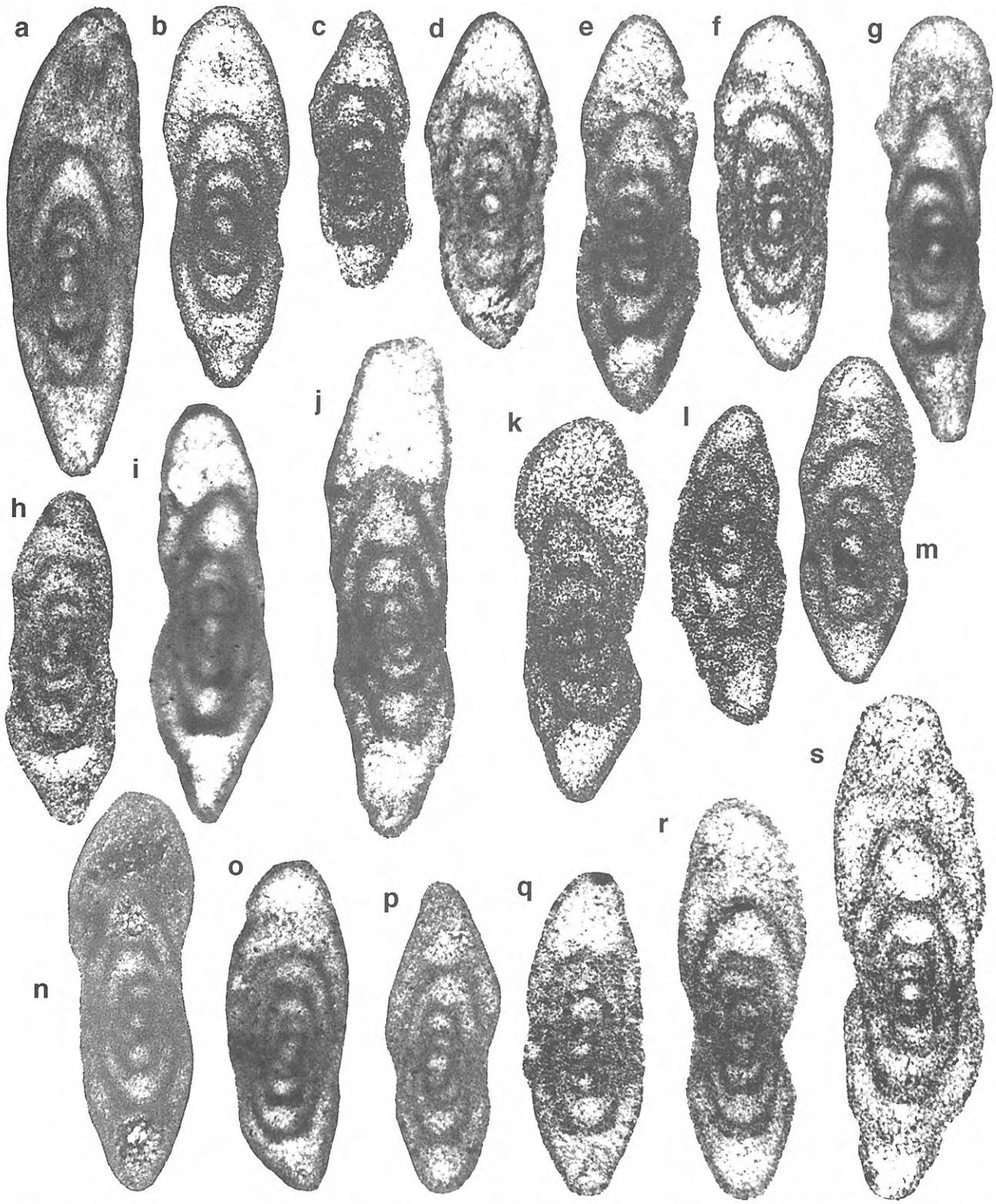

Figure 6. *Millerella* ex gr. *acutissima* (Kireeva, 1949), specimens **a.** 13/24, **b.** 13/73, **c.** 13/71(2), **d.** 13/11(2), **e.** 13/80, **f.** 13/7(1), **g.** 13/15(1), **h.** 13/51, **i.** 13/79, **j.** 13/52(2), **k.** 13/48, **l.** 13/83, **m.** 13(71(1), **n.** 13/52(1), **o.** 13/65(1), **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* Brazhnikova, 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):

Millerella graciosa Manukalova *et al.*, 1969, and *M. 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.

5. *Pseudonovella* ex gr. *irregularis* Kireeva, 1949.

Novella (Pseudonovella) irregularis, *Eostaffella nautiloides* Manukalova, 1950, *Pseudonovella venusta* Ryazanov, 1958, and *Millerella megasphaerica* Chen and Wang, 1983.

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 13.

Measurements:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th	R.v.	F.r.
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.	F.r.
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 paraconcinna* (Manukalova *et al.*, 1969). Less similar is *Millerella_prilukiensis* 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.	F.r.
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 paraconcinna* (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 pseudostruvei* 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.	F.r.
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
41(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	-	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**. 11/9(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:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th	R.v.	F.r.
69(1)	4.5	25	98	156	340	0.45	10	192	0.40
21(3)	4.5	36	124	210	428	0.42	13	226	0.40
9(1)	4	28	116	206	372	0.43	9	208	0.38
23(1)	4	34	128	212	376	0.39	12	220	0.34

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 pseudostruvei* (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 uralica* 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:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th	R.v.	F.r.
69(3)	4.5-5	20	86	150	348	0.38	10	196	0.34
33(5)	4	-	112	184	300	0.32	7	176	0.27
56(2)	3.5	26	108	184	244	0.41	8	140	0.36
69(2)	3.5	30	116	200	260	0.37	7	148	0.30

Comparisons

Like *Pseudonovella* sp 5, this small species also resembles *Millerella* of the *Millerella pseudostruvei* species group. Particularly similar are *Pseudonovella variabilis* (Rauzer-Chernousova, 1951), *P. uralica* (Kireeva, 1951), *P. graciosa* (Manukalova *et al.*, 1969), and *Millerella pseudostruvei* var. *losovskensis* (Manukalova *et al.*, 1969). The type specimen of *Pseudonovella variabilis*, in comparison with the Algerian specimens, shows relatively low and wide whorls. In this respect, the Algerian form is closer to *Pseudonovella uralica* and *Pseudonovella graciosa*. The two latter species have more whorls, and a smaller diameter at corresponding volutions. *Millerella pseudostruvei* var. *losovskensis* has a thicker wall, probably somewhat better developed secondary deposits, and larger maximum values for diameter of shell and proloculum.

Remarks on the *Pseudonovella* species from the Tagnana Formation

The *Pseudonovella* species from samples SA 11 and SA 13 resemble forms of the *Pseudonovella carbonica* and *Pseudonovella elegantula* species groups as well as some *Millerella* species (e. g. *M. grozdilovae* and *M.* ex gr. *pseudostruvei*). Therefore, some of them must be considered as transitional species. Wall structure and development of (discontinuous) chomata of the Algerian forms are essentially similar to these features in *Millerella* (see Moore, 1964 for a detailed description regarding the wall structure on the type species of *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).

Wh.no.	1	2	3	4	5
E	42	**56**	**56**	**47**	**56**
C	**58**	44	44	**47**	33
I				6	11

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 halfwhorl 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 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:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	3.6	27	109	200	297	0.33	8	170	0.28
s	0.4	2	12	26	61	0.05	1.1	36	0.05
n=6	4								

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.

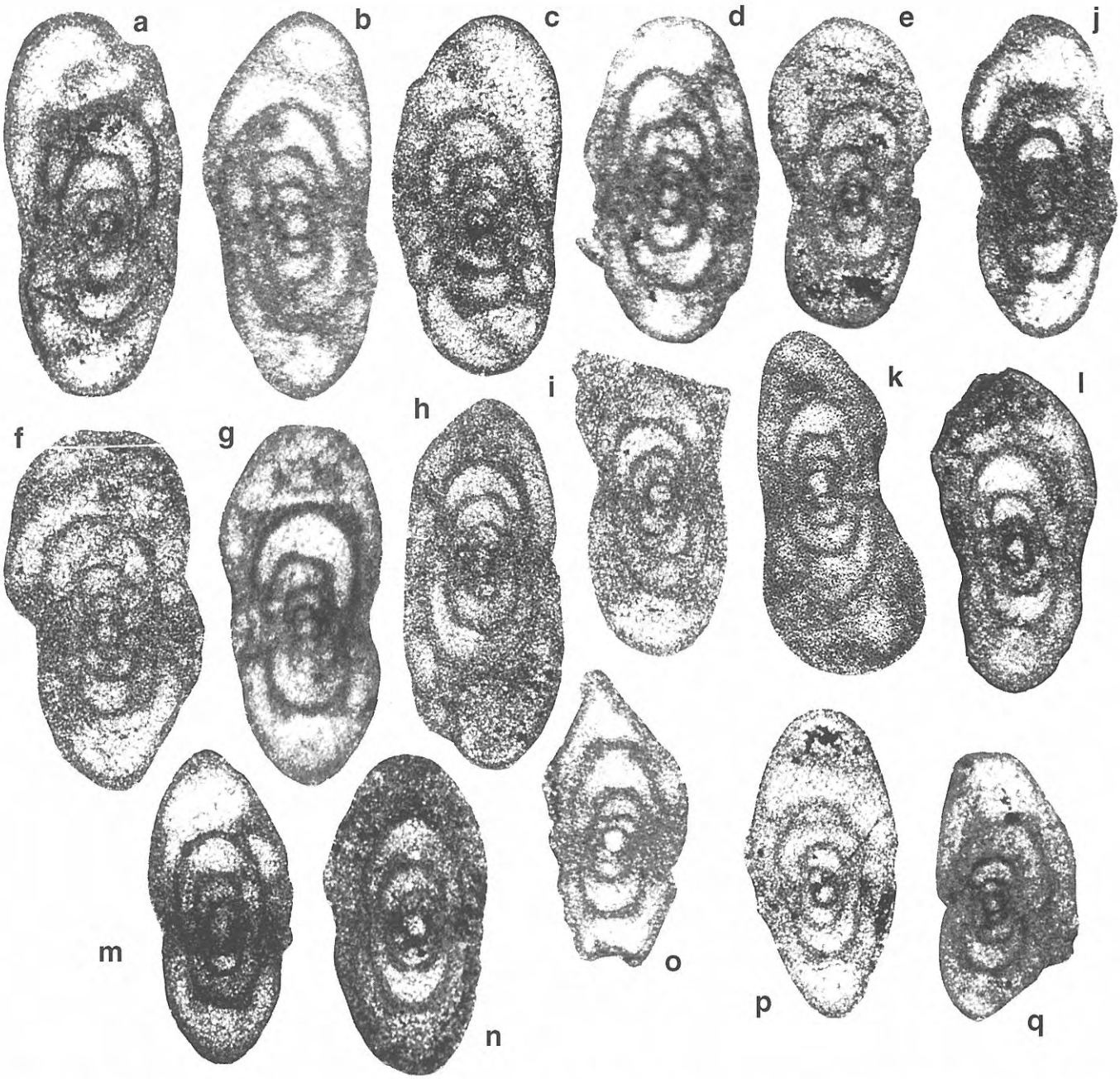

Figure 8. *Millerella* cf. *pseudostruvei* (Rauzer-Chernousova and Belyaev, 1936), specimens **a**. 11/39, **b**. 11/87(1), **c**. 11/99(2), **d**. 11/90(1), **e**. 11/17(5), **f**. 11/51(2), **g**. 11/17(2), **h**. 11/33(1), **i**. 11/48(3), **j**. 11/90(2), **k**. 11/26(1), **l**. 11/37(2), **m**. 11/69(4), **n**. 11/45(3), **o**. 11/18(1), **p**. 11/21(5), **q**. 11/68(1). Axial sections. All x160 (SA 11).

[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 marblensis* 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 depresssions, 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 pseudostruvei* [e.g. *Millerella pseudostruvei*

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:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	3.9	26	118	220	397	0.31	9	224	0.28
s	0.1	2.5	10	22	29	0.03	1.7	22	0.02
n=7		5	4	4				5	5

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:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.2	25	112	206	427	0.33	9	246	0.28
s	0.3	3.5	14	26	75	0.04	1.3	47	0.04
n=19		17							

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 marblensis* by Hoare and Sturgeon (1994, OSU 47727, fig. 3-27). Some specimens suggest a relationship with species of the group of *Millerella pseudostruvei* 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.

Wh.no.	1	2	3	4	5
S	27	23	3		
A	**60**	**65**	31	9	**42**
A(blp)		12	**37**	18	29
Blp	13		22	**36**	29
P(blp)			7	21	
P				16	

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.

Wh.no.	1	2	3	4	5
E	**75**	26	15	35	**75**
C	25	**67**	**70**	**50**	10
I		7	15	15	15

Table 6. Development of evolute versus involute coiling in *Millerella* ex gr. *acutissima* (explanation as in Table 4).

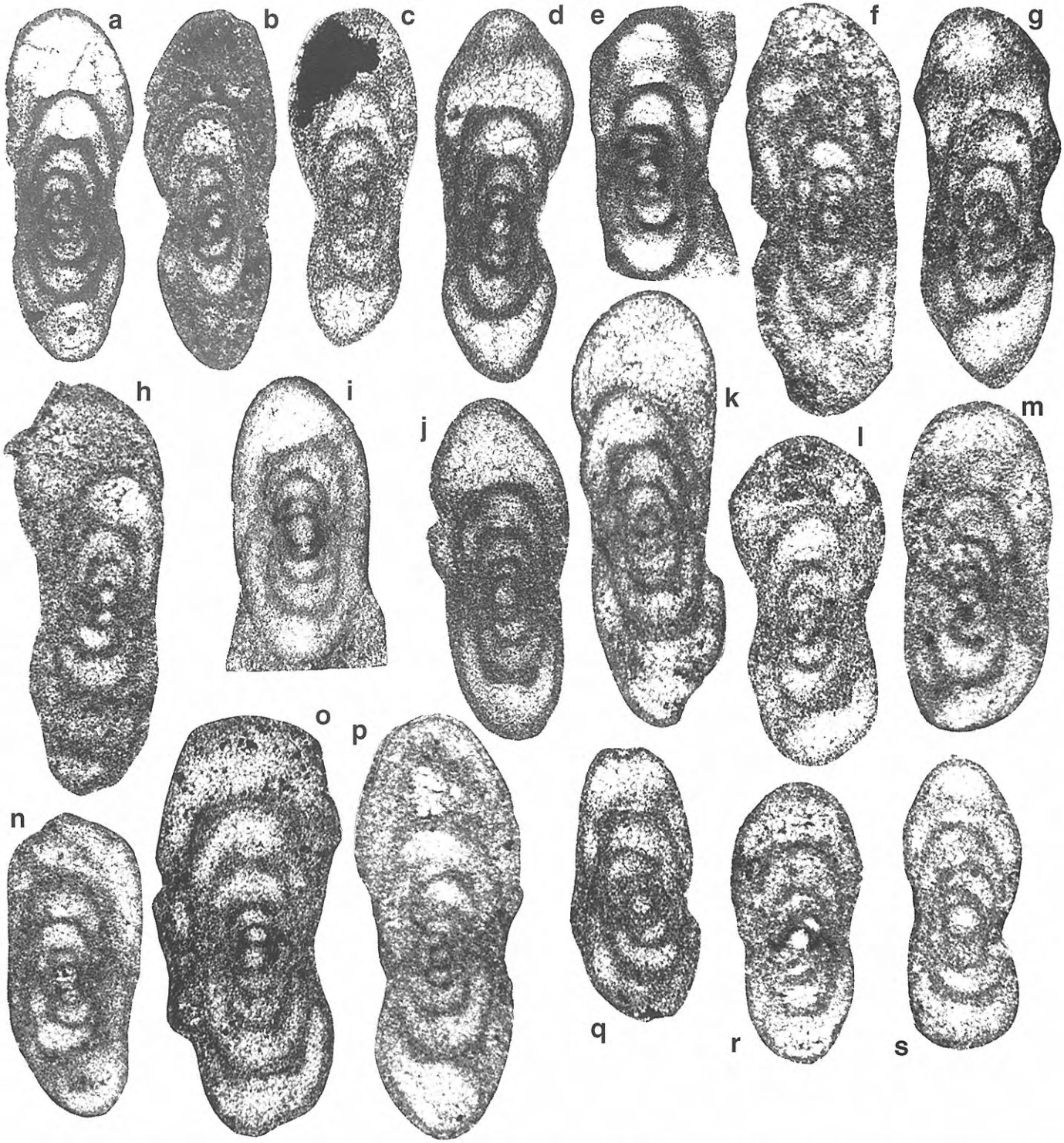

Figure 9. *Millerella angusta* (Kireeva, 1951), specimens **a**. 11/83(1), **b**. 11/1(1), **c**. 11/99(3), **d**. 11/64(2), **e**. 11/83(7), **f**. 11/44(4), **g**. 11/81(6), **h**. 11/78(2), **i**. 11/17(4), **j**. 11/56(1), **k**. 11/20(5), **l**. 11/21(9), **m**. 11/33(3), **n**. 11/33(4), **o**. 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

Millerella ex gr. *acutissima* contains small and slender species, showing an acute periphery, and partially evolute, occasionally involute coiling. The Eurasian species here considered to belong to this group are besides *Millerella acutissima*, also *M. suixiensis* Wang, 1981, *M. samarica* Reitlinger, 1961, *Eostaffella levencovica* Manukalova *et al.*, 1969, *Millerella paracarbonica* Manukalova *et al.*, 1969, *M. elevata* Han and Zhao, 1984 (in Zhao *et al.*), and *M. extensa* Marshall, 1969 (see also Maslo and Vachard, 1997, p. 47, 48).

Wh.no.	1	2	3	4	5
S	23	29	16	2	
A	**65**	**65**	**61**	37	37
A(blp)	4	3	23	**48**	**63**
Blp	8	3		10	
P(blp)				3	
P					

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

Sample: SA 11.

Measurements:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.15	27	111	192	363	0.49	9.5	207	0.43
s	0.4	2.5	16	28	54	0.03	1.5	30	0.04
n=17		16					13		

Description

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

Coiling is planispiral, or inner one to two whorls are at a moderate angle to subsequent whorls. Volutions are evolute (first whorl), in contact (second whorl), involute (third-fourth whorls), 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 *Eostaffella 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.

Wh.no.	1	2	3	4	5
E	**58**	24	6		
C	42	**47**	44	24	**64**
I		29	**50**	**76**	36

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

Wh.no.	1	2	3	4	5
S	18	22	21	3	
A	**79**	**72**	**53**	**42**	29
A(blp)			23	29	**42**
Blp	3	6	3	26	29
P(blp)					
P					

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

Sample: SA 11.

Measurements:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.1	27.5	114	200	363	0.42	9	209	0.37
s	0.4	5	18	30	66	0.05	2	39	0.05
n=22		21							

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 whorls and shallow to deep in the outer whorls. Peripheral rim is predominantly arched in whorls 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 whorls. Coiling is evolute or in contact (first whorl), in contact (second-fourth whorls), and evolute (fifth whorl) (Table 10).

Except for the initial one or two whorls which are single-layered, the spirotheca shows a tectum overlying a thicker,

Wh.no.	1	2	3	4	5
E	**50**	30	5	32	**70**
C	**50**	**40**	**60**	**36**	30
I		30	35	32	

Table 10. Development of evolute versus involute coiling in *Millerella angusta* (explanation as in Table 4).

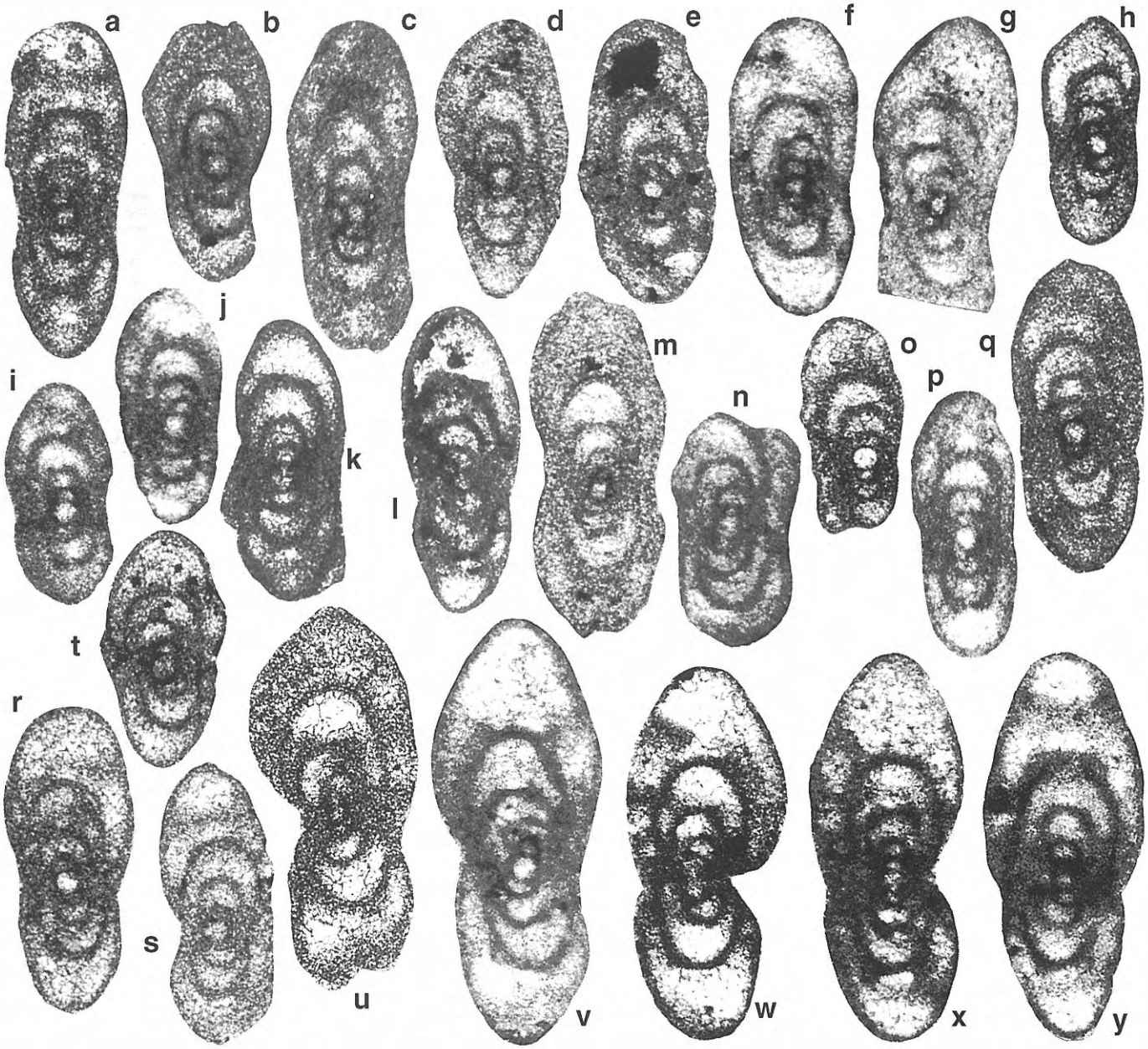

Figure 10. a-t. *Millerella jugorskensis* (Solovieva, 1984), specimens **a**. 11/37(1), **b**. 11/67, **c**. 11/16(2), **d**. 11/24(5), **e**. 11/42(3), **f**. 11/26(3), **g**. 11/5(5), **h**. 11/20(3), **i**. 11/26(4), **j**. 11/22(3), **k**. 11/81(2), **l**. 11/58(1), **m**. 11/41(6), **n**. 11/79(1), **o**. 11/23(4), **p**. 11/78(1), **q**. 11/44(6), **r**. 11/34(2), **s**. 11/44(5), **t**. 11/63(5); **u-y.** *Millerella* sp.1 ex gr. *M. pseudostruvei* (Rauzer-Chernousova and Belyaev, 1936), specimens **u**. 11/66(2), **v**. 11/84, **w**. 11/7(3), **x**. 11/76, **y**. 11/17(3). Axial sections. All x160 (SA 11).

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

Wh.no.	1	2	3	4
S	15	19		8
A	**85**	**75**	**75**	25
A(blp)		6	25	**67**
Blp				
P(blp)				
P				

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 whorls, being up to five for *Millerella* sp. and up to four and one half for the Algerian species. The form identified as *Eostaffella pseudostruvei* 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 spirotheca, slightly greater number of whorls, and slightly smaller proloculum; it is very similar to the specimens here distinguished as Form C. Another related species may be *Millerella porcupinensis* 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)

Fig. 10 a-t

Sample: SA 11.

Measurements:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	3.75	24.5	103	183	290	0.45	8	163	0.39
s	0.25	2.6	9	21	39	0.05	0.9	22	0.04
n=23		22			22	22	20		

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 whorls 1-4 are shown in Table 11.

Specimens show skew coiling in the two first whorls 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.

Wh.no.	1	2	3	4
E	**68**	**44**	12	12
C	32	**44**	**50**	38
I		12	38	**50**

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

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

Fig. 10 u-y

Sample: SA 11.

Measurements:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.35	23	99	174	382	0.43	9	220	0.37
s	0.15	3.5	7	12	24	0.03	1	19	0.03
n=5		4							

Description

Shell shape changes from nautiliform (first-third whorls) to discoidal (fourth-fifth whorls); the last whorl usually shows conspicuous umbilical cavities. The periphery is predominantly arched or flat (first-second whorls), 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 whorls. Volutions are predominantly evolute in the first two whorls and mainly in contact in the following whorls. 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 pseudostruvei shows a slightly wider arched peripheral rim in outer whorls, and possibly shallower umbilical depressions. *Millerella bigemmicula* Igo, 1957 has slightly fewer volutions and a larger proloculum. The diameter of the fourth whorl is slightly greater and the spirotheca is slightly thicker. Secondary deposits may be better developed. Less similar is

Figure 11. a-g. *Millerella* sp. 2 ex gr. *M. pseudostruvei* (Rauzer-Chernousova and Belyaev, 1936), specimens **a**. 11/88(2), **b**. 11/70, **c**. 11/81(3), **d**. 11/34(6), **e**. 11/34(1), **f**. 11/50(1), **g**. 11/6(9); **h-j.** *Millerella* sp. 3 ex gr. *M. pseudostruvei* (Rauzer-Chernousova and Belyaev, 1936), specimens **h**. 11/74(1), **i**. 11/58(2), **j**. 11/65(3); **k.** *Millerella* or *Eostaffella*, specimen 79(3). **a-g, h-j**. axial sections (all x160); **k**. sagittal section (x70). All SA 11.

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. *pseudostruvei* sp. 2.

Remarks

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

Eostaffella alongensis Saurin, 1967, *E. amabilis* Grozdilova and Lebedeva, 1954, *E. etoi* Ota, 1971, *E. evolutica* Rumyantseva, 1970, *E. excavata* Niko, 1987, *E. instabilis* Ektova, 1976, *E. (E.) pseudostruvei angusta* Kireeva, 1951, *E. pseudostruvei yugorskensis* Solovieva, 1984, *E. (Millerella) umbilicata* Kireeva, 1951, *Millerella bigemmicula* Igo, 1957, *M. concinna* Potievskaya, 1964, *M. komatui* Igo, 1957.

Eostaffella postmosquensis Kireeva, 1951, *E. akiyoshiensis* Sada, 1975, and *E. cumberlandensis* Rich,

Wh.no.	1	2	3	4	5
S	9	8	7		
A	**91**	**92**	**58**	21	**62**
A(blp)			21	36	13
Blp			14	**43**	25
P(blp)					
P					

Table 13. Development of the degree of angularity of the peripheral rim in *Millerella* sp. 2 ex gr. *pseudostruvei* (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. pseudostruvei* but to the more primitive species group of *E. parva* (Möller, 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 *pseudostruvei* species group probably descended from *Endostaffella* as well.

Millerella sp. 2 ex gr. *M. pseudostruvei* (Rauzer-Chernousova and Belyaev, 1936)

Fig. 11 a-g

Locality: SA 11.

Measurements:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.45	21	99	186	434	0.44	10.5	239	0.39
s	0.3	3	9	23	61	0.02	1	31	0.03
n=7		5	6						

Description

Inner volutions are nautiliform or lenticular; outer whorls discoidal. The umbilical region in the inner whorls is usually flat, occasionally slightly umbonate; 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 whorls, which usually are at an angle to subsequent whorls. Slight axial shifts may occur throughout growth. Volutions are usually in contact in whorls 1-2, mainly involute in whorls 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 whorls 1.5-2.5 and take the form of low or moderately high and relatively wide, discontinuous, chomata which have fairly steep slopes at the side of the tunnel (up to 90 degrees near the tunnel openings).

Comparisons

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

Wh.no.	1	2	3	4	5
E	25	16		16	**42**
C	**62**	**42**	7	16	**42**
I	13	**42**	**93**	**68**	16

Table 14. Development of evolute versus involute coiling in *Millerella* sp. 2 ex gr. *pseudostruvei* (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 nautiliform and involute.

Millerella sp. 3 ex gr. *M. pseudostruvei* (Rauzer-Chernousova and Belyaev, 1936)

Fig. 11 h-j

Sample: SA 11.

Measurements:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
65(3)	4.5	24	108	204	452	0.38	11	244	0.35
74(1)	4-4.5	23	108	182	392	0.44	10	232	0.37
58(2)	4.5	23	102	194	484	0.40	10	272	0.35

Description

Specimens are discoidal and have flat or clearly depressed umbilical areas. The periphery changes from flat (first whorl), arched (second-third whorls), arched to bluntly pointed (fourth whorl) to arched (fifth whorl). The initial whorl is at an angle to the second whorl; the axis of coiling is not fully stable in succeeding whorls. Coiling is evolute or in contact (first whorl), in contact or involute (third-fourth whorls), and again evolute (fifth whorl). Chomata are discontinuous, and usually fairly high adjacent to the septa. The wall consists of tectum and a thicker, more translucent, lower layer.

Comparisons

The present species resembles *Millerella* sp. 2 ex gr. *M. pseudostruvei* described above, but differs in the slight angular shifts of the axis of coiling during growth, whereas *Millerella* sp. 2 is planispiral. There could be a relationship with *Plectostaffella longiscula* Rumyantseva and Orlova *in* Kulagina *et al.* (1992) which species probably belongs to the *Plectostaffella varvariensis* species group. However, the Algerian specimens are considered closer to *Millerella* than to *Plectostaffella*.

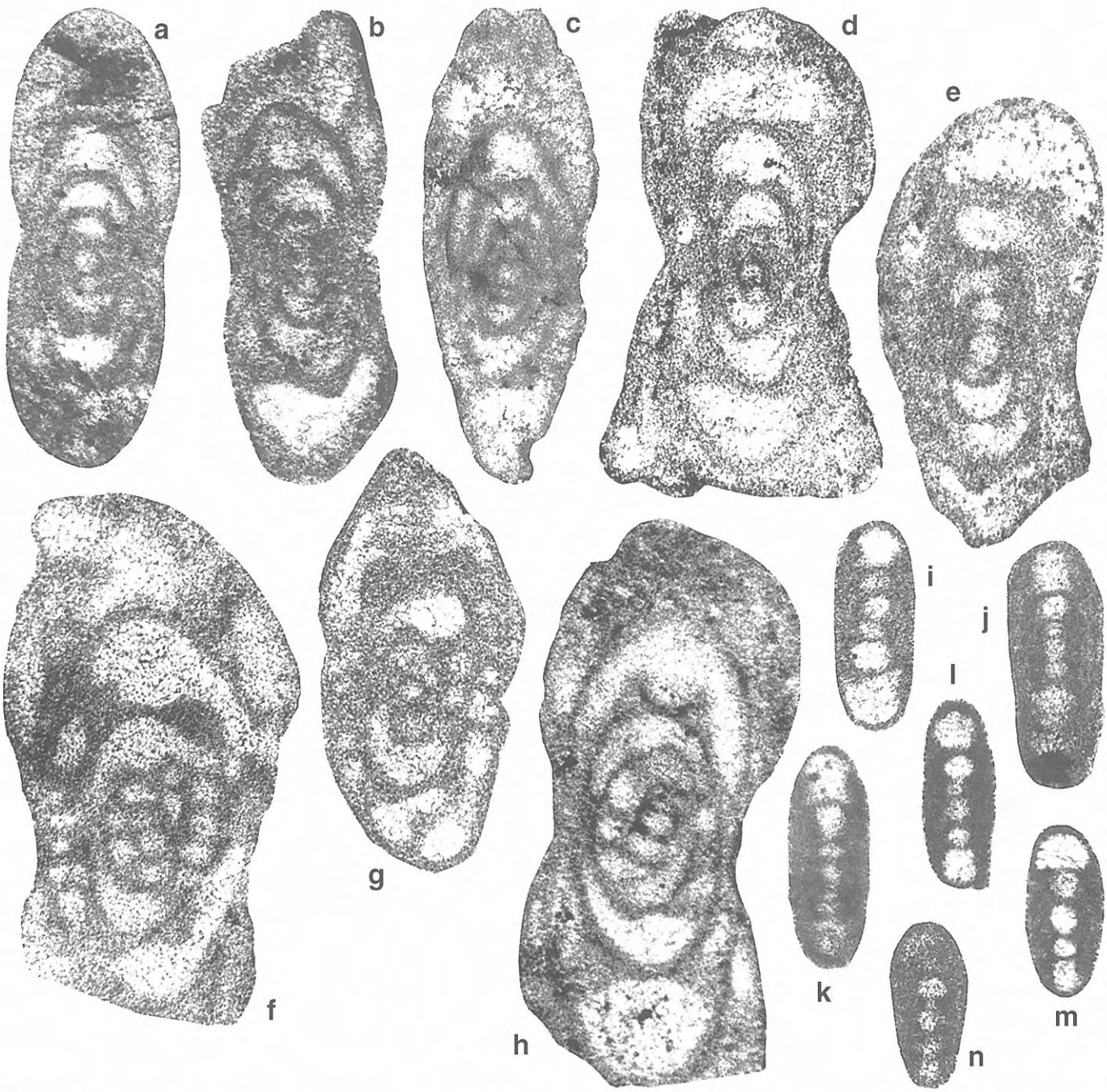

Figure 12. a-c. *Millerella* ex gr. *chomatifera* (Kireeva, 1951), specimens **a**. 11/9(3), **b**. 11/24(4), **c**. 13/20(1); **d,e.** *Millerella* cf. *paraumbilicata* Manukalova *et al.*,1969, specimens **d**. 11/44(1), **e**. 11/78(3); **f-h.** *Millerella* aff. *paraumbilicata* Manukalova *et al.*,1969, specimens **f**. 11/49(1), **g**. 11/62(2), **h**. 11/24(2); **i-n.** *Mediocris breviscula* (Ganelina, 1951), specimens **i**. 11/62(4), **j**. 11/9(4), **k**. 11/46(5), **l**. 11/77(2) **m**. 11/91(6), **n**. 11/31(5). Axial sections. All x160 (SA 11; specimen **c**: SA 13).

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

Fig. 12 a-c

Sample: SA 11 and SA 13.

Measurements:

Specimen No.	wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
(SA 11)									
24(4)	4.5	22	124	210	460	0.38	9	244	0.36
9(3)	4.5	26	108	208	450	0.37	12	248	0.34
1(2)	5.5	22	104	180	528	0.36	12	300	0.31
(SA 13)									
20(1)	4-4.5	27	120	224	480	0.35	10	284	0.30
42(1)	4-4.5	19	105	195	416	0.45	9.5	264	0.38
20(2)	3.5-4	32	140	278	432	0.42	9	240	0.37

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 chomatifera* (Kireeva, 1951) (= *Eostaffella pseudostruvei chomatifera* 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 chomatifera* differs in shape: plano-nautiliform in *Millerella chomatifera* 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 *Eostaffella postmosquensis acutiformis* of Groves (1991).

Remarks

Species closely related to *Millerella pseudostruvei* but showing better developed chomata are included in the species group *Millerella chomatifera*. In addition to *Eostaffella chomatifera* Kireeva, 1951, the present report includes the following species: *Eostaffella citata* Bogush and Yuferev, 1962, *E. designata chaoxianensis* Wang, 1981, *E. endothyroidea* Chang, 1962, *E. fenghuangshanensis*, Wang, 1981, *E. klautzanae* Grozdilova and Lebedeva, 1960, *E. mixta* Rauzer-Chernousova, 1951, *E. paraendothyroidea* Rich, *Millerella inflecta* Thompson, 1945, *M. paraumbilicata* Manukalova *et al.*, 1969, *M. pinguis* Thompson, 1994, and *M. porcupinensis* Ross, 1967. (See also Maslo and Vachard, 1997, p. 44).

Millerella cf. *paraumbilicata* Manukalova *et al.*, 1969

Fig. 12 d,e

Sample: SA 11.

Measurements:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
44(1)	4.5(5)	27	108	200	472	0.40	11	276	0.34
78(3)	4.5	34	120	212	432	0.51	14	248	0.44

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 *Eostaffella*? 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:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
24(2)	4.5(5)	-	176	284	608	0.47	16	320	0.45
49(1)	4.5	35	168	312	(625?)	-	12	372	0.43
62(2)	3.5	30	160	312	420	0.49	12	244	0.42

Description

Large shell in comparison with other fusulinoideans from the present locality. Inner 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 Yuferev, 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: *Eostaffella*? (*Plectostaffella*) *jakhensis* Reitlinger, 1971.

Plectostaffella aff. *varvariensis* (Brazhnikova and Potievska, 1948)

Fig. 13 a-s

Sample: SA 11.

Measurements:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.1	25	101	176	325	0.43	8.5	185	0.38
s	0.4	2.5	10	20	47	0.05	1	27	0.04
n=24		22	23	23	23	22	22		23

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

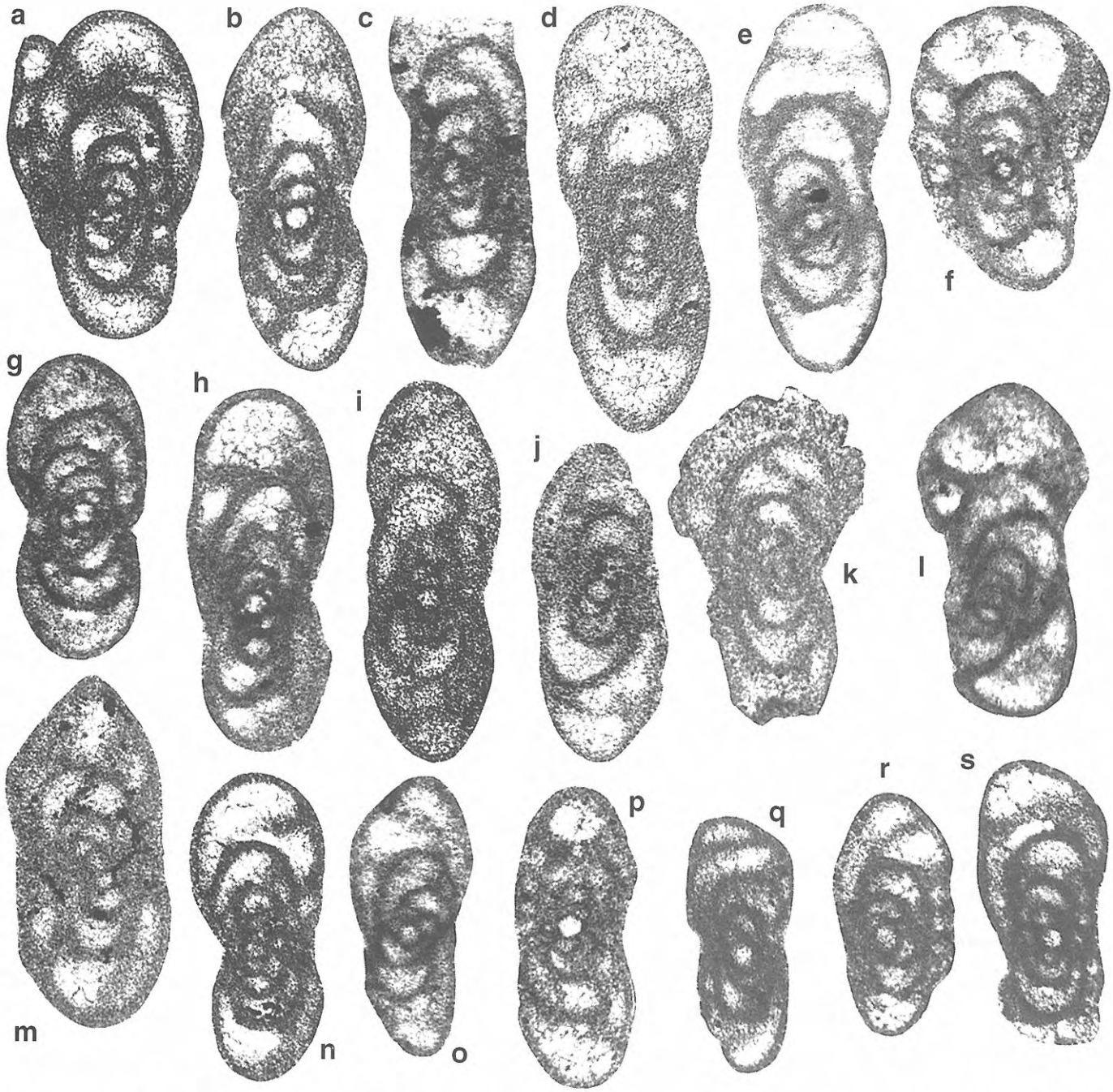

Figure 13. *Plectostaffella* aff. *varvariensis* (Brazhnikova *et* Potievska, 1948), specimens **a**. 11/35(2), **b**. 11/15(5), **c**. 11/46(2), **d**. 11/64(1), **e**. 11/52(2), **f**. 11/31(1), **g**. 11/35(1), **h**. 11/42(7), **i**. 11/99(1) **j**. 11/15(2), **k**. 11/36(2), **l**. 11/74(2), **m**. 11/63(4), **n**. 11/83(5), **o**. 11/46(1), **p**. 11/73(1), **q**. 11/81(5), **r**. 11/27(2), **s**. 11/83(2). Axial sections. All x160 (SA 11).

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

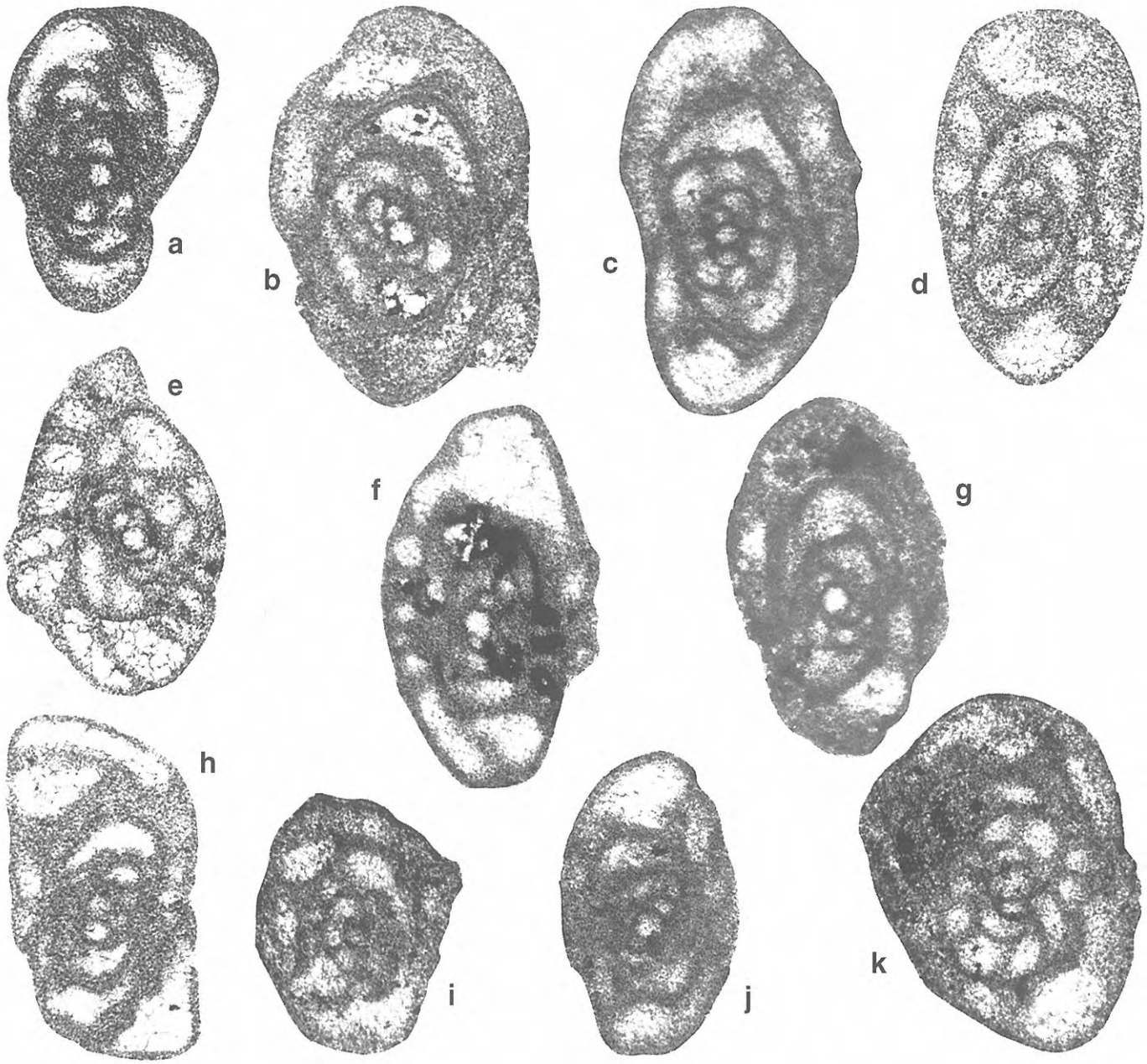

Figure 14. *Plectostaffella jakhensis* (Reitlinger, 1971), specimens **a**. 11/42(5), **b**. 11/29(4), **c**. 11/3(1), **d**. 11/44(7), **e**. 11/50(2), **f**. 11/63(2), **g**. 11/52(4), **h**. 11/27(1), **i**. 11/41(4), **j**. 11/60(3), **k**. 11/58(5). Axial sections. All x160 (SA 11).

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 evolutica* 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 pseudostruvei*. 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:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.0	30	123	208	373	0.59	11	207	0.53
s	0.4	4.5	16	31	46	0.07	1	28	0.07
n=11						10	9		10

Description

Test develops from discoidal in the inner one to two whorls, to nautiliform in the outer whorls. Umbilical

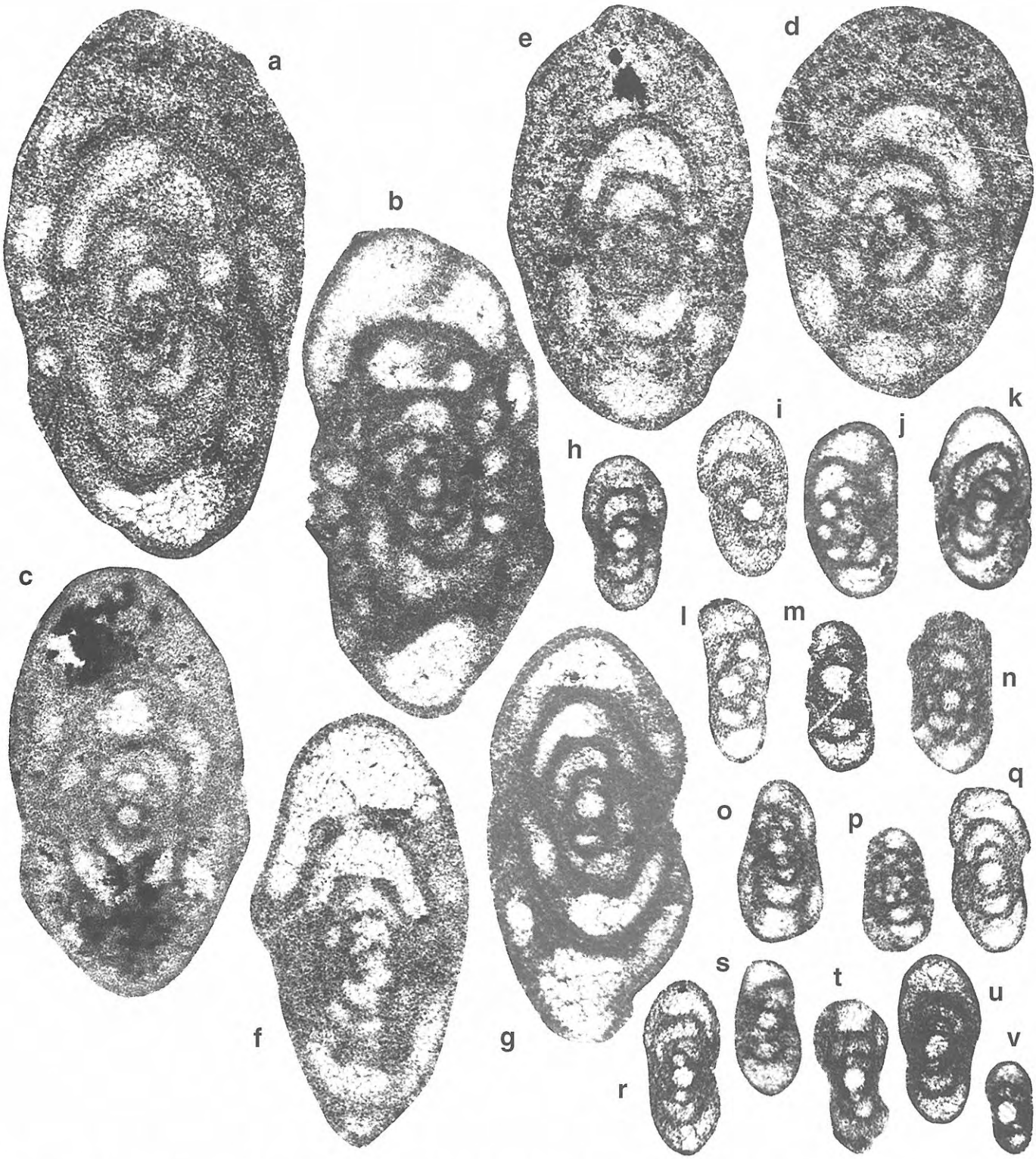

Figure 15. a-c. *Plectostaffella?* sp., specimens **a**. 11/62(1), **b**. 11/77(1), **c**. 11/22(1); **d, e.** *Eostaffellina libera* (Rumyantseva, 1970), specimens **d**. 11/4(3), **e**. 11/38; **f, g.** *Eostaffella* ex gr. *parastruvei* (Rauzer-Chernousova, 1948), specimens **f**. 11/5(1), **g**. 11/36(1); **h-v.** *Endostaffella*? sp., specimens **h**. 11/42(10), **i**. 11/8(1),**j**. 11/73(4), **k**. 11/32(4), **l**. 11/49(3), **m**. 11/89(4), **n**. 11/42(8), **o**. 11/42(9), **p**. 11/91(9), **q**. 11/4(4), **r**. 11/6(10), **s**. 11/41(5), **t**. 11/81(10), **u**. 11/91(4), **v**. 11/89(5). Axial sections. All x160 (SA 11).

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 whorls 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 whorls show fairly well-developed chomata.

Comparisons

The specimens described by Manukalova *et al.* (1969) as *Eostaffella paraprotvae* Rauzer-Chernousova, 1948a, *Eostaffella paraprotvae* var. *acuta* var. nov., and *Eostaffella* aff. *paraprotvae* 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 seslavica* (Rumyantseva, 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:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
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 fusulinoidean 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 whorls. Umbilical depressions are shallow or absent. The periphery is arched in the inner 2.5-3.5 whorls; arched or bluntly pointed in subsequent whorls. The axis of coiling may shift throughout growth, but large shifts occur only in the inner whorls; one specimen that has five whorls 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 desposits 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. (Rumyantseva *in* Kulagina *et al.*, 1992, pl. X, fig. 7) and *Eostaffella parastruvei* of Rumyantseva (1970, pl. VI, fig. 18). *Eostaffella parastruvei* (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 protvae* Rauzer-Chernousova, 1948a.

Eostaffellina cf. *libera* (Rumyantseva, 1970)

Fig. 15 d, e

Sample: SA 11.

Measurements:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
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 whorls are at an angle to subsequent whorls. Coiling is involute, except for the inner whorls, 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* Rumyantseva, 1970 and *Eostaffella paraprotvae* 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) parastruvei* Rauzer-Chernousova, 1948b.

Eostaffella ex gr. *parastruvei* (Rauzer-Chernousova, 1948b)

Fig. 15 f,g

Sample: SA 11.

Measurements:

Specimen	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.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 whorls, and arched to pointed in the outer whorls. The first whorls show slight shifts in the axis of coiling; later whorls are planispiral. Volutions are in contact in the inner two whorls, involute or in contact in the outer whorls. Spirotheca single-layered in the inner two whorls and with tectum and a lower, less dense layer, in outer whorls. Discontinuous(?) chomata are present in the outer three whorls; 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 *Mediocris*).

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* Vissarionova, 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 attenta* 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 kanmerai* (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:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	4.4	30	120	211	452	0.47	11	255	0.42
s	0.3	3	13	19	56	0.05	2	32	0.04
n=19		16				18	18		

Description

The shell is discoidal, nautiliform or lenticular; umbilical cavities are shallow or absent. The peripheral rim develops from predominantly arched (first three whorls) towards arched to bluntly pointed (last two whorls) (Table 15).

Wh.no.	1	2	3	4	5
S	**43**	39	15	8	
A	**48**	**45**	**58**	29	36
A(blp)	9	16	24	**45**	**50**
Blp			3	18	14
P(blp)					
P					

Table 15. Development of the degree of angularity of the peripheral rim in *Eostaffella* aff. *chusovensis* (explanation as in Table 5).

Wh.no.	1	2	3	4	5
E	**69**	10	6		
C	31	**77**	44	21	27
I		13	**50**	**79**	**73**

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 whorls; 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 whorls) (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 whorls of *Eostaffella chusovensis* is lower, the proloculum larger, the diameter at corresponding whorls 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:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
m	3.0	28	112	171	185	0.50	6.5	104	0.44
s	0.4	4	119	23	27	0.06	1.25	17	0.05
n=19		18		13			18		

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 Ukraina 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. *varvariensis* or *Millerella* ex gr. *pseudostruvei* which are also present in the sample.

Mediocris Rozovskaya, 1961

Type species: *Eostaffella mediocris* Vissarionova, 1948.

Mediocris breviscula (Ganelina, 1951)
Fig. 5 q, 12 i-n

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

Measurements:

	No.wh.	D(0)	D(2)	D(3)	D	L/D	W.th.	R.v.	F.r.
Spec.3(4)	2-2.5	27		145	0.34	4	84	0.29	
m	2.4	31	152	244	201	0.40	6	113	0.34
s	0.4	5.5	27		31	0.04	0.9	20	0.04
n=8				2					

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*.

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APPENDIX

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

Locality		Thickness (m.)
SA 17	Two banks of well-layered grey limestone (abundant débris of recristallized algae)	6
	Poorly exposed sequence; includes oolitic limestone and some friable sandstone	17
	Dark grey limestone	5
	Poorly exposed sequence; contains sandstone, quartzitic sandstone and thin beds of fossiliferous limestone	11.5
	Yellow-greenish weathering, fossiliferous oolitic limestone	0.5
	Poorly exposed sequence; probably mainly cross-bedded sandstone	13

	Cross-bedded sandstone showing a limestone -breccia at its base	1
	Inferred upper boundary of Tagnana-III	
	Dark grey limestone	6.5
SA 13	Poorly exposed sequence; includes shale occasionally with silicified mollusks, and thin beds of oolitic limestone	16
	Grey limestone with *Syringopora*	3
	Poorly exposed sequence including shale and thin layers of oolitic limestone	27
	Yellow-brown weathering dolostone	1
	Quartzitic sandstone alternating with grey and yellow-greenish oolitic limestone	5
SA 11	Massive limestone, possibly comparable with *calcaire massif gris en gros blocs* (Legrand-Blain, 1967, p. 304)	5
	Friable or quartzitic sandstone	3
	Fossiliferous (brachiopods) calcareous shale	
	Unconformable contact?	
	High limestone cliff (probably Tagnana-II Member)	0.5