A Late Devonian (Frasnian) Microbiota from the Farewell-Lyman Hills Area, West-Central Alaska

By BERNARD L. MAMET and GEORGE PLAFLER

CONTRIBUTIONS TO PALEONTOLOGY

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CONTRIBUTIONS TO PALEONTOLOGY

A LATE DEVONIAN (FRASNIAN) MICROBIOTA FROM THE FAREWELL-LYMAN HILLS AREA, WEST-CENTRAL ALASKA

BY BERNARD L. MAMET1 and GEORGE PLAGKER

ABSTRACT

A limestone sequence near Farewell in the Alaska Range foothills of west-central Alaska contains a microbiota that includes a large diverse assemblage of foraminifers of Frasnian (early Late Devonian) age not previously reported from Alaska. The fossil assemblages and lithology suggest that the limestone sequence was deposited on a very shallow open marine bank containing patch reefs of corals, stromatoporoids, and algae. The Frasnian limestone appears to overlie pillow basalt and is probably unconformably overlain by Permian limestone and clastic rocks.

The only comparable microfauna reported from the North American Cordillera is from the Southesk Formation in Jasper National Park, Alberta, Canada, which represents a somewhat more restricted facies than the coeval Alaskan carbonates. Frasnian rocks containing complex and diversified microfaunas have been widely reported in the U.S.S.R., but little information is available on their microfacies. The excellent preservation of foraminifers in the Alaskan rocks permits emendation of descriptions originally made by Russian paleontologists for the genera Frondilina Bykova 1952 and Multiseptida Bykova and description of a new species, Multiseptida farewell Mamet. Plafker is largely responsible for descriptions of the geologic setting and lithologic units; Mamet identified and described the microfossils. J. T. Dutro, Jr., identified the megafossils, and A. K. Armstrong kindly made a preliminary evaluation of the microfossils.

LOCATION OF SAMPLES AND GEOLOGIC SETTING

Samples discussed in this paper were collected along the north flank of the rugged Alaska Range, bordered on the north by the upper Kuskokwim Lowland, less than 500 m above sea level, and hills that rise between 300 and 600 m above the lowland (fig. 1; Fernald, 1960). The area lies within the southeastern part of the McGrath quadrangle. In this area, the rocks crop out only in the hills and mountains because the lowlands are underlain by Quaternary unconsolidated deposits.

Geologic information on the Paleozoic bedrock in the upper Kuskokwim area is sparse, consisting largely of reconnaissance studies by Spurr (1900), Brooks (1911), Cady, Wallace, Hoare, and Webber (1955), and Fernald (1960). Churkin, Reed, Carter, and Winkler (1977) carried out a stratigraphic study of lower Paleozoic rocks in the Alaska Range approximately 35 km southeast of Farewell, and Sainsbury (1965) made...
a detailed study of the geology in the vicinity of the White Mountain quicksilver mine. Reed and Nelson (1977) completed a 1:250,000-scale geologic mapping project in the Alaska Range (Talkeetna quadrangle), immediately adjacent to the area on the east, that included reconnaissance mapping and sampling in the vicinity of Farewell. Churkin (1973) recently summarized the stratigraphy of the Paleozoic rocks of Alaska and their role in its structural evolution, but that publication includes minimal information on the Farewell-White Mountain area.

The rocks of the area are mostly sedimentary and are assigned to the Holitna (Ordovician?, Silurian, and Devonian), Gemuk (Carboniferous to Cretaceous), and Kuskokwim (Cretaceous) Groups (Cady and others, 1955).

Paleozoic rocks in nearby parts of the Alaska Range form a predominantly clastic sequence about 1,000 m thick of Early Ordovician through Late Silurian age (Churkin and others, 1977). In general, the Paleozoic rocks in the Alaska Range have been highly folded, cut by numerous faults, intruded by dikes and granitic plutons, and locally metamorphosed. In the Lyman Hills area (north of the Farewell fault and west of Big River), the Paleozoic rocks are largely calcareous; on the basis of their megafaunas, they include strata of Middle (?) Ordovician and Devonian (?) age in the vicinity of the White Mountain mine (Sainsbury, 1965). Permian clastic rocks and carbonates occur in the Lyman Hills area in fault contact with, or unconformably overlying, the older Paleozoic units. The Paleozoic rocks in the foothills commonly are moderately to strongly folded and faulted but are much less altered and metamorphosed than coeval rocks of the Alaska Range.

The major fault in the region is the Farewell fault (fig. 1), generally considered to be part of the Denali system that extends in a broad arc for 1,600 km across Alaska from the Canadian border on the east to Bristol Bay on the west. Although displacement on the Denali system east of the Farewell fault has been mainly strike-slip during the Quaternary, Holocene movement on the Farewell segment has been predominantly dip-slip with the south side relatively upthrown (Plafker
and others, 1977). Dextral separation may have occurred during the earlier history of the fault, although published estimates suggest that the offset is less than 100 km (Churkin and others, 1977; Grantz, 1966) and new unpublished data (George Plafker and Travis Hudson, 1976) indicate that it could be as little as 10 km.

Five sample localities, shown on figure 1 and table 1, yield diagnostic Devonian microfaunas. Localities 1-3 are from a thick moderately folded sequence of carbonates that is in contact toward the southeast with interbedded fine-grained clastic rocks and carbonates that include beds of probable Permian age. The limestone is thin to thick bedded, gray-weathering, black, and locally fetid. It contains megafossils in varying abundance; these include bivalves, corals, and algae. One thin sandy bed within the limestone contained an abundant fauna of brachiopods in growth position. Immediately southwest of sample locality 1 along the Cheeneetnuk River, dark-colored altered and sheared pillow basalt crops out over a small area. Although the contact between the limestone and basalt is not exposed, it appears that the basalt lies structurally below the limestone.

Sample localities 4 and 5 are immediately north of the Farewell fault approximately 6.4 km southwest of Farewell. Locality 4 is an isolated ridge, several meters high and a few tens of meters long, of slabby to massive-bedded, gray-weathering black calcite-veined limestone containing a moderately abundant and well-preserved fauna. It is separated by a small valley in the headwaters of Sheep Creek from locality 5, an elongate ridge 200 m high along the north side of the Farewell fault. The north end of this ridge is underlain by tightly folded fossiliferous limestone of the kind at locality 4. A covered interval separates the limestone from a greenish-black pillow basalt that underlies part of the ridge to the southwest.

**MICROFACIES, MICROBIOTA, AND AGE**

Of the five samples that contained diagnostic fossils, three (samples 76APr235, 76APr239, 76APr260) are from the Lyman Hills area and two (samples 76APr243 and 76AH156) from near Farewell (table 1). The distribution of foraminifers in the samples is given in table 2 and the microfacies, microbiota, and age of these samples are summarized below.

**Sample: 76AH156**

Algal fossil wackestones and packstones. Few corals and stromatoporoids.

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**Sample: 76AH156**

Algal fossil wackestones and packstones. Few corals and stromatoporoids.

<table>
<thead>
<tr>
<th>Sample localities (fig. 1)</th>
<th>Field Nos. U.S.G.S. quadrangle</th>
<th>Township, range, section</th>
<th>Microfacies</th>
<th>Megafauna</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>76APr239</td>
<td>T. 23 N., R. 32 W., sec. 34</td>
<td>Fossiliferous packstone.</td>
<td>Bivalves, corals, algae.</td>
</tr>
<tr>
<td>3</td>
<td>76APr260</td>
<td>do</td>
<td>Recrystallized algal wackestones. Recrystallized fossiliferous packstones to wackestones.</td>
<td>Indospirifer? sp., Gypidula sp., Thamnopora, algae.</td>
</tr>
<tr>
<td>5</td>
<td>76AH156</td>
<td>do</td>
<td>Algal fossil wackestones and packstones.</td>
<td>Algae, few corals and stromatoporoids.</td>
</tr>
</tbody>
</table>

**Table 1: Localities, microfacies, and megafauna of microfossil samples of Frasnian age in the Farewell-Lyman Hills area**

<table>
<thead>
<tr>
<th>Sample localities (fig. 1)</th>
<th>Field Nos. U.S.G.S. quadrangle</th>
<th>Township, range, section</th>
<th>Microfacies</th>
<th>Megafauna</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyman Hills area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>76APr239</td>
<td>T. 23 N., R. 32 W., sec. 34</td>
<td>Fossiliferous packstone.</td>
<td>Bivalves, corals, algae.</td>
</tr>
<tr>
<td>3</td>
<td>76APr260</td>
<td>do</td>
<td>Recrystallized algal wackestones. Recrystallized fossiliferous packstones to wackestones.</td>
<td>Indospirifer? sp., Gypidula sp., Thamnopora, algae.</td>
</tr>
<tr>
<td>Farewell area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>76AH156</td>
<td>do</td>
<td>Algal fossil wackestones and packstones.</td>
<td>Algae, few corals and stromatoporoids.</td>
</tr>
</tbody>
</table>
**Contributions to Palaeontology**

*Kamaena* sp.
*Multiseptida corallina* Bykova
*M. farewell* n. sp.
*Paratikhinella* sp.
*Tikhinella* sp.
"Uslonia" sp.

**Age:** Frasnian.

**Sample:** 76APr235


*Bisphaera* sp.
*Calcisphaera* sp.
*Eogeinitzina* sp.
*Eonodosaria* sp.
*Frondilina sororis* Bykova
*Girvanella* sp.
"Irregularina" sp.
*Issinella* sp. (extremely abundant; forms boundstone and bafflestone patches)
*Kamaena* sp.
*Multiseptida* sp.
*Multiseptida corallina* Bykova
*Multiseptida farewell* n. sp.
*Parathurammina* sp.
*Pseudoglomospira* sp.
*Semitextularia* sp.
*Tikhinella* sp.
*Uslonia* sp.

**Age:** Frasnian.

**Sample:** 76APr239

Fossiliferous packstones.
*Eonodosaria* sp.
*Frondilina sororis* Bykova
*Paratikhinella* sp.
*Tikhinella* sp.

**Age:** Frasnian.

**Sample:** 76APr243


*Bisphaera* sp.
*Eonodosaria evanensis* (Lipina).
*Eogeinitzina* sp.
*Evania* sp.
*Frondilina sororis* Bykova
*Girvanella* sp.
*Issinella* sp.
*Kamaena* sp.
*Multiseptida corallina* Bykova
*M. farewell* n. sp.

**Age:** Frasnian.

**Sample:** 76APr246

Recrystallized fossiliferous packstones to wackestones.

*Earlandia?* sp.
*Girvanella staminea* Garwood
*Eonodosaria* sp.
*Kamaena* sp.
*Multiseptida farewell* n. sp.
*Nanicella* sp.
*Palaeobereselleae*
*Parathurammina* sp.
*Paratikhinella* sp.
*Pseudoglomospira* sp.
*Pseudosolenopora* sp.
*Semitextularia* sp.
*Tikhinella* sp.
*Umbellina* sp.
*Uslonia* sp.

**Age:** Frasnian.

**Table 2.** Distribution of microfossils in the Farewell-Lyman Hills area

<table>
<thead>
<tr>
<th>Species</th>
<th>Farewell area</th>
<th>Lyman Hills area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>McGrath B-2</td>
<td>McGrath B-4</td>
</tr>
<tr>
<td>Auroria sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Bisphaera sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Calcisphaera sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Earlandia sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Eogeinitzina sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>cf. Eogeinitzina sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Eonodosaria evanensis</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Eonodosaria sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Evania sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Frondilina sororis</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Girvanella staminea</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Girvanella sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>&quot;Irregularina&quot; sp</td>
<td></td>
<td>x x</td>
</tr>
<tr>
<td>Issinella sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Kamaena sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Multiseptida corallina</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Multiseptida farewell</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Multiseptida sp</td>
<td></td>
<td>x x</td>
</tr>
<tr>
<td>Nanicella sp</td>
<td></td>
<td>x x</td>
</tr>
<tr>
<td>Palaeobereselleae</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Parathurammina sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Passatikhinella sp</td>
<td></td>
<td>x x</td>
</tr>
<tr>
<td>Pseudoglomospira sp</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Pseudosolenopora sp</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Semitextularia sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Tikhinella sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Umbellina sp</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>&quot;Uslonia&quot; sp</td>
<td></td>
<td>x x</td>
</tr>
</tbody>
</table>

**Sample:** 76APr260

Recrystallized fossiliferous packstones to wackestones.

*Earlandia?* sp.
*Girvanella staminea* Garwood
*Eonodosaria* sp.
*Kamaena* sp.
*Multiseptida farewell* n. sp.
*Nanicella* sp.
*Palaeobereselleae*
*Paratikhinella* sp.
*Tikhinella* sp.
The carbonate microfacies suggests a very shallow open-marine bank with abundant corals, stromatoporo-
ids, and algae. Algal microflora is mostly represented by abundant tabulate Issinella and a few Kamaenae,
many of the two genera intertwined to form baffled stones. Red algae (Pseudosolenopora) are scarce. Gir-
vanelia and Calcisphaeridae are present but uncommon. Usually this kind of assemblage contains Sphaerocodium, but none was found here.

This environment, within the photic zone, is favorable to the foraminifers, which are abundant but undiver-
sified; Multiseptida, Frondilina, and Eogeinitzina are the most widespread genera.

Umbellinids, of probable charophyte affinities, are represented only by occasional floated, mud-filled specimens of Umbellina.

**MEGAFAUNA**

Fossil bivalves, corals, and algae were observed in the limestone at localities 76AAP235, 239, 243, and 260, but preservation is rarely good enough for iden-
tifications to be made at the species level. Brachiopods from locality 76AAP260 include large Indosipirifer? sp.,
large Gypidula sp., and poorly preserved tabulate cor-
als (Thamnopora) that range in age from early Middle Devonian to early Late Devonian (J. T. Dutro, Jr., writ-
ten commun., 1978). A diverse assemblage of Mid-
dle(?) Devonian corals was collected earlier from the Lyman Hills area immediately north of the Cheeneet-
nuk River. According to Oliver, Merriam, and Churkin
(1975, table 14), the corals identified include Alveolites
sp., Cladopora sp., Favosites sp., Heliolites sp.,
Pachyfavosites sp., Syringopora sp., Thamnopora sp.,
Siphonophrentis sp., and Sociophyllum sp., cf. S.
glomerulatum (Crickmay). The megafossils suggest deposition on a shallow open marine bank with patch reefs.

Environmental interpretations and ages based on megafossils are consistent with the conclusions arrived
at in this paper from microscopic studies of limestone samples from these same localities.

**CORRELATIONS, FRASNIAN MICROBIOTA**

**NORTH AMERICA**

The only closely comparable Frasnian microbiota re-
ported from the American Cordillera is that of the Southesk Formation, Ancient Wall carbonate complex,
Jasper National Park, Alberta (Toomey and others, 1970), Canada. In this carbonate complex, which represents a restricted and lagoon environment, cal-
cispheres and parathuramminids dominate; tikhinellids and multiseptidids are scarcer than in the Farewell-
Lyman Hills area. Dasycladacean algae, like Ver-
imoporella, are associated with blue-green "chain algae" such as Sphaerocodium.

In our samples, parathuramminids and calcisphaerids are scarce, birdseyes are not observed, and plurilocular foraminifers are dominant. Of the microflora, the only abundant specimens are Issinella. These differences with the Southesk Formation indicate more open marine conditions and greater water agitation for the Alaskan localities. Although there are differences in relative abundances between the Canadian and Alaskan material, the elements of the foraminiferal assemblage is similar, as both include Eogeinitzina, Eonodosaria, Multiseptida, Nanicella, Paratikhinella, and Tikhinella.

Other described North American microbiotas show less similarity to the Alaskan microbiota, even though they have some fossil elements in common. Examples are biotas from: (1) the Leduc Formation of central Alberta (Toomey, 1965), where abundant parathuram-
minids are mixed with tikhinellids, paratikhinellids, and nanicellids; (2) the Lime Creek Shale (Upper De-
vonian) of Iowa, which contains an Eonodosar-
ia/Eclaninia assemblage (Toomey, 1972) including some Semitextularia (Miller and Carmer, 1933); (3) the Mount Hawk Limestone of British Columbia, which displays a Girvanella/Eonodosaria/Nanicella as-
semblage (Toomey, 1972); and (4) the Cedar Valley Limestone (Middle Devonian) of Iowa, which contains mostly Bisphaera/Semitextularia/Parathuramminidae, mixed with Girvanella, Sphaeroporella, Vermiporella, kamaeniids, and red algae (Kettenbrink and Toomey, 1975). All these microbiota characteristically have very low diversity at both the generic and specific levels.

**EURASIA**

Frasnian foraminiferal assemblages in the U.S.S.R.
are reported on and described in Lipina (1950),
Bykova (1952), Reitlinger (1954), Bykova in Bykova
and Polenova (1955), Chuvashov (1963, 1965), and
Manukalova-Grebeniuk (1974). Although little analysis
of the faunal and floral distributions in relation to the carbonate microfacies has been made by Russian paleontologists, the Russian microbiota are clearly more diversified than their American counterparts.

Toomey (1972, p. 628) coined the term Tikhin-
ella/Eonodosaria/Multiseptida microfauna and de-
scribed it as "the most complex assemblage in terms of biotic abundance." This description is certainly valid in the American Cordillera but not in Eurasia, where far more complex and diversified faunal assemblages have
been described from the Russian Platform and from the Urals (see Toomey and Mamet, 1979).

SYSTEMATIC PALEONTOLOGY
Phylum PROTOZOA
Order FORAMINIFERIDA Eichwald, 1830
Family undetermined
Genus FRONDILINA Bykova, 1952, emend. herein

Discussion.—In the original diagnosis of Frondilina, Bykova (1952, p. 24) states that the foraminifers consist of a series of uniserial overlapping chambers. The type of the genus, Frondilina deuexis, was drawn (Bykova, 1952, pl. 5, fig. 4b) flattened and laterally compressed with a rectilinear pseudobiserial arrangement. The other representative of the genus, Frondilina sororis (Bykova, 1952, pl. 5, fig. 5b) also was reported to be uniserial with bilateral symmetry. This diagnosis was accepted by Bykova, Dain, and Fursenko (in Rauzer-Chernousova and Fursenko, 1959) and by Loeblich and Tappan (1964). However, Loeblich and Tappan (1964) stated that the chamber arrangement is similar to that of Lunucammina, a uniserial nodosinellid with a longitudinal depression giving a pseudobiserial appearance.

The uniserial character described in Bykova's original diagnosis, however, does not fit the rest of the description. Bykova noted that "the chambers are not always located on one plane. Part of them are sometimes deflected around the longitudinal axis on the body" (translated). For example, her drawing of the holotype (Bykova, 1952, pl. 5, fig. 4a) shows that the third and the fourth chambers are not in the same plane as the first and second chambers. A thin section of the paratype (pl. 6, fig. 7) shows an "erratic" deviation of the chambers. Bykova (1952) described this deviation "towards the end quite often a deflection of the chambers around the longitudinal axis is noted and the plane of the chambers becomes almost perpendicular to the planes of the others. The result of this is sections in which part of the chambers are in transverse and part in a longitudinal direction" (translated). If this description is correct, a simple uniserial bilateral disposition of the chambers is unlikely.

The second special feature attributed to the genus as represented by Frondilina sororis is equally puzzling. In the diagnosis uniserially arranged chambers are "sometimes deflected to one side or another along the longitudinal axis" (translated). For the type (Bykova, 1952, pl. 5, figs. 5b and 5c), a simple straight-forward uniserial arrangement is drawn. But in one of the paratypes (pl. 6, fig. 9), the highly irregular disposition is described as "sections in which six chambers are cut laterally and two longitudinally, due to the deflection of the chambers along the longitudinal axis" (translated). Many longitudinal, axial, and oblique sections of Frondilina from Alaska allow a somewhat different reconstruction (fig. 2). In axial section, the chambers do not have bilateral symmetry as reported by Bykova (1952, see her idealized drawings pl. 5, figs. 4b and

![Figure 2](image-url)
5b) but are triradiate with deep sutures. In addition, the chambers are strongly arcuate and overlap each other. An axial cut, therefore, shows the three round tips of the overlying chamber (see pl. 2, figs. 12-17).

A deceptive illusion that the chambers are situated in the same plane is produced by a longitudinal section along the sutures (see, for instance, pl. 1, fig. 4); but the 120° symmetry of the triradiate chambers is demonstrated in plate 1, figures 11-14.

With respect to the nature of the wall structure, Bykova (1952) mentioned an outer micritic layer and an inner radial layer, the sutures being “three-layered.” “Three-layered” sutures are well displayed in our material, as exemplified along the septa of the specimen figured in plate 1, figure 9. This structure, however, is produced by penecontemporaneous cementation and is not an original microstructure. Most of our material shows partial dissolution of the wall and development of early cement. We suggest that the same process diagenetically altered Bykova’s material.

We therefore propose the following emendation of Frondilina.

*Emended diagnosis.*—Test elongate, free, tapering, consisting of a uniserial series of triradiate chambers. In axial section, chambers have a ternary symmetry. Chambers are curved, roundly tapered toward the end, and overlap one another. In thin section, this arrangement gives the illusion of uniserial-biserial and triserial series, depending on the orientation of the cut. Sutures deep. Aperture is a round opening in the depressed apertural face. Wall double-layered, consisting of a dark micritic layer and a thin, commonly dissolved, yellowish pseudofibrous layer.

*Type of genus.*—1952. *Frondilina devesis* Bykova. VNIGRI Trudy 60, Mikrofauna SSSR, Sbornik 5, p. 25, pl. 5, Figs. 4a, b, c, pl. 6, Figs. 4-7.

Taxa included in the genus *Frondilina*:

1952 *devesis* Bykova
1952 *sororis* Bykova

*Remarks.*—Figure 4b of the type is idealized and contradicts figures 4a and 4c, which are more nearly correct.

Though originally assigned to the Lagenidae by Bykova (1952), transferred to the Nodosinellidae/Nodosinellinae by Loeblich and Tappan (1964), and considered a Lagenidae/Lageninaceae by Chuvashov (1965), the genus does not belong to either family. The same holds true for the Frasnian *Eogeinitzina, Eonodosaria*, which belong to an as yet undescribed family.


*Diagnosis.*—Test elongate, tapering, consisting of 9 to 11, exceptionally 12, uniserial triradiate chambers. Chambers have a ternary symmetry in axial section. Sutures deep. In longitudinal section, chambers are arcuate, and overlap one another. Chambers increase uniformly in width; their height increases less sharply.

Total length for 6 chambers (range): 480-610 \( \mu \) 7 chambers (range): 500-640 \( \mu \) 8 chambers (range): 660-800 \( \mu \) 9 chambers (range): 750-930 \( \mu \) 10 chambers (range): 810-970 \( \mu \) 11 chambers (range): 850-980 \( \mu \) 12 chambers (range): 850-1,040 \( \mu \)

Diameter of the sixth chamber (range): 210-340 \( \mu \) seventh chamber (range): 240-360 \( \mu \) eighth chamber (range): 260-370 \( \mu \)

Chambers taper toward the peripheral end, where they become rounded. Peripheral border of the test roundly lobate. Wall double-layered, thin, about 10-15 \( \mu \). Thickness difficult to estimate owing to extensive diagenetic alteration and subsequent early cementation. Proloculum, oval to round, extremely variable, commonly crushed or deformed, varying from 70-160 \( \mu \) in diameter.

*Remarks.*—By its general morphology, our material is very similar to that of the original description of Bykova (1952). Bykova’s types and paratypes, however, are immature forms. She drew tests consisting of four to seven chambers, but in her description, cites “nine or more chambers.” Our material shows that the adults have indeed 9 to 11 chambers, 12 being exceptional. The only noticeable difference between the American and Russian material is the shape and size of the proloculum. Bykova reports an oval form, whereas our material shows all types of deformation owing to the large size of the first chamber. This characteristic should not be used as a valid argument for the erection of a new taxon.

*Stratigraphic range and distribution.*—Frasnian. Eurasia and Alaska.

*Figured specimens.*—USNM 305135, USNM 305173.

*Genus MULTISEPTIDA* Bykova, 1952


**Diagnosis.**—Test free, elongate, cylindrical, slowly tapering, rectilinear, uniserial. Proloculum spherical, about 20-40 μ in diameter, followed by low discoidal overlapping chambers. Number of chambers 6-10, the most common count being 8 or 9.

**Type of genus.**—Multiseptida corallina Bykova, 1952.

1982 farewell new species

Multiseptida akkusica Bogush and Yuferev 1962, which is not a foraminifer, should be transferred to the botanical realm. It is probably related to the Palaeoberesellae.

**Remarks.**—Diagrammatic reconstructions of the genus by Bykova (1952), later reproduced by Bykova and others (1959), Pokorony (1963), and Loeblich and Tappan (1964) are correct. Multiseptida was originally assigned to the Lagenidae by Bykova (1952), considered as a Nodosariidae by Pokorny (1963), transferred to the Collaniellidae by Loeblich and Tappan (1964) and to the Lagenidae/Collaniellidae by Chuvashov (1965) and by Toomey, Mountjoy, and MacKenzie (1970).

Colaniella is exclusively Upper Permian, and Multiseptida, Upper Devonian. Because there is no link between the two genera, they should not be included in the same family.

The occurrence of secondary partitions is of little value for the erection of a new family or subfamily. Secondary partitions have appeared at least three times among Devonian, Carboniferous, and Permian foraminifers. For instance, in the Viséan, Valvulinella (see pl. 4, fig. 20 and compare with Multiseptida) is derived from Pseudotaxis by progressive development of secondary walls. Both Valvulinella and Pseudotaxis have always been placed in the same family.

**Stratigraphic range and distribution.**—Frasnian. Eurasia, Alaska, Alberta.

**Multiseptida corallina Bykova, 1952**

Plate 2, figures 22-23; plate 3, figures 5-6

1952. Multiseptida corallina Bykova, VNIGRI Trudy 60, Mikrofauna SSSR, Sbornik 5, p. 27, pl. 7, figs. 1-4, pl. 8, figs. 1-5.


**Diagnosis.**—Test free, elongate, cylindrical, tapering, rectilinear, uniserial. Proloculum spherical, about 20-40 μ in diameter, followed by low discoidal overlapping chambers. Number of chambers 6-10, the most common count being 8 or 9.

Septa long with terminal thickenings. Total length for adult specimens varies from 300-520 μ. For individuals of seven chambers, length varies between 370 and 430 μ, for individuals of nine chambers, length varies between 450 and 510 μ. Diameter of the seventh chamber varies between 160 and 230 μ, diameter of the ninth chamber varies between 180 and 250 μ.

Wall double layered with an inner dark microcrystalline layer and an outer hyaline layer. Wall commonly dissolved and replaced by early penecontemporaneous cement. Owing to recrystallization, leaching, and early cementation, original thickness of the wall is difficult to assess. Bykova (1952) reports 13-18 μ. Toomey (1970) somewhat more. Our specimens are closer to Bykova’s estimate. Early cementation in our material produces a “three-layered wall” (see pl. 3, fig. 6). Diameter of the aperture 30-50 μ. Number of secondary septa in our material 8-12; Bykova reports 8-11; Toomey, 8-12.

**Stratigraphic range and distribution.**—Frasnian. Eurasia, Alaska, Alberta, British Columbia.
**Figured specimens**.—USNM 305174, 305175 (part), 305187, and 305188.

*Multiseptida farewellii* Mamet, new species
Plate 2, figure 23; plate 3, figures 1-4, 7-11; plate 4, figures 1-19

**Diagnosis.**—Test free, elongate, cylindrical, tapering. Nine to 11 cylindrical chambers. Exceptionally large round, fragile, usually crushed, around 100-140 μm in diameter. Chambers low, discoidal, strongly overlapping, with deep suture. Diameter of chambers increase progressively:

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Average (μm)</th>
<th>Height progression (μm)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>160-240</td>
<td>225-25</td>
</tr>
<tr>
<td>2</td>
<td>180-270</td>
<td>255-33</td>
</tr>
<tr>
<td>3</td>
<td>195-300</td>
<td>265-41</td>
</tr>
<tr>
<td>4</td>
<td>230-340</td>
<td>280-42</td>
</tr>
<tr>
<td>5</td>
<td>255-380</td>
<td>320-48</td>
</tr>
<tr>
<td>6</td>
<td>300-410</td>
<td>375-58</td>
</tr>
<tr>
<td>7</td>
<td>330-480</td>
<td>400-66</td>
</tr>
<tr>
<td>8</td>
<td>390-550</td>
<td>430-88</td>
</tr>
<tr>
<td>9</td>
<td>420-550</td>
<td>450-90</td>
</tr>
<tr>
<td>10</td>
<td>460-550</td>
<td>500-100</td>
</tr>
<tr>
<td>11</td>
<td>550-560</td>
<td>560-123</td>
</tr>
<tr>
<td>12</td>
<td>570-600</td>
<td>575-130</td>
</tr>
</tbody>
</table>

Range of total length for adult specimens: 9 chambers, 560-720 μm; 10 chambers, 580-810 μm; 11 chambers, 680-830 μm.

Wall double layered with inner dark microcrystalline layer and an outer yellowish layer, typically dissolved. Penecontemporaneous cement and recrystallization obscure the original ultrastructure making the actual wall thickness difficult to assess. Micritic layer about 15 μm thick, commonly reduced to 10 μm or less by leaching. Septa have septal thickenings.

The number of secondary partitions increases with the number of chambers as follows:

<table>
<thead>
<tr>
<th>Chamber</th>
<th>Average number of partitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>29</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>35</td>
</tr>
<tr>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>11</td>
<td>40</td>
</tr>
</tbody>
</table>

The apertural size increases progressively and is proportional to its diameter.

**Comparison.**—Specimens of *Multiseptida farewellii* are readily distinguishable from those of *M. corallina* by having larger tests with more chambers and by having more secondary partitions in its chambers than those of *corallina*. The secondary partitions of *farewellii* appear to be remarkably similar to those of Pseudotaxidae from the Viséan. For comparison, the secondary chamberlets of *Valvulinella youngi*, a Viséan Pseudotaxidae, are shown on plate 4, figure 20.

**Range and distribution.**—Frasnian. Apparently endemic to Alaska.

**Figured specimens.**—USNM 305176-305186; 305189-305207; and 305175 (part).

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PLATES 1-4

[Contact photographs of the plates in this report are available, at cost, from the U.S. Geological Survey Photographic Library, Federal Center, Denver, Colorado 80225]
PLATE 1


All samples from Frasnian, Farewell-Lyman Hills area. See table 1 for locations. Thin sections from a given sample are designated by a letter following sample number.


4. Longitudinal section along suture of series of triradiate chambers, giving illusion that they are coplanar (× 73). USNM 305138, 76APr156A (10). Univ. Montreal 458/32.


7. Oblique section along tip of front row of chamber, then through aperture (× 90). USNM 305141, 76APr156A (11). Univ. Montreal 458/16.

8. Section similar to figure 3, showing arcuate, overlapping chambers (× 90). USNM 305142, 76APr156A (10). Univ. Montreal 458/26.


10. Section similar to figure 7 (× 90). USNM 305144, 76APr243D, Univ. Montreal 456/15.

11. Section similar to figure 7 (× 90). USNM 305145, 76APr156D (2). Univ. Montreal 459/18.


13. Longitudinal section passing through axis of one "row" of chambers and showing other "row" at 120° (× 90). USNM 305147, 76APr156D (2). Univ. Montreal 459/17.


18. Section similar to figure 17 (× 90). USNM 305152, 76APr156A (10). Univ. Montreal 458/27.
FRONDILINA SORORIS BYKOVA
All samples from Frasnian, Farewell-Lyman Hills area. See table 1 for locations. Thin sections from a given sample are designated by a letter following sample number.

1. Highly oblique, nearly axial section, through two rows at 120°, and along top of chambers of third “row” (× 90). USNM 305153, 76APr243D (1), Univ. Montreal 456/11.


8. Section as in figure 7 (× 90). USNM 305160, 76APr243D (7), Univ. Montreal 456/34.


10. Slightly oblique axial section (× 90). USNM 305162, 76APr156A (6), Univ. Montreal 458/6.

11. Section similar to figure 10 (× 90). USNM 305163, 76APr156A (11), Univ. Montreal 459/7.


13. Section similar to figure 12 (× 90). USNM 305165, 76APr156A (4), Univ. Montreal 457/34.


15. Section similar to figure 12 (× 90). USNM 305167, 76APr156A (4), Univ. Montreal 459/22.

16. Section similar to figure 12 (× 90). USNM 305168, 76APr243D (13), Univ. Montreal 457/10.

17. Section similar to figure 12 (× 90). USNM 305169, 76APr243D (5), Univ. Montreal 456/32.

18. Longitudinal very high section along end of one “row” of chambers (× 90). USNM 305170, 76APr156D (2), Univ. Montreal 459/20.


20. Section similar to figure 18 (× 90). USNM 305172, 76APr156A (10), Univ. Montreal 458/31.

21. Section similar to figure 18 (× 73). USNM 305173, 76APr156A (10), Univ. Montreal 458/34.

22-23. Multiseptida corallina Bykova 1952 and Multiseptida farewellii n. sp. (p. 8,9)


**FIGURES 1-4, 7-13. Multiseptida farewelli Mamet, n. sp., (p. 9).**

All samples from Frasnian, Farewell-Lyman Hills area. See table 1 for locations.

1. Centered longitudinal section along apertures; first chambers crushed ($\times 90$). USNM 305176, 76APr156A (10), Univ. Montreal 458/35.
2. Longitudinal section, passing through proloculum. Type of new species ($\times 90$). USNM 305177, 76APr156D (8), Univ. Montreal 457/29.
4. Slightly off-centered, longitudinal section showing secondary partitions ($\times 90$). USNM 305179, 76APr156A (10), Univ. Montreal 458/35.
5. Oblique section showing strong lateral slant of secondary partitions ($\times 90$). USNM 305180, 76APr156A (7), Univ. Montreal 458/15.
6. Slightly oblique longitudinal section, off-centered at proloculum and within apertures at last chambers ($\times 90$). USNM 305181, 76APr156A (3), Univ. Montreal 457/24.
7. High, off-centered, longitudinal section ($\times 73$). USNM 305182, 76APr156A (10), Univ. Montreal 458/16.


5. Centered longitudinal section along apertures ($\times 90$). USNM 305187, 76APr235 (2), Univ. Montreal 402/12.
6. Oblique high section showing heavy secondary partitions ($\times 90$). USNM 305188, 76APr156A (3), Univ. Montreal 457/25.
MULTISEPTIDA FAREWELLI MAMET, N.SP. AND MULTISEPTIDA CORALLINA BYKOVA
All samples from Frasnian, Farewell-Lyman Hills area. See table 1 for locations.


4. Section similar to that in figure 1, but slightly off-center (× 90). USNM 305192, 76APr156A (3). Univ. Montreal 457/17.


6. Section similar to that in figure 1 (× 90). USNM 305194, 76APr156A, Univ. Montreal 401/38.


20. *Valvulinella youngi* (Brady), 1876. (p. 9).
Dagirsacik Plateau near Ankara, Turkey. Late Middle to Early Late Viséan. Sample of Professor S. Erk. Axial section showing secondary chamberlets. (× 58). Compare with figures 8, 11, and 17. Univ. Montreal 454/1.