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Rolf W. Feyling-Hanssen

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S. Funder, Geological Museum, Øster Voldgade 5–7, DK-1350 Copenhagen K, Denmark. Telephone +45 33 11 42. Telefax +45 33 11 46 37.

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Fossil foraminiferal assemblages occurring in fine-grained sediments of the Kap København Formation, Peary Land, North Greenland, are grouped into six assemblage zones: the *Elphidium funderi* Zone, oldest, the *Cassidulina laevigata* Zone, the *Elphidiella rolfi* Zone, the *Elphidium* cf. *excavatum* Zone, the *Elphidium excavatum* Zone, and the *Elphidiella gorbunovi* Zone, youngest.

Comparison of these zones with fossil foraminiferal assemblages from other Arctic localities and with fossil assemblages from borings in the North Sea indicates that the *Elphidium funderi* Zone and the *Cassidulina laevigata* Zone are of Upper Pliocene age whereas the *Elphidium excavatum* Zone belongs to the Lower Pleistocene. The *Elphidiella rolfi* Zone is an uppermost Pliocene shallow water zone, and the *Elphidium* cf. *excavatum* Zone probably represents a transition zone between the Pliocene and the Pleistocene.

Rolf W. Feyling-Hanssen, Geological Institute, University of Aarhus, DK-8000 Århus C, Denmark.

The Kap København Formation is a shallow water deposit of unconsolidated marine sediments in coastal areas of eastern Peary Land, North Greenland (Funder & Hjort 1980; Funder *et al.* 1984; 1985). It covers an area of 500 km^2 and is at least 100 m thick (Figs 1 and 2). At the type section two distinctive lithological units have been distinguished (Fig. 3); the lower member A is composed of finely laminated, red or grey clay and silt, and the upper member B is composed mainly of sand, excluding subunit B2, which is composed of silt (Funder *et al.* 1984). This member is noteworthy for its abundant and well preserved plant and insect remains (Bennike & Böcher in press; Bennike in press).

The age of the Kap København Formation has been assessed by a number of different methods. Previous foraminifer stratigraphical work located the Plio-Pleistocene boundary in unit B2 at the type section (locality 50) (Funder *et al.* 1985; Feyling-Hanssen 1987). Vertebrate remains from unit B3 indicated an age between 2 and 2.4 ma (Repenning *et al.* 1987; Bennike in press). These results are in agreement with palaeomagnetic measurements from member B (Abrahamsen & Marcussen 1986), and amino acid analyses of bivalve shells (Funder *et al.* 1987).

The sediments of the Kap København Formation are in many places tectonically deformed and disturbed. Thrust sheets of older parts of the deposit may occur above younger units (Funder *et al.* 1984; 1985). A major objective of the present study has been to throw light on the age relationships between the many exposures scattered over a large area.

Material and methods

Foraminifera occur in the fine-grained sediments of member A and unit B2 (Fig. 3). Some of them are well preserved with glistening test surfaces; others are in a poor state of preservation with broken chambers or, more often, with etched test surfaces. This may be due to the dissolution of calcium carbonate by the ground water becoming acidic by percolating through sediments rich in plant remains. This may also explain why many sediment samples were barren or nearly barren of fossil foraminifera even though molluscan shells occurred in them. Maybe for the same reason some samples contained relatively many agglutinating specimens and only a few, badly preserved calcareous tests.

A total of 152 samples have been examined, they originate from 23 localities scattered over the Kap København area (Fig. 2). The dry weight of the samples was 100–200 g. One hundred and eleven samples contained fossil foraminifera, 41 were barren. Only some of the fossiliferous samples, however, contained reasonably well preserved foraminifera. Examples of counts of some of these samples are given below, and the total counts from the type locality (loc. 50) are shown in Table 9 (in pocket).

Despite the fact that subsequent glacial-tectonic squeezing and displacement of the sediment, solifluction (Funder *et al.* 1985) and even deformation of single foraminiferal tests, have obliterated the original depositional order, it is still possible to reconstruct a stratigraphical succession based on the foraminifera. The

Fig. 1. Localities mentioned in the text.

following assemblage zones are defined: The *Elphidium funderi* Zone, oldest, the *Cassidulina laevigata* Zone, the *Elphidiella rolfi* Zone, the *Elphidium* cf. *excavatum* Zone, the *Elphidium excavatum* Zone, and the *Elphidiella gorbunovi* Zone, youngest. The *Elphidium funderi* and the *Cassidulina laevigata* Zones represent a subdivision of the *Nonion erucopsis* Zone of Feyling-Hanssen (1987).

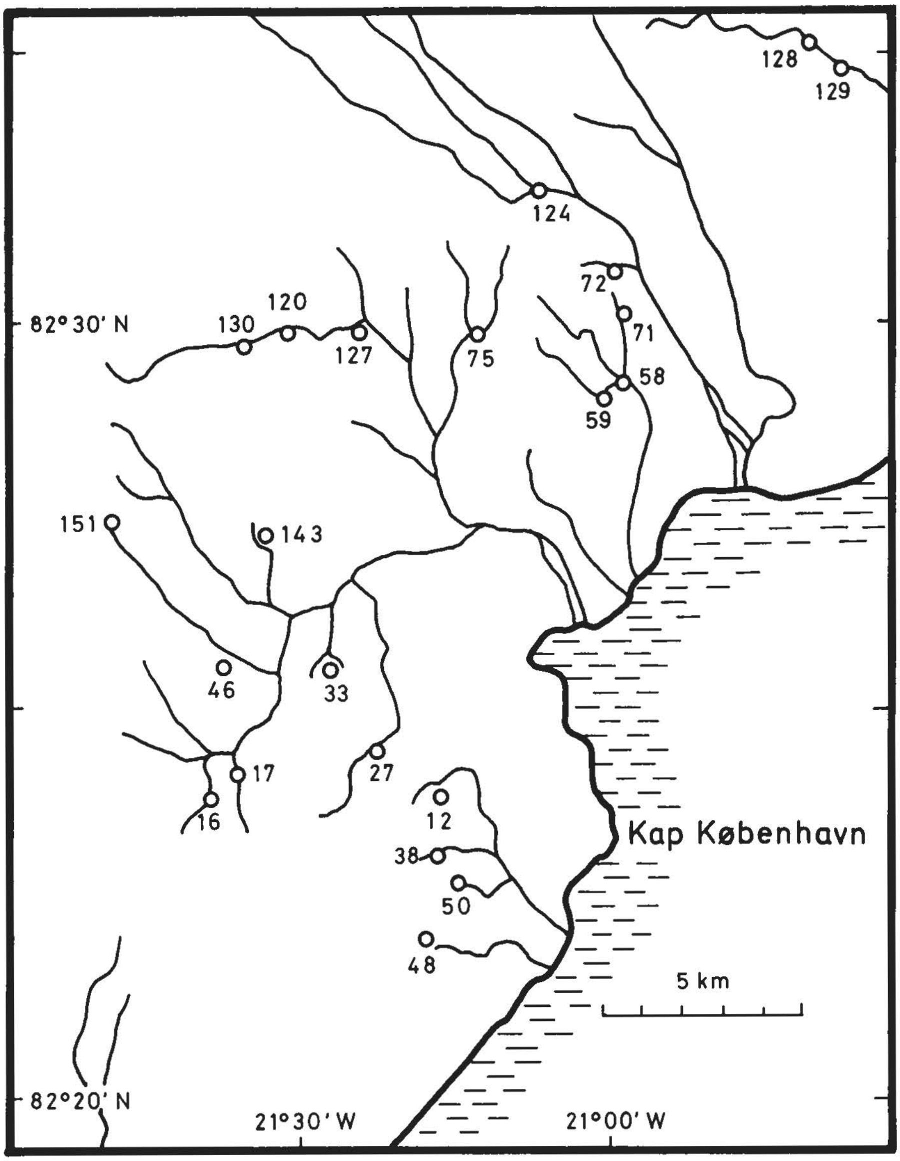
These zones are described below, starting with assemblages from member A (Fig. 3).

Assemblage zones and their age

The *Elphidium funderi* Zone

Examples of this assemblage are shown in Tables 1, 2 and 9. In the fauna shown in Table 1, from the upper part of member A, many specimens had slightly etched test surfaces but were otherwise well preserved. Of particular note in this assemblage is the frequent occurrence of *Nonion erucopsis* Todd. This species was origi-

Fig. 2. The Kap København area with the localities from where the investigated samples were taken.



nally described from the Miocene-Oligocene (?) (cf. McNeil *et al.* 1982) of Carter Creek, northern Alaska. It is an intermediate species between *Nonion barleeanum*

Table 1. Locality 120, sample no. 53212, dry weight 100 g

Species	Percentage
Nonion erucopsis Todd	43
Elphidium funderi n. sp.	37
Cassidulina reniforme Nørvang	9
Epistominella vitrea Parker	4
Glandulina laevigata d'Orbigny	3
Elphidium cf. *excavatum* (Terquem)	2
6 other species each accounting for <1%.	
Counted 339 specimens (the whole sample).	
Number of species: 12.	

(Williamson), which is larger and broader, with a wider umbilicus and a more conspicuous limbate ring around it, and *Nonion affine* (Reuss), which is smaller and laterally more compressed. The second diagnostic feature of the assemblage is the frequent occurrence of *Elphidium funderi* n. sp. This is an *Elphidium* species with an acute, almost keeled periphery. It shows a slight resemblance to *Polystomella cryptostoma* Egger from the Miocene of Nieder-Bayern, Germany, and a still weaker resemblance to *Polystomella angulata* Egger, also from the Miocene of Nieder-Bayern. It shows also affinity to *Cribrononion occidentalis* Margerel (1968) from the Redonien (Pliocene) of north-western France.

The specimens of *Cassidulina* present in this zone seem to belong to the species *C. reniforme* Nørvang.

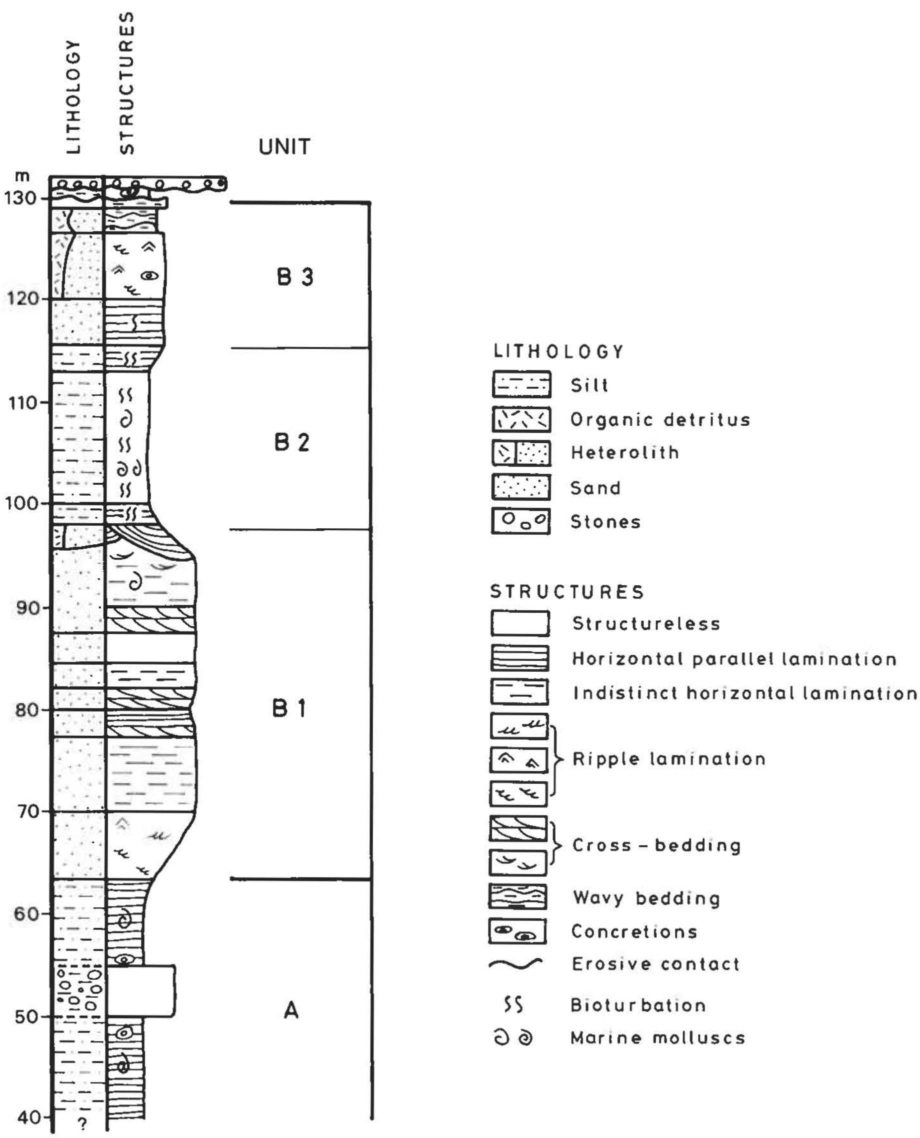


Fig. 3. The type section of the Kap København Formation (locality 50) adapted from Funder *et al.* 1985).

They are, however, smaller than normal and have some kind of a recrystalized coating on their surfaces. The specimens referred to as *Elphidium* cf. *excavatum* (Terquem) show affinity to both *E. funderi* and *E. excavatum*. They have a subacute periphery and lack sutural bridges in their earlier sutures. They have a faint resemblance to *Cribrononion* sp.2 of Margerel (1968) from the Pliocene of north-western France.

The fauna shown in Table 2, from lower part of member A, is dominated by *Nonion erucopsis*, but has more *Cassidulina reniforme* than *Elphidium funderi*. *Cassidulina teretis* Tappan, a characteristic species of Pliocene and Lower Pleistocene deposits (Tappan 1951; Feyling-Hanssen 1980a) also occurs, as does an elongated *Quinqueloculina* species referred to *Quinqueloculina longa*

Table 2. Locality 59, sample no. 56890, dry weight 200 g

Species	Percentage
Nonion erucopsis Todd	37
Cassidulina reniforme Nørvang	35
Elphidium funderi n. sp.	14
Buccella frigida (Cushman)	3
Quinqueloculina longa Gudina	3
Cassidulina teretis Tappan	2
Elphidium cf. *excavatum* (Terquem)	2
Cassidulina cf. *teretis* Tappan	1
Nonion orbiculare (Brady)	1
Pyrgo simplex d'Orbigny	1

4 other species each accounting for <1%.
Counted 447 specimens (⅔ of the sample).
Number of species: 14.
Number of specimens/100 g: 335.

Gudina. This latter species was originally described from the Quaternary of north-western Siberia. It resembles *Q.* cf. *venusta* Karrer as figured by Cushman & Todd (1947) from Amchitka Island, near Nome, Alaska. *Cassidulina reniforme* in this and other samples, particularly in member A, is laterally more compressed than Pleistocene and Recent specimens of this species. It has a subacute periphery and often an irregular, lobulate outline. These specimens are close to *Cassidulina sagminensis* described by Asano & Nakamura (1937) from Pliocene deposits in Japan.

As demonstrated by these two examples, the *Elphidium funderi* Zone possesses considerable number of *Nonion erucopsis* and also many *Cassidulina reniforme*. It is, however, characterized by the new species, *Elphidium funderi*, which it has been named after.

Foraminiferal assemblages from the *Elphidium funderi* Zone were usually not well preserved.

The *Cassidulina laevigata* Zone

Typical examples of these assemblages are shown in Tables 3 and 4. At locality 16 (Fig. 2) a dislocated thrust sheet is found at the top of the section. It is most probably derived from the lower part of member A. A sample from this thrust sheet yielded an assemblage dominated by *Cassidulina reniforme* with many *Cassidulina laevigata* d'Orbigny as well as many *Nonion erucopsis* and *Cassidulina teretis* (Table 3).

Cassidulina laevigata is known from the Tertiary as well as from the Quaternary and Recent. Many of the specimens from this sample are large with a carinate periphery, as is often seen in Pliocene deposits of the North Sea and of the Netherlands (cf. *C. pliocarinata* van Voorthuysen 1950). *Cassidulina teretis* is common in Pliocene and Lower Pleistocene deposits, but according to Sejrup *et al.* (1987), it continues into the Middle Pleistocene in part of the North Sea region as well. Five specimens of the large and conspicuous *Cibicides grossa* Ten Dam & Reinhold were also found. The latter species is known from Upper Pliocene deposits in the Arctic (cf. Feyling-Hanssen 1980a, 1985; McNeil 1989) as well as in the North Sea basin (cf. King & Hughes 1983). *Nonion erucopsis* is also quite frequent, whereas *Elphidium funderi* n. sp. is rare. *Quinqueloculina obliquecamerata* Grigorenko has been recorded in Upper Miocene and Pliocene deposits of Sakhalin, and *Nonion matchigaricus* Voloshinova was found in the Miocene there. A few specimens of *Quinqueloculina parkeri* (Brady), similar to those figured by Voloshinova *et al.* (1970) from the Pliocene of Sakhalin, also occur in the sample.

Table 3. Locality 16, sample no. 56714, dry weight 200 g

Species	Percentage
Cassidulina reniforme Nørvang	47
Cassidulina laevigata d'Orbigny	16
Nonion erucopsis Todd	10
Cassidulina teretis Tappan	9
Elphidium excavatum (Terquem)	3
Epistominella vitrea (Parker)	3
Quinqueloculina obliquecamerata Grigorenko	3
Elphidium albiumbilicatum (Weiss)	2
Nonion matchigaricus Voloshinova	2
Buccella frigida (Cushman)	1
Cibicides grossa Ten Dam & Reinhold	1
Elphidium cf. *excavatum* (Terquem)	1

14 other species each accounting for <1%.
Counted 656 specimens (⅓ of the sample).
Five additional species occurred in the uncounted part.
Number of species: 31.
Number of specimens/100 g sediment: 1770.

Table 4. Locality 16, sample no. 56609, dry weight 200 g

Species	Percentage
Cassidulina reniforme Nørvang	34
Cassidulina teretis Tappan	9
Elphidium cf. *excavatum* (Terquem)	9
Nonion erucopsis Todd	8
Cassidulina laevigata d'Orbigny	7
Elphidium excavatum (Terquem)	7
Nonion matchigaricus Voloshinova	7
Elphidium albiumbilicatum (Weiss)	3
Elphidium funderi n. sp.	3
Buccella frigida (Cushman)	2
Elphidium hallandense Brotzen	2
Elphidium hughesi Cushman & Grant	1
Elphidium subglobosum Voloshinova	1
Epistominella vitrea (Parker)	1
Guttulina austriaca d'Orbigny	1
Guttulina lactea (Walker & Jacob)	1
Guttulina roemeri (Reuss)	1
Nonion barleeanum (Williamson)	1
Nonion orbiculare (Brady)	1

4 other species each accounting for <1%.
Counted 318 specimens (the whole sample).
Number of species: 23.

The faunal composition of another sample from the same locality and apparently from the same thrust sheet, although 100 m away, is shown in Table 4.

Cassidulina reniforme also dominates this assemblage, and *Cassidulina teretis, C. laevigata,* and *Nonion erucopsis* are firmly represented. The two samples are thus considered to belong to the same zone. This is also demonstrated by the relatively high incidence of species in both samples. A difference is the high frequency of *Elphidium* cf. *excavatum* in sample no. 56609.

Age of the *Elphidum funderi* Zone and the *Cassidulina laevigata* Zone

The four examples of foraminiferal assemblages from the clay of member A of the Kap København formation shown above, and other investigated samples from this unit, are all characterized by *Nonion erucopsis, Elphidium funderi, Cassidulina laevigata,* and *Cassidulina teretis*. None of these species could belong in the cryophilic assemblages of the Pleistocene – particularly not at the high latitude of Kap København. The same is the case with most of the other species from member A. They do not reflect a cold Pleistocene environment. They are, however, known from Upper Tertiary deposits, particularly from the Pliocene but some of them also from the Miocene. On the other hand, typical Miocene forms such as members of the family Uvigerinidae, and species like *Cibicidoides sp. 800* McNeil and *Asterigerina staeschei* (Franke), which characterize the Miocene of the Beaufort-Mackenzie Basin (McNeil 1989), are completely absent in the member A assemblages. A Pliocene age for member A is, therefore, most likely.

Furthermore, the assemblages within member A fall into two groups, one characterized by *Nonion erucopsis* and *Elphidium funderi* and another characterized by *Nonion erucopsis, Cassidulina reniforme, C. laevigata,* and *C. teretis*. The former is referred to the *Elphidium funderi* Zone and the latter the *Cassidulina laevigata* Zone. Because of glaciotectonic activity in the area it is not immediately clear what stratigraphical relationship those two zones have. We do know, however, from other localities that *Cassidulina teretis* together with *Cibicides grossa* belong in the Upper Pliocene. The *Cassidiulina laevigata* Zone of Kap København could, therefore, also belong in the Upper Pliocene. It has, furthermore, been observed at least in one North Sea boring that a *Nonion* dominance occurs below a unit with *Cassidulina teretis* and *Cibicides grossa* (Ásbjörnsdóttir 1987) which could indicate a greater age for the *Elphidium funderi* Zone than for the *Cassidulina laevigata* Zone of the Kap København Formation. This view is supported by the occurrence of both *Elphidium excavatum*, a typical Pleistocene cold-water species, and of the transitional form between *Elphidium funderi* and *E. excavatum,* viz. *Elphidium* cf. *excavatum,* in the assemblages of the *Cassidulina laevigata* Zone. This and the occurrence of some other species known from the Pleistocene in the *Cassidulina laevigata* Zone signals an approach to harsher palaeoenvironmental conditions.

The *Elphidium funderi* Zone, which seems to form the lower part of the *Nonion erucopsis*-bearing deposits, might then have a Lower Pliocene age. However, certain Lower Pliocene markers seem to be absent. The *Elphidium funderi* Zone may, therefore, also be of Upper Pliocene age, but older than the *Cassidulina laevigata* Zone.

The *Elphidium funderi* Zone and *Cassidulina laevigata* Zone correspond to the *Cibicides grossa* Interval zone of McNeil (1989) from the Beaufort-Mackenzie Basin, which is considered to be of Lower Pliocene age.

The *Elphidiella rolfi* Zone

At the type section (loc. 50) of the Kap København Formation (Figs 2 and 3), only poorly preserved remnants of the *Cassidulina laevigata* Zone were found in the clays of member A. Foraminifera were not observed in the lower sands of unit B1 of member B. But in the upper part of unit B1 and in the lowest part of the silty unit B2 well preserved assemblages with a very characteristic species association occurred (Fig. 4 and Table 9). An example is given in Table 5.

Table 5. Locality 50, sample no. 197134, dry weight 160 g

Species	Percentage
Nonion niveum Lafrenz	28
Globulina cf. *granulosa* Egger	25
Nonion orbiculare (Brady)	23
Elphidiella rolfi Gudina & Polovova	8
Elphidium hughesi (Cushman & Grant)	7
Buccella frigida (Cushman)	3
Elphidium ustulatum Todd	2
Nonion matchigaricus Voloshinova	2
Pseudopolymorphina dollfussi Cushman & Ozawa	1
5 other species each accounting for <1%.	
Counted 507 specimens (½ of the sample).	
Number of species: 14.	
Number of specimens/100 g sediment: 640.	

Even though the small species *Nonion niveum* Lafrenz, dominates this assemblage, the large and conspicuous *Elphidiella rolfi* Gudina & Polovova characterizes it. This species, which resembles *Elphidiella subcarinata* Voloshinova from the Miocene and Pliocene of Sakhalin (cf. Funder *et al.* 1985), was described from uppermost Pliocene/lowermost Pleistocene deposits of Ajon Island, northern Chukotka, USSR (Gudina *et al.* 1984). One specimen of *Elphidiella hannai* Cushman & Grant, or a species close to it, occurs together with *E. rolfi* in sample no. 197134, and a few more *E. hannai* were observed in some of the other samples from the lowermost part of unit B2. This species is characteristic of the Pliocene/Pleistocene transition in shallow-water deposits of the southern North Sea basin (van Voorthuysen 1950; Doppert 1980; King & Hughes 1983; Feyling-Hanssen 1986). It occurs also in the inner shelf deposits of a boring in the Beaufort Sea, which has been referred to the Pliocene-Pleistocene transition (McNeil *et al.* 1982). *Elphidiella rolfi* was observed together with *E. hannai* in the same layers (Funder *et al.* 1985; Feyling-Hanssen 1986). Anvilian deposits of the lower Pleistocene of the western Seward Peninsula (Hopkins *et al.* 1974) also possess a few *Elphidiella hannai.* One of the species from the Seward Peninsula, illustrated in Plate 3 as Figs 12 and 13 in Hopkins *et al.* (1974) and referred to *Cribrononion obscurus* Gudina, may very well turn out to be *Elphidiella rolfi.*

This lowest part of unit B2 in the type section, locality 50, is here called the *Elphidiella rolfi* Zone (Fig. 4 and Table 9).

Other species occurring frequently in this zone are *Elphidium hughesi* Cushman & Grant (1927), originally described from the Pliocene of Monterey, California, and the laterally compressed form of *Nonion orbiculare* (Brady), as is found in the Neogene deposits of the Netherlands (Doppert 1980). Frequent and characteristic is also the small *Nonion niveum,* originally de-

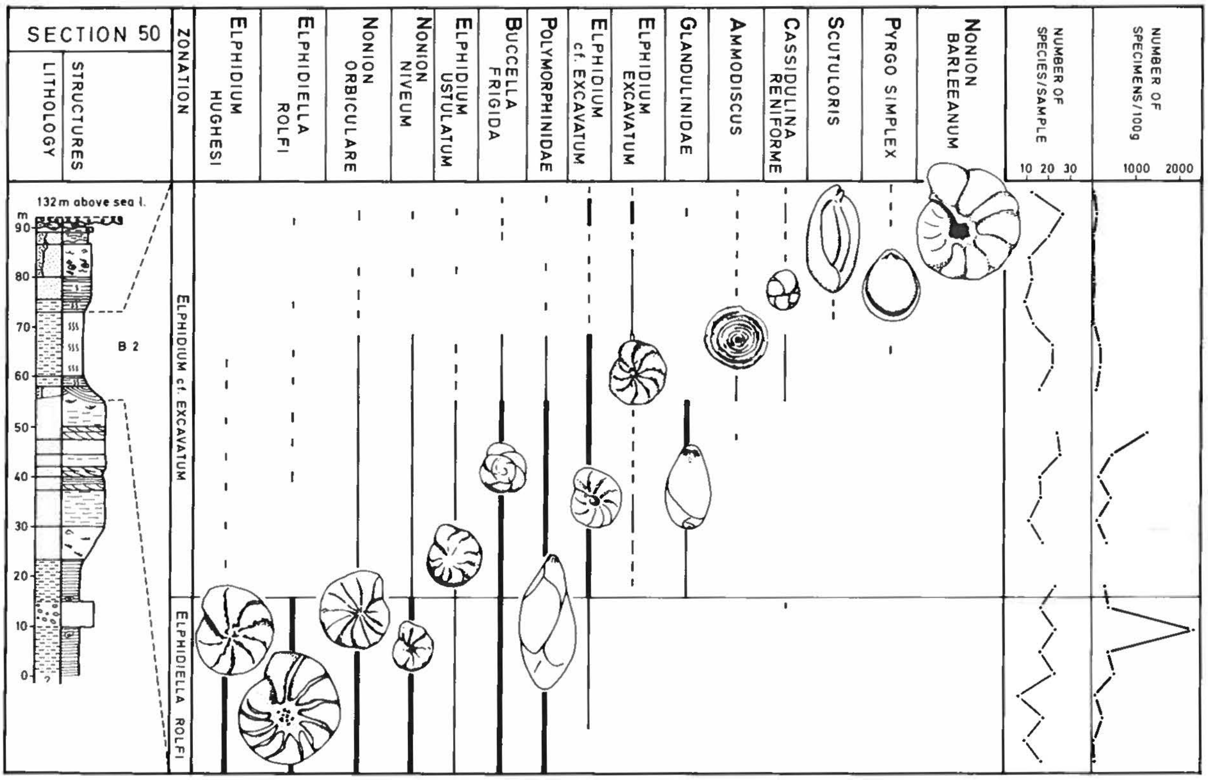


Fig. 4. Frequency distribution of the most common taxa of foraminifera from litho-unit B2 of the type section (locality 50). The other litho-units of this section contained only few and badly preserved specimens and fragments of foraminifera. See also Table 9 (in pocket).

scribed from Eemian deposits of Schleswig-Holstein but occurring throughout the Pleistocene. *Buccella frigida* (Cushman) is frequent and so are also different species belonging to the Polymorphinidae. Quite characteristic is also *Elphidium ustulatum* from the Oligocene?-Miocene-Pleistocene (Todd 1957; McNeil *et al.* 1982).

The *Elphidiella rolfi* Zone may thus represent a shallow-water facies of the uppermost Pliocene.

The *Elphidium* cf. *excavatum* Zone

The foraminiferal assemblages occurring above the *Elphidiella rolfi* Zone in unit B2 of the type section (Figs 3, 4 and Table 9) may indicate a slight deepening of the water. Typical large shallow-water species disappeared and species of the family Glandulinidae become frequent, particularly *Esosyrinx curta* (Cushman & Ozawa) and *Glandulina laevigata* (Table 6). Characteristic is, above all, *Elphidium* cf. *excavatum*. This species resembles *Elphidium excavatum* but has a nearly subacute peripheral margin and possesses sutural bridges only in the last two sutures. True *Elphidium excavatum* is rare in this part of the section. *Ammodiscus* cf. *concinnus* Kuznetzova, originally described from the Lower Miocene of Sakhalin (Voloshinova *et al.* 1970), occurs higher up in the section. A broad *Pyrgo*, most probably referable to *Pyrgo simplex* (d'Orbigny), an elongated *Scutuloris* and large specimen of *Nonion barleeanum* (Williamson) characterize the uppermost fossiliferous part of unit B2 at locality 50 (Tables 7 and 9, Fig. 4). *Buccella frigida* is frequent throughout the lower half of the zone (Table 6).

Table 6. Locality 50, sample no. 223283, dry weight 100 g

Species	Percentage
Elphidium cf. *excavatum* (Terquem)	31
Buccella frigida (Cushman)	12
Esosyrinx curta (Cushman & Ozawa)	11
Scutuloris pyriformis (Gudina)	11
Glandulina laevigata d'Orbigny	7
Nonion orbiculare (Brady)	5
Elphidium ustulatum Todd	3
Globulina cf. *granulosa* (Egger)	3
Nonion matchigaricus Voloshinova	3
Elphidium albiumbilicatum (Weiss)	2
Miliolinella subrotunda (Montagu)	2
Nonion niveum Lafrenz	2
Elphidium excavatum (Terquem)	1
Guttulina austriaca d'Orbigny	1
Guttulina roemeri (Reuss)	1
Quinqueloculina seminulum (Linné)	1

6 other species each accounting for <1%.
Counted 553 specimens (¼ of the sample).
Number of species: 22.
Number of specimens/100 g sediment: 1250.

Table 7. Locality 50, sample no. 223287, dry weight 200 g

Species	Percentage
Elphidium cf. *excavatum* (Terquem)	34
Elphidium excavatum (Terquem)	23
Cassidulina reniforme Nørvang	7
Elphidium albiumbilicatum (Weiss)	7
Nonion barleeanum (Williamson)	6
Glandulina laevigata d'Orbigny	4
Quinqueloculina longa Gudina	2
Scutuloris pyriformis (Gudina)	2
Elphidium bartletti Cushman	1
Elphidium hallandense Brotzen	1
Epistominella vitrea Parker	1
Esosyrinx curta (Cushman & Ozawa)	1
Miliolinella valvulinaris (Reuss)	1
Nonion matchigaricus Voloshinova	1
Parafissurina lateralis (Cushman)	1
Pyrgo simplex (d'Orbigny)	1
9 other species each accounting for <1%.	
Counted 213 specimens (the whole sample).	
Number of species: 25.	
Number of specimens/100 g sediment: 100.	

The age of this approximately 10 m thick unit is uncertain. It could belong to the lowest Pleistocene as it displays some similarity to the *Miliolinella pyriformis* Zone established by Gudina (1969) in the Lower Pleistocene of the Yenisey lowland of Siberia. In fact the elongated *Scutuloris* of the upper part of the *Elphidium* cf. *excavatum* Zone of the type section may be conspecific with *Miliolinella pyriformis* Gudina, and this latter species may belong to the genus *Scutuloris* rather than to *Miliolinella* (cf. Gudina 1969, Pl. 5, Fig. 5a and Pl. 6, Figs 1a and b).

On the other hand, many of the species present in the *Elphidium* cf. *excavatum* Zone at locality 50 – and of other localities of the Kap København area – are not typical Pleistocene species as most of them have also been recorded in the Tertiary.

The *Elphidium* cf. *excavatum* Zone may, therefore, represent a transition Zone between the Pliocene and the Pleistocene in the area.

A slight deepening of the sedimentation basin seems to be reflected in this fauna.

The *Elphidium excavatum* Zone

Some fossil foraminifera assemblages in the northern part of the Kap København area are characterized by the dominance of *Elphidium excavatum* and by the frequent occurrence of quite large shallow-water species such as *Nonion orbiculare, Elphidium asklundi,* and *Elphidium bartletti. Cassidulina reniforme* is present in all but the shallowest samples, *Nonion niveum* is also firmly represented, as is *Elphidium ustulatum.* All these species are well known from the Pleistocene of numerous other localities in the Northern Hemisphere.

The frequency distribution of foraminifera of samples from a 4 m thick part of a section at locality 72 is illustrated in Fig. 5 (symbols explained in Fig. 6). The sediment in this fossiliferous part of the section is silt.

The *Elphidium excavatum* Zone at locality 72 represents a shallow-water deposit throughout. The content of shallow-water specimens is high in all the samples, approximately 30%.

A slight deepening upwards is reflected in the upwards increasing frequency of *Cassidulina reniforme.* But the palaeodepth was hardly more than 20 m, certainly less in the lower part of the section.

Elphidiella hannai occurs commonly in the two lowest samples at locality 72, and is present also in the uppermost sample. *Elphidiella rolfi* is present in four of the samples and *Elphidium hughesi* in five (cf. Fig. 5).

These three species indicate a Lower Pleistocene age for the fossiliferous part of the section at locality 72, referable to the *Elphidium excavatum* Zone of Kap København.

The zone is most probably younger than the *Elphidium* cf. *excavatum* Zone at locality 50. For one thing the species occurring at locality 72 are undisputably Pleistocene, whereas many of those present in the *Elphidium* cf. *excavatum* Zone are not. Moveover, the transitional form between *Elphidium funderi* and *Elphidium excavatum,* viz. *Elphidium* cf. *excavatum,* which was frequent at locality 50, does not occur – or is extremely rare – at locality 72.

As is shown above, *Elphidium* cf. *excavatum* occurs in the *Elphidium funderi* Zone, becomes more common in the *Cassidulina laevigata* Zone, is present in the *Elphidiella rolfi* Zone, flourishes in the *Elphidium* cf. *excavatum* Zone at locality 50, and is practically absent in the *Elphidium excavatum* zone at locality 72. Also for this reason the *Elphidium excavatum* Zone of the section at locality 72 is considered to be younger than the *Elphidium* cf. *excavatum* Zone at locality 50.

It is also known from borings in the North Sea that forms comparable to *Elphidium* cf. *excavatum* flourish stratigraphically below the *Elphidium excavatum*-dominated layers in the Lower Pleistocene (cf. Ásbjörnsdóttir 1987).

It is interesting to note here that Brouwers *et al.* (in press) found a similar difference in the ostracod faunas between localities 50 and 72, with the "young" species *Rabilimis septentrionalis* (Brady) occurring only at locality 72 (one individual at locality 75). However, they interpreted this as due to a difference in environment, not in age.

The *Elphidiella gorbunovi* Zone

In the uppermost sample of the section at locality 72 a few specimens of the large and conspicuous species *Elphidiella gorbunovi* Stschedrina occurred.

This species, with its narrow, subacute peripheral margin, was originally described from the eastern Arctic Ocean (Stschedrina 1946; Voloshinova *et al.* 1970). It is also known from a few borings in the North Sea (in the

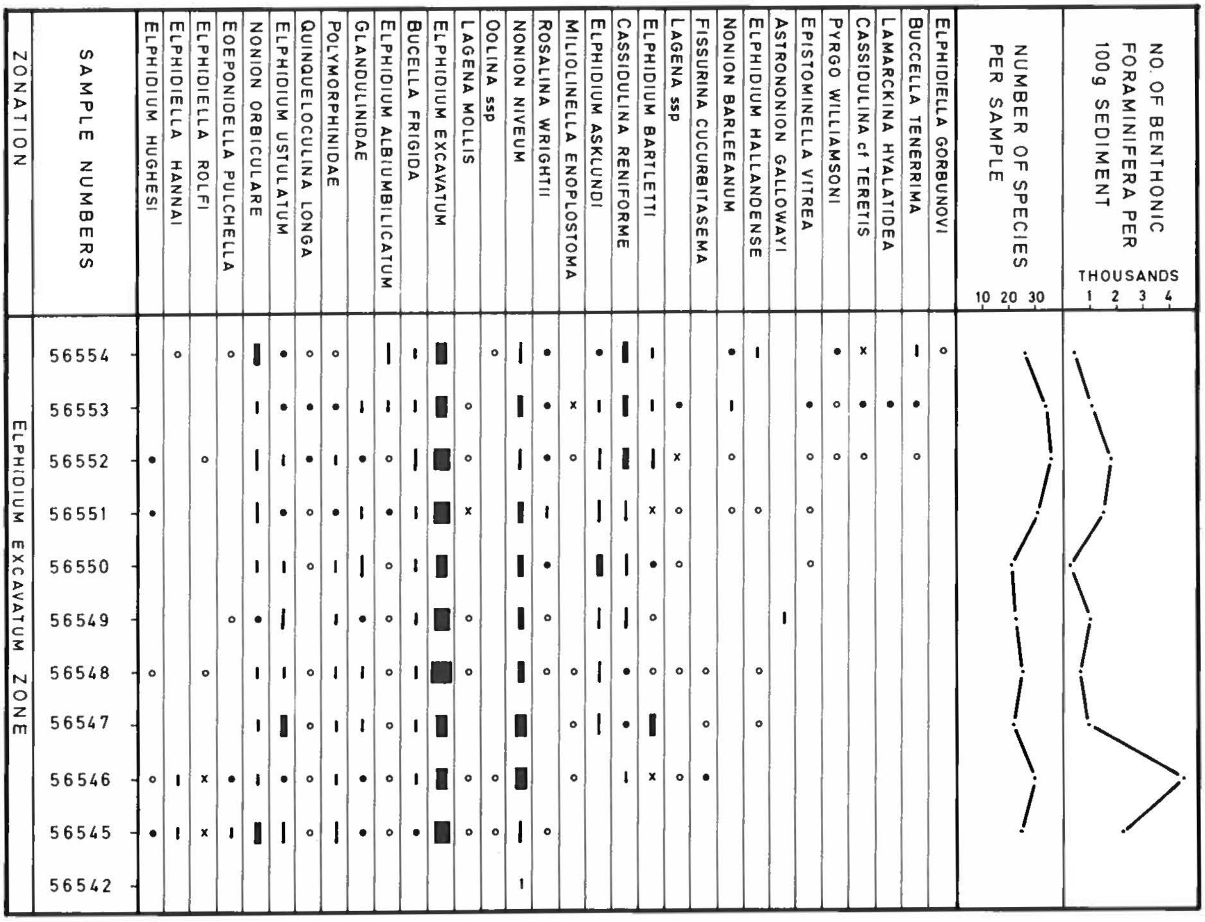


Fig. 5. Frequency distribution of the most common foraminifera from the section at locality 72. (Symbols explained in fig. 6).

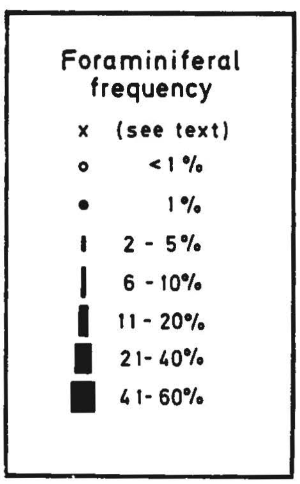


Fig. 6. Symbols used in fig. 5 (x means that the species occurred in the uncounted part of the sample).

Balder Field, the Tyra Field, and the Josephine Boring). *Elphidiella gorbunovi* gives its name to a distinct foraminiferal zone which occurs well above the Pliocene/Pleistocene boundary but under the Brunhes/Matuyama palaeomagnetic boundary in two borings in the Central North Sea, TWB-12, Tyra Field and the Josephine boring, (Pedersen 1987). This zone thus belongs in the upper part of the Lower Pleistocene but is older than 700,000 years.

In the northern part of the Kap København area a sample from locality 129 contained 10 specimens of *Elphidiella gorbunovi* (Table 8). This is the only analysed sample from what is considered the youngest part of the Kap København Formation. It is taken to represent the uppermost part of its foraminiferal zonation: The *Elphidiella gorbunovi* Zone.

Tertiary/Quaternary foraminiferal morphogenesis

A morphological transformation and succession within the foraminiferal populations seem to appear at the boundary between the Tertiary and the Quaternary periods in North Greenland. The Tertiary *Elphidium funderi* has an acute, sometimes even keeled (carinate), peripheral margin. This margin becomes subacute to

Table 8. Locality 129, sample no. 53259, dry weight 100 g

Species	Percentage
Elphidium excavatum (Terquem)	25
Nonion orbiculare (Brady)	21
Cassidulina reniforme Nørvang	17
Buccella frigida (Cushman)	7
Elphidium bartletti (Cushman)	7
Nonion barleeanum (Williamson)	3
Nonion niveum Lafrenz	3
Buccella tenerrima (Bandy)	2
Elphidium asklundi Brotzen	2
Elphidiella gorbunovi Stschedrina	2
Miliolinella subrotunda (Montagu)	2
Buccella hannai arctica Voloshinova	1
Cassidulina cf. *teretis* Tappan	1
Elphidium albiumbilicatum (Weiss)	1
Elphidium groenlandicum Cushman	1
Elphidium ustulatum Todd	1
Miliolinella enoplostoma (Reuss)	1
Glabratella wrightii Brady	1

20 other species, each accounting for <1%.
Counted 570 specimens (1/15 of the sample).
Number of species: 38.
Number of specimens/100 g sediment: 2140.

rounded in *Elphidium* cf. *excavatum* in the uppermost Pliocene near the boundary, and develops into the more broadly rounded peripheral margin of *Elphidium excavatum* in an increasing number of specimens in the Pleistocene. This development, which in this case may be phylogenetic, may reflect a morphological response to decreasing water temperature.

Other lines of development can be mentioned, some with phylogenetic continuity, others without. The Oligocene *Nonion affine,* which is laterally compressed and with almost a subacute periphery, develops through the less compressed and with more rounded peripheral margin *Nonion erucopsis,* to the large and broadly rounded *Nonion barleeanum* in the Lower Pleistocene of Kap København. *Elphidiella rolfi* with its subacute to almost acute periphery should also be mentioned. It occurs in the Pliocene, flourishes in its uppermost part and in the transitional zone between the Pliocene and Pleistocene and fades away in the Lower Pleistocene. *Elphidiella hannai,* with its more rounded peripheral margin, could be considered as a replacement for *Elphidiella rolfi* in the lowermost Pleistocene, and the broadly rounded *Elphidiella arctica* could be a successor for *Elphidiella hannai* higher up in the Pleistocene (van Voorthuysen 1953). Sharp-edged, carinate species such as *Cassidulina teretis* and *Cassidulina laevigata* do not occur in the Pleistocene shallow-water deposits of Kap København. As far as is known, they do not occur at all in shallow cold water deposits in the Northern Hemisphere, either during the Pleistocene or at the present day. But they, or similar species, do occur in warmer Atlantic deep water in the Arctic region of to-day (for North Sea occurrences cf. Sejrup *et al.* 1987 and Mackensen & Hald 1988).

Narrow, flat, carinate and spinate forms are rare in Arctic shallow-water biotopes with low temperatures, whereas they are common in low-latitude shallow-water assemblages. Compare for instance in a general way shallow-water assemblages from Arctic coasts with those from Mediterranean coastal waters (Boltovskoy & Wright 1976).

That these differences are controlled by water temperature is apparent from studies of foraminiferal faunas from North Sea borings penetrating glacial and interglacial deposits. Arctic, cold water faunas dominate the glacial sequences of the borings. These are all rounded and broad forms. Temperate water faunas with carinate and spine-carrying taxa return to the locality during interglacials. The decrease in temperature through the Upper Tertiary into the Quaternary was worldwide. McNeil suggests that it started near the end of the Miocene, marked by a regionally recognized "Late Miocene unconformity" in the Arctic (McNeil *et al.* 1982; McNeil 1989). It was particularly felt in the northern (and the Antarctic) regions of the globe where Tertiary woodlands were transformed into the Arctic deserts of to-day. Most of the present-day cold water foraminiferal species must have developed during these transitional epochs.

The above-mentioned morphological changes took place during the transition from the Tertiary temperate water conditions to the Quaternary cold-water condition also at Kap København. There are, however, certain exceptions to this general trend. One of these is *Elphidiella gorbunovi*, mentioned above.

Concluding remarks

The sediments of the Kap København formation are tectonically disturbed, most probably by glacier ice overriding the area after their deposition. In addition to this, many of the examined samples were barren of fossil foraminifera, and others contained only badly preserved remnants which could not safely be identified. Any certain pattern in the geographical distribution of the stratigraphical zones dealt with above, has thus not been observed.

Pliocene as well as Pleistocene layers occur in a few cases at the same locality. At others only Pliocene or only Pleistocene deposits occur. Pliocene deposits have been frequently recognized in the southern and south-eastern part of the Kap København area, whereas Pleistocene layers are more often met within the northern and north-eastern part. The apparently youngest Lower Pleistocene sample was collected from locality 129 in the north-east.

Stratigraphically the Kap København Formation correlates with the Iperk Sequence of the Beaufort-Mackenzie Basin (Dixon & Dietrich 1988) when compared with the foraminiferal zonation presented by McNeil

BAFFIN ISLAND: Clyde	BAFFIN ISLAND: Qivituq	GREENLAND: Lodin Elv	GREENLAND: Kap København	CENTRAL NORTH SEA	EPOCH
			Elphidiella gorbunovi	Elphidiella gorbunovi	Lower Pleistocene
Islandiella islandica Zone	Zone F Islandiella islandica		Elphidium excavatum	Elphidium excavatum	
Cassidulina teretis Zone	Zone G Cassidulina teretis	Zone II Cassidulina cf. teretis	Elphidium cf. excavatum	Elphidiella hannai	Pliocene
			Elphidiella rolfi	Cassidulina cf. teretis and Cibicies grossa	
Cibicides grossa Zone	Zone H Cibicides grossa	Zone I Cibicides grossa	Cassidulina laevigata		
Nonion tallahattensis Zone	Zone J Nonion cf. tallahattensis		Elphidium funderi		

Fig. 7. Proposed correlation of the foraminiferal zones of Kap København with other outcrops in Greenland and on Baffin Island, and with occurrences in some North Sea borings.

(1989) (cf. also McNeil 1985). All the foraminiferal zones from the Kap København Formation seem to belong to McNeil's *Cribroelphidium* Assemblage Zone. The *Elphidiella gorbunovi* Zone, the *Elphidium excavatum* Zone, the *Elphidium* cf. *excavatum* Zone and the *Elphidiella rolfi* Zone may all fit in the upper part of McNeil's inner neritic *Cribroelphidium clavatum* biofacies, and the deeper water *Cassidulina laevigata* Zone and *Elphidium funderi* Zone in the lower part of McNeil's outer neritic *Cassidulina teretis* biofacies. McNeil's *Cibicides grossus* Interval Zone probably corresponds to the *Elphidium funderi, Cassidulina laevigata,* and *Elphidiella rolfi* Zones of Kap København, and his *Cribroelphidium ustulatum* Interval Zone correlates with the *Elphidium* cf. *excavatum* Zone, the *Elphidium excavatum* Zone and the *Elphidiella gorbunovi* Zone. McNeil's zonation was based on borehole material.

Local differences in environmental conditions make it difficult in may cases to recognize assemblages of the same age from one locality to another. Still, the presence or absence of certain stratigraphical markers usually makes it possible to make out the age in spite of "environmental noise". An attempt at this is illustrated in Fig. 7, where the stratigraphy of the outcrops of the Kap København Formation are compared with the stratigraphy of other outcrops in Greenland and on Baffin Island. The localities are the Clyde Foreland (Feyling-Hanssen 1985), Qivituq Peninsula (Feyling-Hanssen 1980) and Lodin Elv (Feyling-Hanssen *et al.* 1982). A column with assemblages from the Central North Sea is also inserted (Ásbjörnsdóttir 1987; Pedersen 1987; King & Hughes 1983; Feyling-Hanssen 1986).

The foraminifera reveal that the Kap København Formation, or at least parts of it, was deposited on an inner shelf, in a sublittoral to littoral environment during the Upper Pliocene and Lower Pleistocene. Open water must have occurred, at least seasonally, in the area during this period. This conclusion is in good agreement with results reached by Funder and coworkers already in 1984.

Brouwers *et al.* (in press) have analysed the ostracod faunas of the Kap København Formation. Their conclusions regarding climate, ecology and age are in general agreement with those described here. However, there is some disagreement concerning the age of the faunas at locality 72 in the northern part of the area, which they consider to have an age of 2.7–2.8 Ma. This is older than the estimate given here.

Systematic notes on the foraminifera

Very few agglutinating foraminifera are present in the Kap København material.

Family AMMODISCIDAE

Ammodiscus cf. *concinnus* Kuznetzova

Plate 1, figs 1, 2.

Ammodiscus concinnus Kuznetzova, in Voloshinova, Kuznetzova, Leonenko 1970, p. 50; pl. 4, figs 1–2.

The specimens in the present material are smaller than those described by Kuznetzova (1970) from the Miocene of Sakhalin. They frequently occur in the upper half of the *Elphidium* cf. *excavatum* Zone at locality 50. They are most probably overrepresented in those samples due to the dissolution of calcareous tests.

Family TEXTULARIIDAE

Textularia cf. *canaensis* Bermudez

Plate 1, figs 3, 4.

Textularia canaensis Bermudez 1949, p. 59; pl. 2, figs 25–27.

A few specimens of this species occur in the *Cassidulina laevigata* Zone at locality 16. These are somewhat twisted along the longitudinal axis, and are smaller than the specimens described by Bermudez from the Middle Miocene.

Family TROCHAMMINIDAE

Trochammina

A few fragments occur in the *Elphidium* cf. *excavatum* Zone at locality 50.

Quite a number of species with porcelaneous test occur:

Family MILIOLIDAE

Quinqueloculina lamarckiana d'Orbigny

Plate 1, figs 5, 6.

d'Orbigny 1839, p. 188; pl. 2, figs 14–15.

This species, with its almost carinate edges, occurs in the *Cassidulina laevigata* Zone at locality 16.

Quinqueloculina longa Gudina

Plate 1, figs 7, 8.

Gudina 1969, p. 9; pl. 2, figs 2–4.

This species occurs quite commonly in the Upper Pliocene and the Lower Pleistocene of the Kap København area.

Quinqueloculina obliquecamerata Grigorenko

Plate 1, figs 9, 10.

Voloshinova *et al.* 1970, p. 69; pl. 12, figs 3–9.

This species is quite common in the Upper Pliocene *Cassidulina laevigata* Zone at locality 16.

Quinqueloculina parkeri (Brady)

Miliolina parkeri Brady 1881, p. 46, 1954, p. 177; pl. 7, figs 14a-c.

A few specimens of this species occur in the Upper Pliocene *Cassidulina laevigata* Zone of Kap København.

Quinqueloculina seminulum (Linné)

Plate 1, figs 11, 12.

Serpula seminulum Linné 1758, p. 786; pl. 2, fig. 1.

Plate 1

Fig. 1,2. *Ammodiscus* cf. *concinnus* Kutznetzova .... p. 14
1, side view of a specimen from the upper part of the *Elphidium* cf. *excavatum* Zone of locality 50. 2, edge view of the same specimen. ×75.

Fig. 3,4. *Textularia* cf. *canaensis* Bermudez .... p. 14
3, side view of a specimen from the *Cassidulina laevigata* Zone of locality 16. 4, edge view of another specimen from the same locality. ×75.

Fig. 5,6. *Quinqueloculina lamarckiana* d'Orbigny .... p. 14
Edge and side view of a specimen from the *Cassidulina laevigata* Zone of locality 16. ×75.

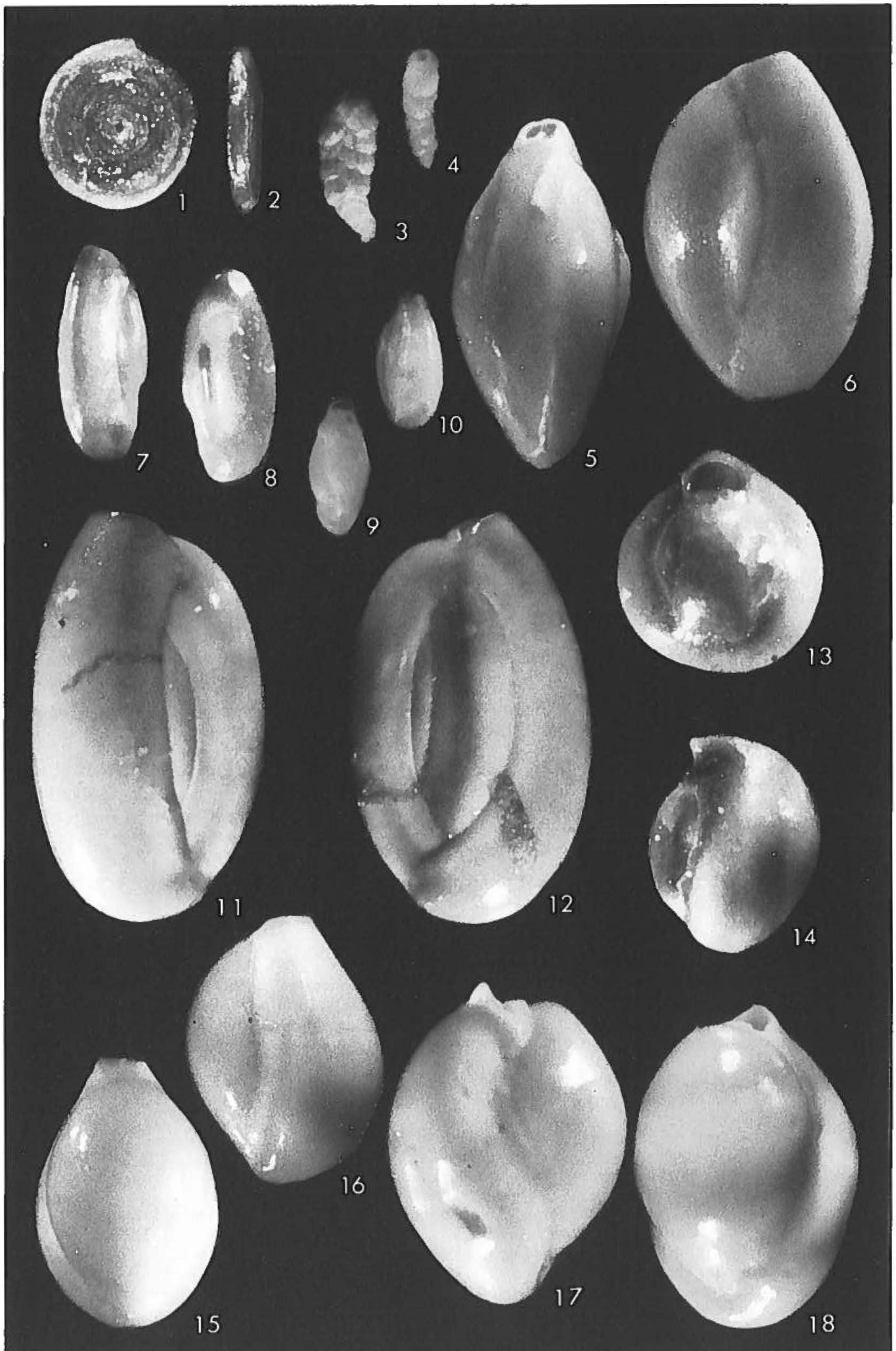
Fig. 7,8 *Quinqueloculina longa* Gudina .... p. 14
Edge and side view of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Figs. 9,10. *Quinqueloculina obliquecamerata* Grigorenko .... p. 14
A specimen from the *Cassidulina laevigata* Zone of locality 16. ×75.

Figs. 11,12. Quinqueloculina seminulum (Linné) .... p. 14
A specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Figs. 13,14. *Pyrgo simplex* (d'Orbigny) .... p. 16
13, apertural view, 14, side view of a specimen from the upper part of the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Figs. 15–18. *Pyrgo williamsoni* (Silvestri) .... p. 16
15–16, front view and side view of a specimen from the *Cassidulina laevigata* Zone of locality 16. 17,18, side view and oblique view of a specimen from locality 72. Both ×75.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Scattered specimens occur both in the Upper Pliocene and in the Lower Pleistocene of Kap København.

Triloculina tricarinata d'Orbigny

d'Orbigny 1826, p. 299, no. 7, modele no. 94. Feyling-Hanssen 1964, p. 258; pl. 6, figs 7–8.

A few specimens of this species are present in the *Elphidium* cf. *excavatum* Zone.

Pyrgo simplex (d'Orbigny)

Plate 1, figs 13, 14.

Biloculina simplex d'Orbigny 1846, p. 264; pl. 15, figs 25–27. *Pyrgo simplex* (d'Orbigny) – Laga 1972, p. 44; pl. 6, figs. 2.

P. simplex occurs in the upper part of the *Elphidium* cf. *excavatum* Zone at the type section, locality 50. This species was originally described from the Tertiary of the Vienna Basin.

Pyrgo williamsoni (Silvestri)

Plate 1, figs 15–18.

Biloculina williamsoni Silvestri 1923, p. 73. *Pyrgo williamsoni* (Silvestri) – Feyling-Hanssen 1964, p. 264; pl. 7, figs 5, 6; pl. 8, figs 3–5.

This species occurs in the upper part of the Lower Quaternary section at locality 72 and in several other samples from the Lower Quaternary of Kap København. It is a common species in Quaternary and Recent deposits in the Northern Hemisphere.

Scutuloris pyriformis (Gudina)

Plate 2, figs 1–6.

Miliolinella pyriformis Gudina 1969, p. 14; pl. 5, figs 4–5; pl. 6, figs 1a-b.

This species is frequent in the upper part of the *Elphidium* cf. *excavatum* Zone of the section at locality 50, Kap København. It was originally described from the Lower Pleistocene of the Yenisey lowland of Siberia.

Miliolinella enoplostoma (Reuss)

Triloculina enoplostoma Reuss 1851, p. 86; pl. 7, fig. 57.

This species is present in the upper part of the *Elphidium excavatum* Zone at localities 72 and 129 of Kap København.

Miliolinella subrotunda (Montagu)

Plate 2, figs 7–9.

Vermiculum subrotunda Montagu 1803, pt. 2, p. 521. *Miliolinella* cf. *subrotunda* (Montagu) – Feyling-Hanssen 1964, p. 261; pl. 7, fig. 1. *Miliolinella subrotunda* (Montagu) – Feyling-Hanssen 1976a, p. 358; pl. 7, figs 15–17.

This is a rare species in the Lower Pleistocene of the Kap København Formation.

Miliolinella valvulinaris (Reuss)

Triloculina valvulinaris Reuss 1851, p. 85; pl. 7, fig. 56. *Miliolinella valvularis* (Reuss) – Feyling-Hanssen 1976b, p. 178.

Single specimens of this species occur in a few samples in the Lower Pleistocene of Kap København. It was originally described from Tertiary deposits of the Berlin

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Plate 2

Figs. 1–6. *Scutuloris pyriformis* (Gudina) .... p. 16
1–3, opposite sides and apertural view of a specimen from the upper part of the *Elphidium* cf. *excavatum* Zone of locality 50. 4–6, another specimen from the same locality. Both ×75.

Figs. 7–9. *Miliolinella subrotunda* (Montagu) .... p. 16
Opposite sides and apertural view of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Fig. 10. *Marginulina subbullata* Hantken .... p. 18
A specimen from the lowest part of the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Fig. 11. *Lagena laevis* (Montagu) .... p. 18
A specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Fig. 12. *Lagena mollis* Cushman .... p. 18
A specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

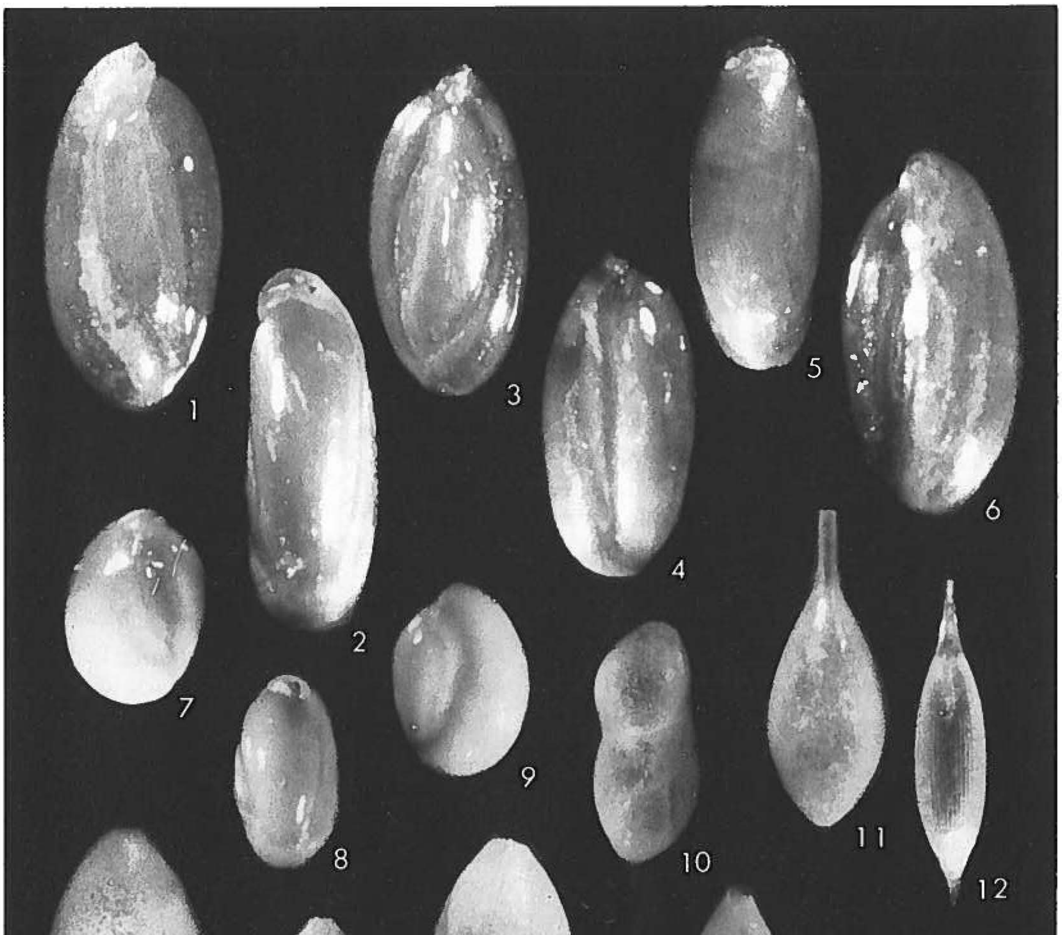
Figs. 13–15. *Guttulina austriaca* d'Orbigny .... p. 18
Three sides of a specimen from the lower part of the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Figs. 16,17. *Guttulina dawsoni* Cushman & Ozawa .... p. 18
Two sides of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Figs. 18,19. *Guttulina orientalis* Cushman & Ozawa .... p. 18
Side view and front view of a specimen from the *Elphidium* cf. *excavatum* Zone locality 50. ×75.

Figs. 20,21. *Pyrulina cylindroides* (Roemer) .... p. 18
Edge and side view of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Fig. 22. *Guttulina* cf. *granulosa* Egger .... p. 18
A specimen from the *Elphidiella rolfi* Zone of locality 50.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area, and was found in some quantity in a sample from the Pleistocene of Broughton Island, Baffin Island, Canada (Feyling-Hanssen 1976b).

Family NODOSARIIDAE

Nodosariids are very sparsely represented in the examined material from Kap København. The following species are present: *Lenticulina gibba* (d'Orbigny), another *Lenticulina, Dentalina fasciata* Seguenza, *Dentalina frobisherensis* Loeblich & Tappan, *Marginulina subbullata* Hantken, *Lagena feildiana* Brady, *Lagena laevis* (Montagu), *Lagena mollis* Cushman, *Lagena substriata* Williamson.

Family POLYMORPHINIDAE

This family is treated collectively in the diagrams figs 4 and 5. It is characteristic of the *Elphidium* cf. *excavatum* Zone, particularly of its lower part. The following species occur:

Guttulina austriaca d'Orbigny
Plate 2, figs 13–15.

Cushman & Ozawa 1930, p. 29; pl. 4, figs 3–5.

This species is observed in the *Cassidulina laevigata* Zone at locality 16. Rare specimens also occurred in the *Elphidium* cf. *excavatum* Zone.

Guttulina dawsoni Cushman & Ozawa
Plate 2, figs 16, 17.

Cushman & Ozawa 1930, p. 47; pl. 12, figs 1–2.

Observed in the *Elphidium* cf. *excavatum* zone.

Guttulina lactea (Walker & Jacob)

Cushman & Ozawa 1930, p. 43; pl. 10, figs 1–4.

Observed in the *Cassidulina laevigata* Zone.

Guttulina orientalis Cushman & Ozawa
Plate 2, figs 18, 19.

Observed in the lower part of the *Elphidium* cf. *excavatum* Zone.

Guttulina roemeri (Reuss)

Cushman & Ozawa 1930, p. 41; pl. 9, figs 3a-c.

Observed in the Upper Pliocene *Cassidulina laevigata* Zone. Scattered specimens also occur in the lowermost Pleistocene of Kap København.

Pyrulina cylindroides (Roemer)
Plate 2, figs 20, 21.

Cushman & Ozawa 1930, p. 56; pl. 14, figs 1–5.

P. cylindroides is present in both the *Elphidiella rolfi* Zone and in the *Elphidium* cf. *excavatum* Zone. It occurs also in the Upper Pliocene of Kap København.

Globulina cf. *granulosa* Egger
Plate 2, fig. 22; pl. 3, figs 1–3.

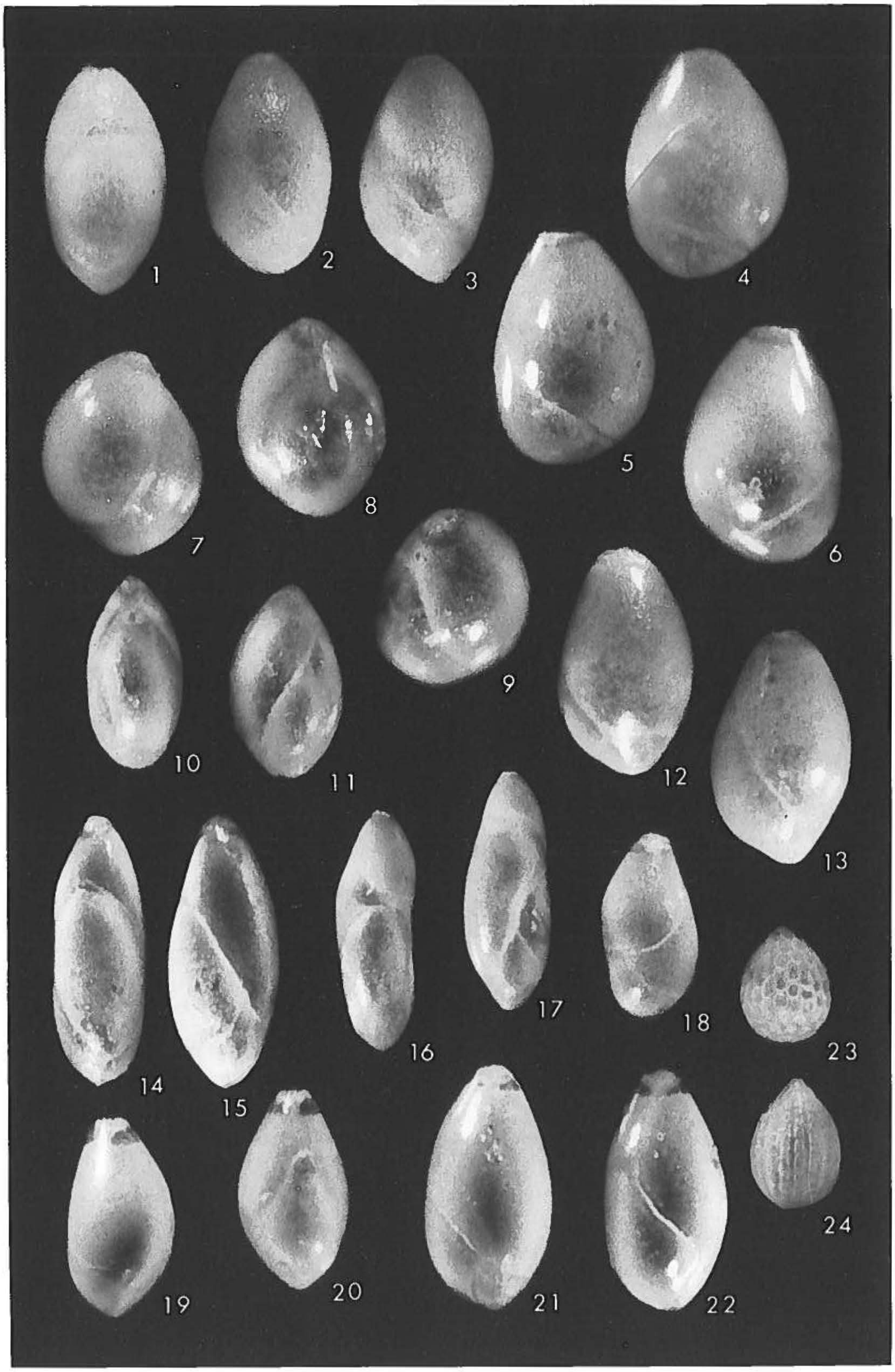
Cushman & Ozawa 1930, p. 81; pl. 20, figs 5 and 7.

The present species is characterized by its very dense longitudinal striation which is much finer than that of *Polymorphina (Globulina) granulosa* Egger. It resembles *Guttulina pulchella* d'Orbigny as described by Laga (1972, p. 108; pl. 7, fig. 8) from the Plio-Pleistocene of the Antwerp area. But in this latter species each succeeding chamber is very little, if at all, removed from the base of the test. *Globulina granulosa* Egger was described from the Younger Tertiary of Europe. The present *Globulina* cf. *granulosa* is quite frequent in the *Elphidiella rolfi* Zone and in the lower half of the *Elphidium* cf. *excavatum* Zone of the section at locality 50.

Globulina inequalis Reuss
Plate 3, figs 4–9.

Plate 3

Figs. 1–3.	*Globulina* cf. *granulosa* Egger .... Three specimens from the *Elphidiella rolfi* Zone of locality 50. ×75.	p. 18
Figs. 4–9.	*Globulina inaequalis* Reuss .... 4–6, three views of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. 7–9, a specimen from the *Elphidiella rolfi* Zone of locality 50. Both ×75.	p. 18
Figs. 10–13.	*Globulina minuta* (Roemer) .... 10,11, a specimen from the *Elphidiella rolfi* Zone of locality 50. 12,13, a specimen from the *Elphidium* cf. *excavatum* Zone of the same locality. Both ×75.	p. 20
Figs. 14,15.	*Pseudopolymorphina decora* (Reuss) .... A specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 20
Figs. 16,17.	*Pseudopolymorphina dollfussi* Cushman & Ozawa .... A specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 20
Fig. 18.	*Esosyrinx curta* (Cushman & Ozawa) .... a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 20
Figs. 19–22.	*Glandulina laevigata* d'Orbigny .... Two specimens of the *Elphidium excavatum* Zone of locality 72. ×75.	p. 20
Fig. 23.	*Oolina hexagona* (Williamson) .... A specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 20
Fig. 24.	*Oolina melo* d'Orbigny .... A specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 20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Cushman & Ozawa 1930, p. 73; pl. 18, figs 2–4.

Scattered occurrence in many of the samples from the Kap København Formation.

Globulina minuta (Roemer)

Plate 3, figs 10–13.

Cushman & Ozawa 1930, p. 83; pl. 20, figs 3–4.

Scattered occurrences in the *Elphidium* cf. *excavatum* Zone.

Pseudopolymorphina decora (Reuss)

Plate 3, figs 14, 15.

Cushman & Ozawa 1930, p. 96; pl. 24, figs 6–8.

Observed in the *Elphidium* cf. *excavatum* Zone of Kap København.

Pseudopolymorphina dollfussi Cushman & Ozawa

Plate 3, figs 16, 17.

Cushman & Ozawa 1930, p. 106; pl. 27, figs 6–7.

A few specimens occur in the *Elphidium* cf. *excavatum* Zone, and in the *Elphidiella rolfi* Zone.

Polymorphina charlottensis Cushman

Cushman & Ozawa 1930, p. 119; pl. 31, figs 1–6.

This species occurs in a sample at locality 129, most probably from the upper part of the *Elphidium excavatum* Zone.

Family GLANDULINIDAE

Specimens of this family have been treated as one taxon in thc diagrams figs 4 and 5. The following species occurred:

Glandulina laevigata d'Orbigny

Plate 3, figs 19–22.

Cushman & Ozawa 1930, p. 143; pl. 40, figs 1a, b.

Scattered specimens of this species occur throughout the Kap København Formation, especially in the *Elphidium* cf. *excavatum* Zone. Many of the specimens show close affinity to *Glandulina nipponica* Asano (1951, p. 14; figs 71–72)-(cf. Voloshinova *et al.* 1970, p. 102; pl. 23, figs 3–5) described from the Miocene and Pliocene of Japan.

Esosyrinx curta (Cushman & Ozawa)

Plate 3, fig. 18.

Pseudopolymorphina curta Cushman & Ozawa 1930, p. 105; pl. 27, fig. 3. *Esosyrinx curta* (Cushman & Ozawa) – Loeblich & Tappan 1953, p. 85; pl. 15, figs 1–5.

This species is quite common in the *Elphidium* cf. *excavatum* Zone.

Only af few unilocular specimens with an entosolanean tube were observed in the investigated material from Kap København. Nevertheless, several species were present, viz.: *Oolina apiculata* Reuss, *Oolina caudigera* (Wiesner), *Oolina hexagona* (Williamson), *Oolina laevigata* d'Orbigny, *Oolina lineatopunctata* (Heron-Allen & Earland), *Oolina mackintoshiana* Earland, *Oolina melo* d'Orbigny, *Oolina squamosa* (Montagu), *Fissurina annectens* (Buchner), *Fissurina cucurbitasema* Loeblich & Tappan, *Fissurina laevigata* Reuss, *Fissurina marginata* (Montagu), *Parafissurina lateralis* (Cushman), *Parafissurina tectulostoma* Loeblich & Tappan.

Family CASSIDULINIDAE

Cassidulina laevigata d'Orbigny

Platc 4, figs 1–3.

Plate 4

Figs. 1–3. *Cassidulina laevigata* d'Orbigny .... p. 20
A specimen from the *Cassidulina laevigata* Zone of locality 16. It is close to the subspecies *pliocarinata* van Voorthuysen. ×75.

Figs. 4–9. *Cassidulina reniforme* Nørvang .... p. 22
Side and edge view of two specimens from the *Elphidium excavatum* Zone of locality 72. ×75.

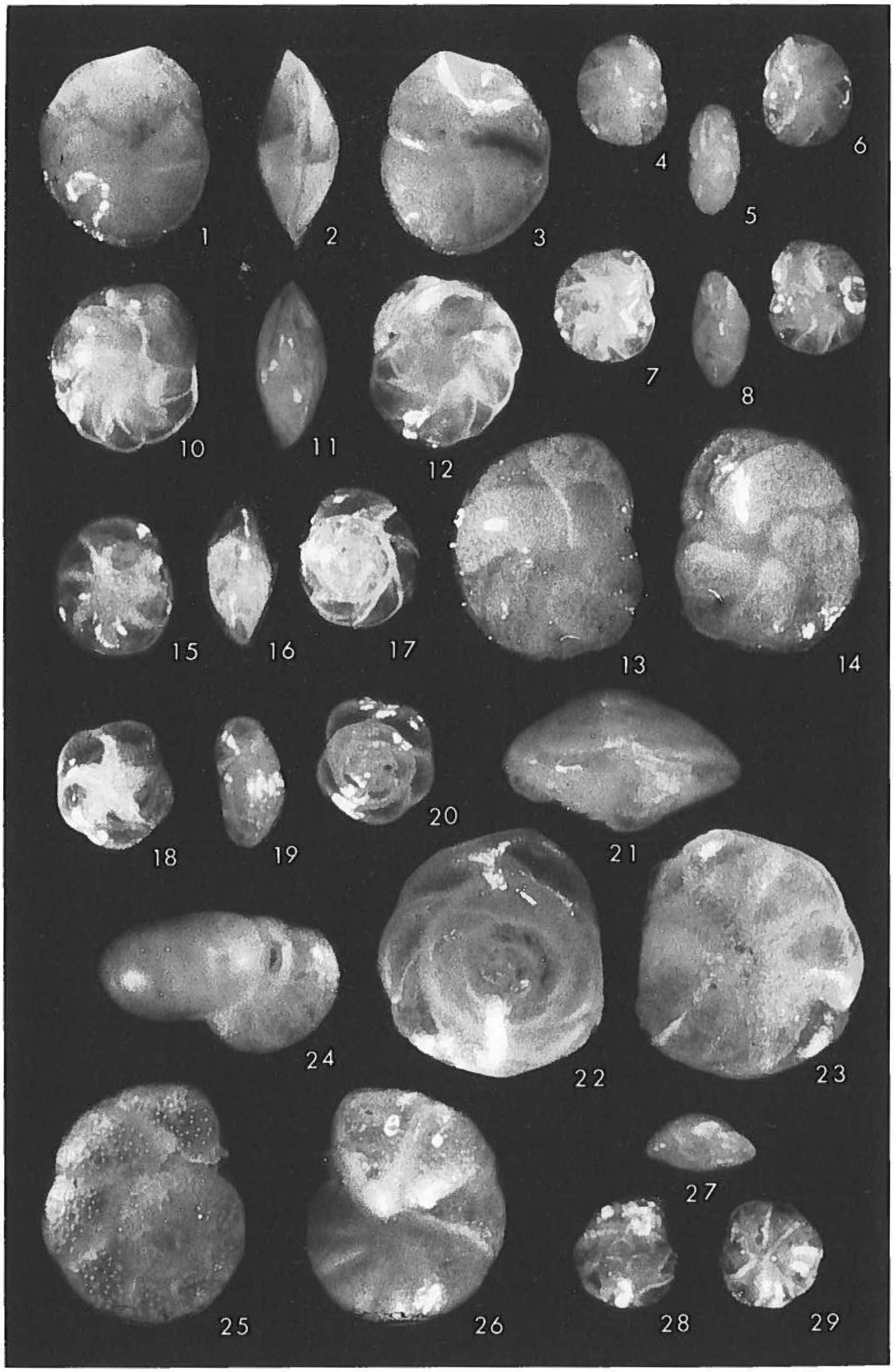
Figs. 10–14. *Cassidulina* cf. *teretis* Tappan .... p. 22
10–12, opposite sides and edge of a specimen from the *Cassidulina laevigata* Zone of locality 16. ×75. 13,14, opposite sides of another specimen from the same locality. ×90.

Figs. 15–20. *Buccella frigida* (Cushman) .... p. 22
Umbilical, edge and spiral side of two specimens from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.

Figs. 21–23. *Buccella tenerrima* (Bandy) .... p. 24
Spiral, edge and umbilical view of a specimen from the *Elphidium excavatum* Zone of locality 72. ×75.

Figs. 24–26. *Cibicides grossa* Ten Dam & Reinhold .... p. 24
24, edge with aperture, 25, spiral side, 26, umbilical side of a specimen from the *Cassidulina laevigata* Zone of locality 16. ×75.

Figs. 27–29. *Epistominella vitrea* Parker .... p. 24
27, spiral side, 28, edge with aperture, 28, umbilical side of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×100.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d'Orbigny 1826, p. 282; pl. 15, figs 4–5. Feyling-Hanssen *et al.* 1971, p. 246; pl. 7, figs 20–21; pl. 18, fig. 12.

This species occurs in the Upper Pliocene of Kap København, and is particularly frequent in its upper part, the *Cassidulina laevigata* Zone. The chambers extend over the central area of the tests in side view. Some of the specimens have a carinate periphery, and thus resemble *Cassidulina laevigata carinata* Silvestri or even *C. laevigata pliocarinata* van Voorthuysen.

Cassidulina reniforme Nørvang

Plate 4, figs 4–9.

Cassidulina crassa d'Orbigny var. *reniforme* Nørvang 1945, p. 41; text-figs 6c-h.

Many specimens of this species, particularly those from the Upper Pliocene part of the Kap København Formation, are laterally compressed and have an almost subacute periphery. They resemble *Cassidulina sagminensis* Asano & Nakamura (1937) from the Pliocene of Japan. Ásbjörnsdóttir (1987) also observed a slightly more compressed form for *C. reniforme* in the Upper Pliocene part of the Nort Sea Josephine boring, where they occurred together with a more globular form of the same species. A few specimens of the compressed form also occur in the Lower Pleistocene of the Kap København Formation.

Cassidulina reniforme is frequent or quite frequent in most of the samples from the Kap København area.

Cassidulina teretis Tappan

Plate 4, figs 10–14.

Tappan 1951, p. 7; pl. 1, fig. 30. Feyling-Hanssen 1980a, p. 165; pl. 4, figs 10, 11, 15.

This species occurs in the Upper Pliocene of Kap København, and is quite frequent in its upper part, together with *Cassidulina laevigata* in the *Cassidulina laevigata* Zone. Some of the specimens have a wavy periphery (in edge view) and a nearly closed central area, thus conforming with the taxon described as *Casssidulina* cf. *teretis* Tappan (Feyling-Hanssen *et al.* 1982, p. 105; pl. 1, figs 6–9, 11–13) from the Lodin Elv Formation in East Greenland.

Family BULIMINIDAE

This family was represented only by the species

Stainforthia loeblichi (Feyling-Hanssen)

Virgulina loeblichi Feyling-Hanssen 1954, p. 191; pl. 1, figs 14–18; text-fig. 3.

A few specimens are present in the Lower Pleistocene of the Kap København Formation.

Family DISCORBIDAE

Eoeponidella pulchella (Parker).

Pninaella (?) pulchella Parker 1952, p. 421; pl. 6, figs 18–20. *Eoeponidella pulchella* (Parker) – Michelsen 1967, p. 234; pl. 4, figs 1–2; text-figs 5–7.

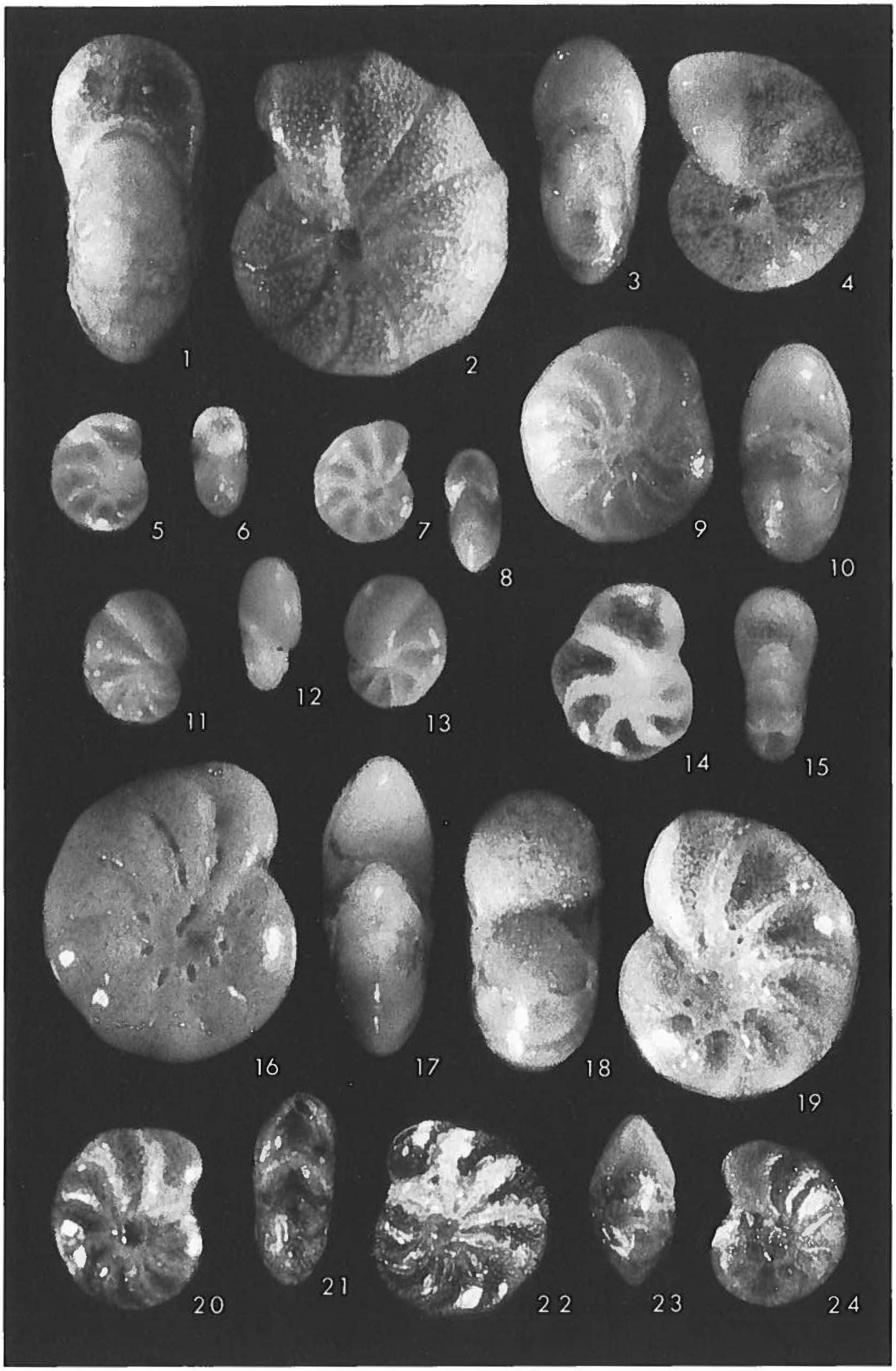
E. pulchella is a very rare species in the *Elphidiella rolfi* Zone at locality 50.

Buccella frigida (Cushman)

Plate 4, figs 15–20.

Plate 5

Figs. 1,2.	*Nonion barleeanum* (Williamson) .... Apertural view and side view of a specimen with an almost polygonal outline, from the *Cassidulina laevigata* Zone of locality 16. ×75.	p. 24
Figs. 3,4.	*Nonion erucopsis* Todd .... Edge and side view of a specimen from the *Elphidium funderi* Zone of locality 120. ×75.	p. 26
Figs. 5,6.	*Nonion matchigaricus* Voloshinova .... Side and edge view of a specimen from the *Cassidulina laevigata* Zone of locality 16. ×75.	p. 26
Figs. 7,8.	*Nonion niveum* Lafrenz .... Side and edge view of a specimen from the lowest part of the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 26
Figs. 9,10.	*Nonion orbiculare* (Brady) .... Side and edge view of a specimen from the *Elphidiella rolfi* Zone of locality 50. ×75.	p. 26
Figs. 11–13.	*Nonionella lobsannensis* (Andrea) .... Edge and opposite sides of specimen from the *Cassidulina laevigata* Zone of locality 16. ×75.	p. 26
Figs. 14,15.	*Elphidium albiumbilicatum* (Weiss) .... Side and edge view of a specimen from the *Cassidulina laevigata* Zone of locality 16.	p. 28
Figs. 16,17.	*Elphidium asklundi* Brotzen .... Side and edge view of a specimen from the *Elphidium excavatum* Zone of locality 72. ×75.	p. 28
Figs. 18,19.	*Elphidium bartletti* Cushman .... Edge and side view of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 28
Figs. 20–22.	*Elphidium excavatum* (Terquem) .... 20, side view of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×105. 21,22, edge and side view of a specimen from the *Elphidium excavatum* Zone of locality 72. ×75.	p. 28
Figs. 23,24.	*Elphidium* cf. *excavatum* (Terquem) .... Edge and side view of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 28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Pulvinulina frigida Cushman 1922, p. 12. *Buccella frigida* (Cushman) – Loeblich & Tappan 1953, p. 115; pl. 22, figs 2–3. *Buccella frigida* (Cushman), emend. Andersen 1952, p. 145–147; text-figs 4–6.

This species occurs commonly throughout all the zones of the Kap København Formation. It is particularly frequent in the *Elphidiella rolfi* Zone and in the *Elphidium* cf. *excavatum* Zone.

The specimens in the Upper Pliocene Zones of the Kap København Formation show affinity to *Buccella floriformis* Voloshinova (1960, p. 270–271; pl. 1, figs 1–5) from the Neogene of Sakhalin.

Buccella hannai arctica Voloshinova

Buccella hannai (Phleger & Parker), subsp. *arctica* Voloshinova 1960, p. 286; pl. 8, figs 2–4.

This species occurs in the Lower Pleistocene of the Kap København Formation.

Buccella tenerrima (Bandy)

Plate 4, figs 21–23.

Rotalia tenerrima Bandy 1950, p. 278; pl. 42, fig. 3. *Buccella inusitata* Andersen 1952, p. 148; figs 10–11.

Specimens of this species are present both in the Upper Pliocene and Lower Pleistocene of the Kap København Formation, especially in the upper part of the *Elphidium excavatum* Zone.

Family BAGGINIDAE

Glabratella wirghtii (Brady).

Discorbis writhtii Brady 1881, p. 413; pl. 21, fig. 6. *Glabratella wrightii* (Brady) – Leslie 1965, p. 161; pl. 10, fig. 7.

A few specimens of this species were observed in the youngest part of the *Elphidium excavatum* Zone at locality 129.

Family ALABAMINIDAE

Epistominella vitrea Parker

Plate 4, figs 27–29.

Parker, *in* Parker, Phleger & Peirson 1953, p. 9; pl. 4, figs 34–36, 40–41.

This species occurs both in the Upper Pliocene and the Lower Pleistocene of the Kap København Formation, though it is never frequent. Some of the Upper Pliocene specimens are close to *Epistominella naraensis* (Kuwano) (*Pseudoparella naraensis* Kuwano 1950, p. 317; text-figs 6a-c), from the Pliocene of Japan.

Family ANOMALINIDAE

Cibicides grossa Ten Dam & Reinhold

Plate 4, figs 24–26.

Cibicides lobatulus (Walker & Jacob) var. *grossa* Ten Dam & Reinhold 1941, p. 62; pl. 5, fig. 5; pl. 6, fig. 1. Feyling-Hanssen 1980a, p. 164; pl. 5, figs 1–6.

Two specimens of this species are present in the lowermost part (sample no 223307) of the type section at locality 50. Both specimens lack their final chambers. *C. grossa* is also present, though rarely in the upper part of the Upper Pliocene of the Kap København Formation, i.e. in the *Cassidulina laevigata* Zone at locality 16.

Taxa belonging to the superfamily Nonionacea are extremely common in the Kap København Formation. Species belonging to the family Nonionidae are most frequent in the Upper Pliocene part of the formation, whereas the Elphidiidae are most common and characteristic of the Lower Pleistocene part of the formation.

Family CHILOSTOMELLIDAE

Pullenia subcarinata (d'Orbigny)

Nonionina subcarinata d'Orbigny 1839, p. 28; pl. 5, figs 23–24. *Nonion quinqueloba* Reuss 1851, p. 71; pl. 5, fig. 31.

This species is present in the *Elphidium* cf. *excavatum* Zone.

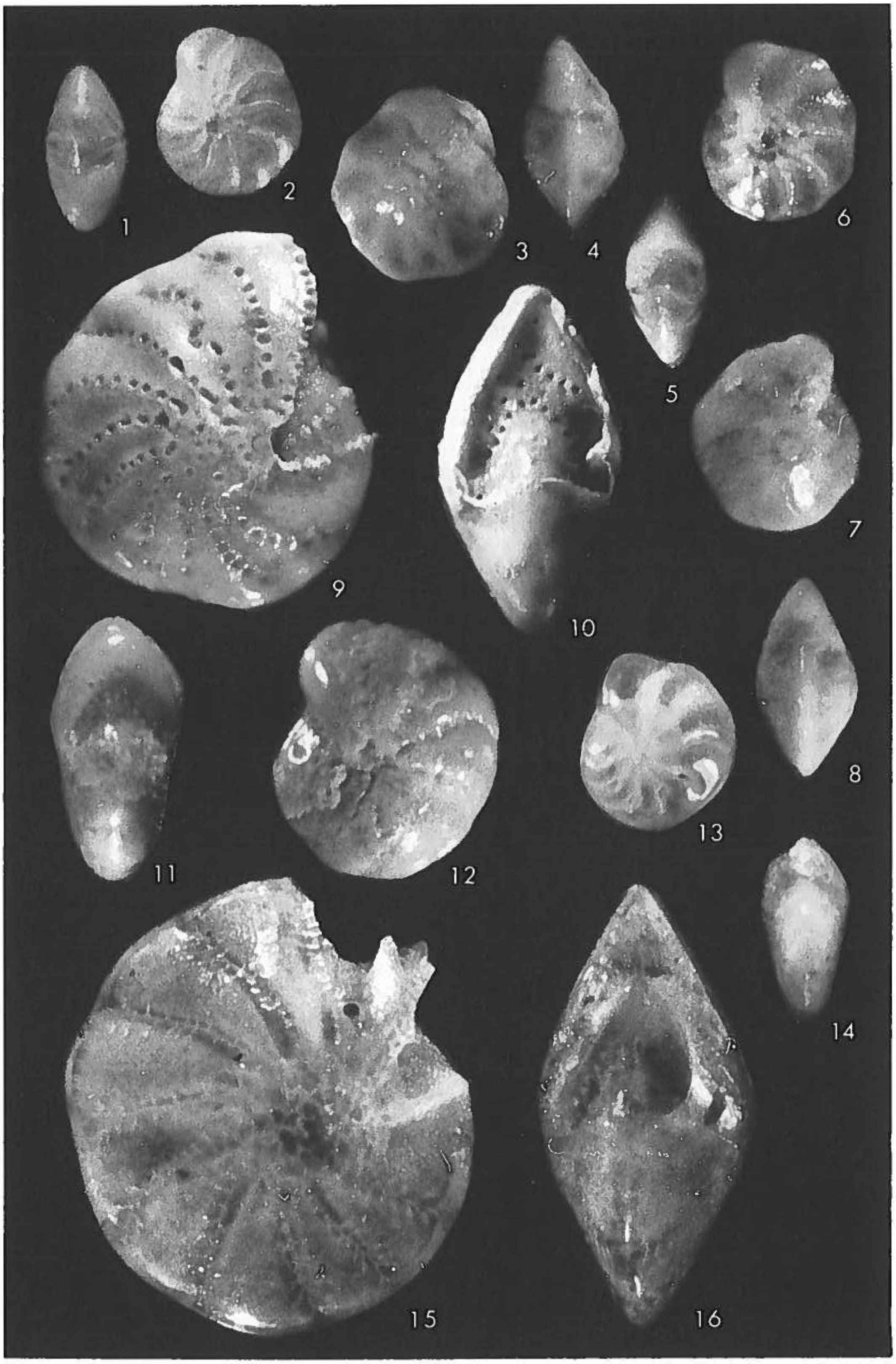
Family NONIONIDAE

Nonion barleeanum (Williamson)

Plate 5, figs 1, 2.

Plate 6

Figs. 1,2.	*Elphidium* cf. *excavatum* (Terquem) .... Edge and side view of a specimen from the *Elphidium* cf. *excavatum* Zone of locality 50. ×75.	p. 28
Figs. 3–8.	*Elphidium funderi* n.sp. .... 3,4, side and edge view of a hypotype (MMH no. 12151) from the *Elphidium funderi* Zone of locality 120. 5, 6, edge and side view of holoptype (MMH no. 12150). 7,8, side and edge view another specimen (MMH no. 12152) from the same locality. All ×75.	p. 28
Figs. 9,10.	*Elphidium groenlandicum* Cushman .... Side and edge view of a broken specimen from the *Elphidiella gorbunovi* Zone of locality 129. ×45.	p. 29
Figs. 11,12.	*Elphidium hughesi* Cushman & Grant .... Edge and side view of a specimen from the *Elphidiella rolfi* Zone of locality 50. ×75.	p. 29
Figs. 13,14.	*Elphidium ustulatum* Todd .... Side and edge view of a specimen from the *Elphidium excavatum* Zone of locality 72. ×75.	p. 29
Figs. 15,16.	*Elphidiella gorbunovi* (Stschedrina) .... Side and edge view of a specimen from the *Elphidiella gorbunovi* Zone of locality 129. ×75.	p. 29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Nonionina barleeanum Williamson 1858, p. 32; pl. 3, figs 68–69. *Nonion barleeanum* (Williamson) – Feyling-Hanssen 1976a, p. 358; pl. 8, figs 1–2. Feyling-Hanssen 1980a, p. 173; pl. 6, figs 1–2.

This species occurs in some frequency in the Lower Pleistocene *Elphidium excavatum* Zone and in the *Elphidium* cf. *excavatum* Zone, particularly in its upper part. It has also been found in the Upper Pliocene *Cassidulina laevigata* Zone.

Specimens of *Nonion barleeanum* from the upper part of the section at locality 50 have a very broadly rounded peripheral margin, but at the same time not a smoothly rounded, but almost polygonal outline, in side view. Some of them have a more irregular lobulate outline. They are all very large, up to 1.1 mm in diameter.

Nonion erucopsis Todd

Plate 5, figs 3, 4.

Todd 1957, p. 231; pl. 28, fig. 15. Feyling-Hanssen 1976a, p. 358; pl. 8, figs 3–4.

This species was described from Carter Creek, northern Alaska (Miocene-Oligocene?, cf. McNeil *et al.* 1982). It has a firm circular outline and a narrow umbilicus with a much less conspicuous limbate ring than is the case with *Nonion barleeanum*. It is an intermediate species between this latter species, which is also larger, and *Nonion affine* (Reuss), which is smaller and laterally more compressed.

Nonion erucopsis is frequent in and characteristic of of the Upper Pliocene *Elphidium funderi* Zone of the Kap København Formation. This zone is probably the oldest zone of the formation. It is also common in the *Cassidulina laevigata* Zone.

Nonion matchigaricus Voloshinova

Plate 5, figs 5, 6.

Voloshinova 1952, p. 22; pl. 1, figs 11a-b. *Cribroelphidium (Rimelphidium) matchigaricum* (Voloshinova) – Voloshinova, Kuznetzova & Leonenko 1970, p. 167; pl. 43, figs 3–4.

This species was described from the Miocene of Sakhalin, and has some similarity to *Nonion niveum*.

It occurs in the Upper Pliocene *Cassidulina laevigata* Zone of the Kap København Formation, and also in the *Elphidiella rolfi* Zone and in the *Elphidium* cf. *excavatum* Zone.

Nonion niveum Lafrenz

Plate 5, figs 7, 8.

Nonion? *niveum* Lafrenz 1963, p. 24; pl. 2, figs 1–4. *Nonion tallahattensis* Bandy 1949 – Feyling-Hanssen 1976a, pl. 7, figs 18–19; pl. 5, figs 9–10. Feyling-Hanssen 1980a, p. 181; pl. 5, figs 10–11 (non *Nonion tallahattensis* Bandy 1949). *Protelphidium gudinae* Feyling-Hanssen 1976a, p. 359; pl. 5, figs 13–14. Feyling-Hanssen 1980, p. 181.

This small species is close to *Nonion akitaensis* Asano (1950, p. 1; pl. 1, figs 1–2) and is probably conspecific with the *Nonion tallahattensis* from Clyde Foreland and from the Qivituq Peninsula, Baffin Island (Feyling-Hanssen 1976a; 1980a).

N. niveum is quite frequent in the *Elphidiella rolfi* Zone, the *Elphidium* cf. *excavatum* Zone and in the *Elphidium excavatum* Zone of the Kap København Formation.

Nonion orbiculare (Brady)

Plate 5, figs 9, 10.

Nonionina orbicularis Brady 1881, p. 415; pl. 21, figs 5a-b. *Protelphidium orbiculare* (Brady) – Feyling-Hanssen 1976a, p. 360; pl. 8, figs 10–13. *Nonion orbiculare* (Brady) – Feyling-Hanssen *et al.* 1983, p. 106; pl. 3, figs 3–4.

This characteristic species is frequent in the *Elphidiella rolfi* Zone, the *Elphidium* cf. *excavatum* Zone, and in the *Elphidium excavatum* Zone of Kap København. It has also been found in the Upper Pliocene *Cassidulina laevigata* and rarely in the *Elphidium funderi* Zone there.

Nonionella lobsannensis (Andreae)

Plate 5, figs 11–13.

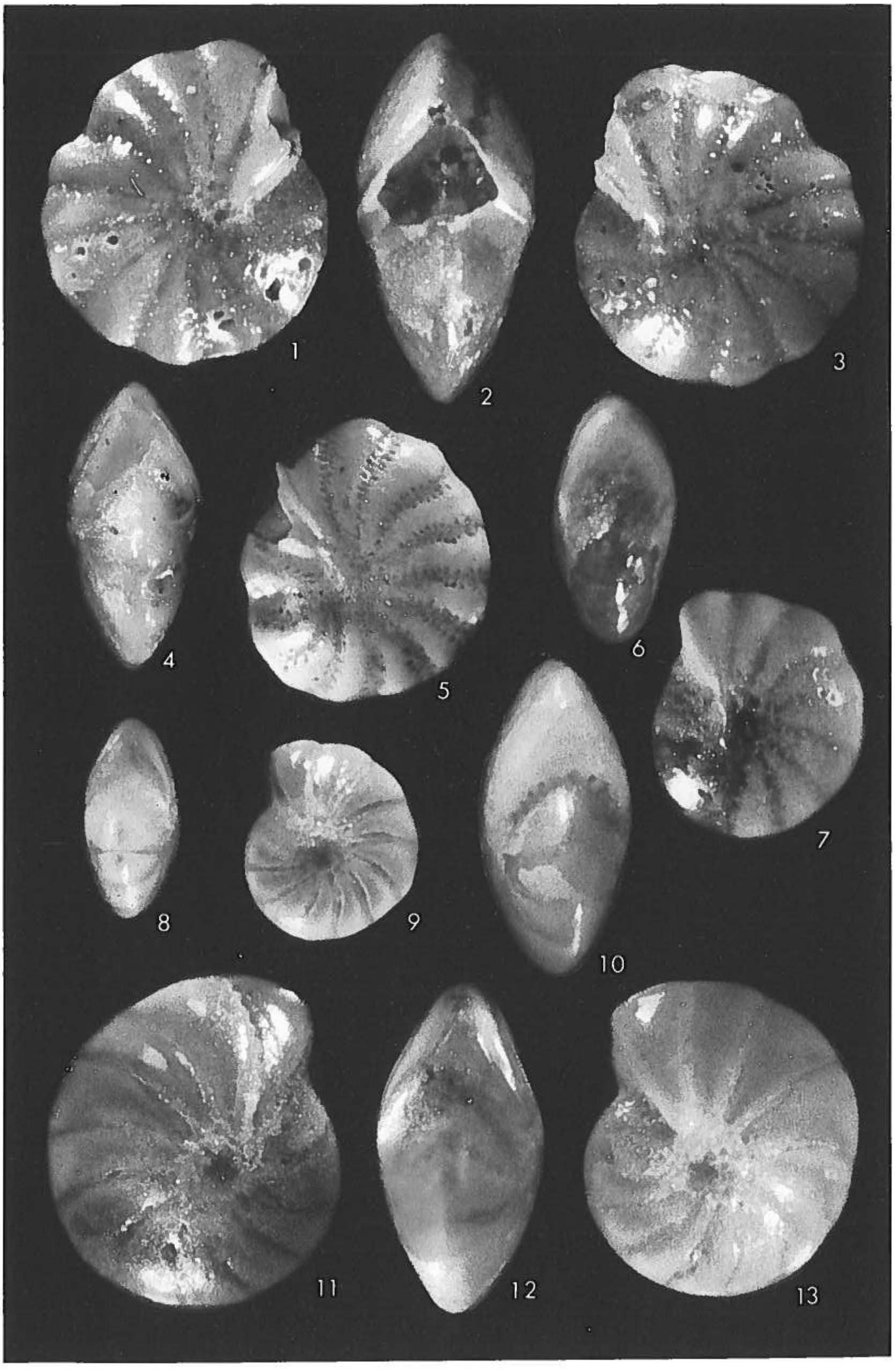
Pulvinulina lobsannensis Andreae 1884, p. 126; pl. 8, figs 16a-c. Batjes 1958, p. 144; pl. 7, fig. 4.

This species occurs in the *Cassidulina laevigata* Zone of profile 16 near Søndre Ladegårdselv. Nine chambers are present on the spiral side and 6 on the umbilical side. The species figured as *Nonionella miocenica* Cushman by Voloshinova *et al.* 1970 (p. 86, pl. 14, figs 10a, c) from the Upper Miocene of Sakhalin shows many similarities with the present specimens.

Plate 7

Figs. 1–7. *Elphidiella hannai* (Cushman & Grant) .... p. 29
1–3, opposite sides and edge view of a specimen from the *Elphidiella rolfi* Zone of locality 50. ×60. 4,5, edge and side view of a specimen also from the *Elphidiella rolfi* Zone of locality 50. ×45. 6,7, edge and side view of a specimen from the *Elphidium excavatum* Zone of locality 72. ×75.

Figs. 8–13. *Elphidiella rolfi* Gudina & Palovova .... p. 29
8,9, edge and side view of a specimen from the *Elphidiella rolfi* Zone of locality 50. 10,11, edge and side view of another specimen from the same Zone and locality. 12,13, edge and side view of a specimen from the upper part of the *Elphidiella rolfi* Zone of locality 50. All ×75.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Astrononion gallowayi Loeblich & Tappan

Loeblich & Tappan 1953, p. 90; pl. 17, figs 4–7.

This species occurs rarely in the upper part of the *Elphidium excavatum* Zone of the Kap København Formation.

Family ELPHIDIIDAE

Elphidium albiumbilicatum (Weiss)

Plate 5, figs 14, 15.

Nonion pauciloculum Cushman, subsp. *albiumbilicatum* Weiss 1954, p. 157; pl. 32, figs 1–2. *Elphidium albiumbilicatum* (Weiss) – Feyling-Hanssen 1976a, p. 355; pl. 2, figs 26–27; pl. 4, figs 9–10.

This species is quite frequent in the *Elphidiella rolfi* Zone and is also present throughout the *Elphidium* cf. *excavatum* Zone and the *Elphidium excavatum* Zone. Scattered specimens also occur in the older parts of the Kap København Formation.

Some of the specimens have relatively few chambers and thus come close to *Elphidium magellanicum* Heron-Allen & Earland (1932, p. 440; pl. 16, figs 26–28). These are here treated together with *Elphidium albiumbilicatum* (Weiss).

Elphidium asklundi Brotzen

Plate 5, figs 16, 17.

Elphidium asklundi Brotzen 1943, p. 267; figs 109–1. Feyling-Hanssen *et al.* 1971, p. 270; pl. 10, figs 20–21; pl. 11, figs 1–5. Feyling-Hanssen 1980a, p. 180; pl. 6, figs 15–16. Feyling-Hanssen 1980b, p. 279; pl. 2, figs 21–22.

This species is common in the Lower Pleistocene *Elphidium excavatum* Zone (e.g. section 72). Many of the specimens are large and somewhat compressed, often with slit-like sutural openings. Some of them are not easily distinguishable from *Elphidium incertum* (Williamson). Other specimens have a less broadly rounded periphery and also a slight assymetry in edge-view, as is the case for *Perfectononion incertaformis* Kuznetzova (in Voloshinova *et al.* 1970, p. 91; pl. 17, figs 14–17), from the Miocene of Sakhalin. These specimens were observed in the Upper Pliocene *Cassidulina laevigata* Zone of the Kap København Formation.

Elphidium bartletti Cushman

Plate 5, figs 18, 19.

Elphidium bartletti Cushman 1933, p. 4; pl. 1, fig. 9. Feyling-Hanssen *et al.* 1971, p. 271; pl. 11, figs 6–9; pl. 20, figs 1–4.

This species is common in the *Elphidium excavatum* Zone of the Kap København Formation.

Elphidium excavatum (Terquem)

Plate 5, figs 20–22.

Polystomella excavata Terquem 1876, p. 429; pl. 2, figs 2a-d.

This species is both frequent and characteristic of the *Elphidium excavatum* Zone of the Kap København Formation, but occurs also in the Upper Pliocene.

Of the many morphotypes of this species described by Feyling-Hanssen (1972) and Miller *et al.* (1982). *Elphidium excavatum* forma *excavatum* (Terquem) (= forma *selseyensis* (Heron-Allen & Earland)) and *E. excavatum* forma *clavata* (Cushman) are the most common ones. No distinction has been made between them in tables and diagrams, though the latter form is more frequently met with in the Pleistocene part of the formation than in its older parts.

Elphidium cf. *excavatum* (Terquem)

Plate 5, figs 23, 24; pl. 6, figs 1, 2.

Elphidium excavatum (Terquem) var., Ásbjörnsdóttir 1987, p. 128; text-figs 2f-h.

This is a small yellowish-brown *Elphidium* with an entire or slightly lobulate outline and sometimes with an almost subacute peripheral margin; it may have a very distinct umbilical boss; the earlier sutures have no sutural bridges and may even be flush with the surface, one to three sutural bridges are developed in the last two or three sutures.

This form of *Elphidium excavatum* is particularly frequent in the *Elphidium* cf. *excavatum* Zone of the section at locality 50, and is quite frequent in the Upper Pliocene zones. This is in good agreement with its occurrence in the Central North Sea "Josephine" boring, where it was observed in the Lower Pleistocene and the Upper Pliocene (Ásbjörnsdóttir 1987). *Elphidium* cf. *excavatum* seems to be a transitional form between *Elphidium funderi* and *Elphidium excavatum*.

Elphidium funderi n. sp.

Plate 6, figs 3–8.

Name: After Svend Funder, Copenhagen, who found and first described the Kap København Formation of North Greenland.

Holotype: (MMH no. 12150) the specimen figured on pl. 6, figs 5 and 6.

Type level: Upper Pliocene.

Type locality: Locality no. 120, sample no. 53212 (clayey silt) from the upper part of a 10 m thick section at Nordre Ladegårdselv, Kap København, Peary Land.

Diagnosis: An *Elphidium* with acute, almost keeled periphery, umbilical boss and 10 chambers in the last whorl.

Description: Test lenticular, biconvex with an acute, sometimes carinate periphery so that the surface area between the periphery and the central part appears concave, involutely coiled with a broad, sometimes indistinct umbilical boss, 10–11 chambers in the final whorl, the two last chambers slightly lobulate. Sutures curved moderately backwards with usually three broad sutural bridges between the three or four last chambers, earlier sutures without bridges, and almost flush with the surface. Wall calcareous perforate, brownish hyaline to milky white, radial when viewed in polarized light, surface smooth: aperture at the base of the apertural face, a row of openings hardly discernable because of calcareous vesicular material at the base of the apertural face. Greatest diameter of holotype 0.38 mm, thickness 0.17 mm. Greatest diameters of paratypes varied from 0.40 mm to 0.51 mm, thicknesses from 0.17 mm to 0.28 mm.

Occurrence: This species occurs in the Upper Pliocene of the Kap København Formation. It is frequent in and characteristic of the lower part of this unit which is here called the *Elphidium funderi* Zone.

Scattered specimens occur in the upper part of the Upper Pliocene and even a few in the *Elphidiella rolfi* Zone.

Affinities: *E. funderi* shows some resemblance to *Polystomella angulata* Egger (1857) from the Miocene of Nieder-Bayern, Germany, but this latter species has no umbilical plug and more, very distinct bridges in all sutures. *Elphidium funderi* also resembles *Polystomella cryptostoma* Egger (1857), also from the Miocene of Nieder-Bayern, but this species differs in its more numerous chambers, its strongly backwards curving sutures and its almost indiscernable bridges in the last suture. *Elphidium funderi* n. sp. is similar to *Cribrononion occidentalis* Margerel (1968) from the Redonien (Pliocene) of north-western France, but this latter species has slightly fewer chambers (9), less curved sutures, and small sutural pores.

Elphidium groenlandicum Cushman

Plate 6, figs 9, 10.

Cushman 1933, p. 4; pl. 1, fig. 10. *Elphidiella groenlandica* (Cushman) – Loeblich & Tappan 1953, p. 106; pl. 19, figs 13–14.

This species is present in the uppermost part of the *Elphidium excavatum* Zone.

Elphidium hallandense Brotzen

Elphidium (Elphidiella) hallandense Brotzen 1943, p. 268; text-figs 2a-c. *Elphidium subarcticum* Cushman 1944, p. 27; pl. 3, figs 34–35. Feyling-Hanssen *et al.* 1971, p. 280; pl. 13, figs 3–7; pl. 22, fig. 9.

This species occurs sparsely in the upper part of the Lower Pleistocene *Elphidium excavatum* Zone.

Elphidium hughesi Cushman & Grant

Plate 6, figs 11, 12.

Cushman & Grant 1927, p. 75; pl. 7, fig. 1.

E. hughesi is quite frequent in the *Elphidiella rolfi* Zone of Kap København, and occurs also in the lower part of the *Elphidium* cf. *excavatum* Zone and in the *E. excavatum* Zone. It is also present in the Upper Pliocene *Cassidulina laevigata* Zone.

Elphidium subglobosum (Voloshinova)

Elphidium vulgare Voloshinova var. *subglobosa* Voloshinova, *in* Voloshinova & Dain 1952, p. 53; pl. 8, figs 9a-b. *Cribroelphidium (Cribroelphidium) subglobosum* (Voloshinova) – Voloshinova, Kuznetzova & Leonenko 1970, p. 166; pl. 43, fig. 5.

This species occurs in the Upper Pliocene *Cassidulina laevigata* Zone of Kap København.

Elphidium ustulatum Todd

Plate 6, figs 13, 14.

Todd 1957, p. 230; pl. 28, fig. 16. Feyling-Hanssen *et al.* 1983, p. 106; pl. 3, figs 11–12.

This species occurs quite commonly in the *Elphidiella rolfi* Zone, in the *Elphidium* cf. *excavatum* Zone, and in the *Elphidium excavatum* Zone of the Kap København Formation. It has also been observed in the Upper Pliocene part of the formation.

Elphidiella gorbunovi (Stschedrina)

Plate 6, figs 15, 16.

Elphidium gorbunova Stschedrina 1946, p. 144; pl. 4, figs 21a-b. *Pseudoelphidiella gorbunovi* (Stschedrina) – Voloshinova, Kuznetzova & Leonenko 1970, p. 179; pl. 49, fig. 3.

This species occurs fairly frequently in the upper part of the *Elphidium excavatum* Zone of the Kap København Formation. It has also been found in the *Elphidiella rolfi* Zone at locality 58.

McNeil (1988) recorded *Elphidiella gorbunovi* from a Pliocene section on Ellesmere Island and from the Pleistocene and Pliocene of borings in the Beaufort-Mackenzie Basin of Arctic Canada (1989). Gudina (1969) recorded it, as a synonym of *Elphidiella groenlandica* (Cushman), from the Pleistocene of the Siberian lowlands. It was originally described as living in the eastern Arctic seas.

Elphidiella hannai (Cushman & Grant)

Plate 7, figs 1–7.

Elphidium hannai Cushman & Grant 1927, p. 77; pl. 8, fig. 1.

This species occurs in the *Elphidiella rolfi* Zone and in the lowest part of the *Elphidium excavatum* Zone at locality 72 (fig. 4).

Elphidiella rolfi Gudina & Polovova

Plate 7, figs 8–13.

Elphidiella rolfi Gudina & Polovova, in Gudina *et al.* 1984, p. 62; pl. 6, fig. 7; pl. 7, figs 1–5. Feyling-Hanssen 1986, p. 28; pl. 2, figs 14–16. *Elphidiella* cf. *subcarinata* (Voloshinova) – Funder *et al.* 1985, p. 544.

The present specimens of *Elphidiella rolfi* are mostly large and lenticular, compressed with subacute periphery, posessing 11–13 chambers in the last whorl – usually 12. A dark field in the central area gives the appearance of central knob, but this is flush with the surface. In some specimens it appears as several small knobs. The sutures are limbate, tapering towards the periphery; sutural pores are only slightly discernible. The aperture is obliterated by papillate shell material. Well preserved specimens are yellowish brown in colour.

This species was referred to as *Elphidiella* cf. *subcarinata* (Voloshinova) by Feyling-Hanssen (in Funder *et al.* 1985). *Elphidiella subcarinata* (Voloshinova) has more chambers – 17–18, but seems otherwise very close to the specimens from Kap København. *Elphidiella rolfi* has affinity also to *Elphidiella nitida* Cushman 1941, but also this species has more chambers. *Elphidiella brunnescens* Todd 1957, from the Miocene (Oligocene?) of Carter Creek, is also related to the present species but has a limbate periphery and no sutural pores.

Elphidiella rolfi is frequent and characteristic of the *Elphidiella rolfi* Zone of the Kap København Formation. In some of the samples this large species may be overrepresented due to the dissolution of smaller, more delicate species. It is rare in the upper part of the *Cassidulina laevigata* Zone, in the lower part of the *Elphidium* cf. *excavatum* Zone and in the the lower part of the *Elphidium excavatum* Zone.

Family GLOBIGERINIDAE

Globigerina pachyderma (Ehrenberg)

Asterospira pachyderma Ehrenberg 1861, p. 303; 1873, p. 386; pl. 1, fig. 4.

Scattered specimens of this species have been observed in the samples from the section at locality 72.

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Table 9. Foraminiferal species at locality 50 (number of identified specimens). Lithology shown in Fig. 3.

Unit	Assemblage zone	Sample No.	Altitude, m a.s.l.	Sample wt., g	Analysed proportion	*Ammodiscus concinnus*	*Buccella frigida*	*Buccella hannai arctica*	*Cassidulina reniforme*	*Cassidulina teretis*	*Cibicides grossa*	*Elphidiella hannai*	*Elphidiella rolfi*	*Elphidium albumbilicatum*	*Elphidium asklundi*	*Elphidium bartletti*
Top layer	?	223293	132.0	100	1/1	-	1	-	-	-	-	-	-	-	-	-
		223292	131.5	100	1/1	-	-	-	-	-	-	-	-	-	-	-
		56882	131.0		1/1	-	-	-	-	-	-	-	-	2	-	-
B3		197162	129.0	200	1/1	-	-	-	-	-	-	-	-	-	-	-
			Hiatus													
B2	?	197149	116.0	100	1/1	-	-	-	-	-	-	-	-	-	-	-
		223289	115.0	200	1/1	-	-	-	-	-	-	-	-	-	-	-
	Elphidium cf. *excavatum* Zone	223288	114.0	100	1/1	1	4	-	3	-	-	-	1	-	-	-
		223287	113.5	200	1/1	1	1	-	16	-	-	-	1	16	-	2
		197146	113.0	200	1/1	1	1	-	6	-	-	-	-	7	-	3
		197145	112.0	200	1/1	2	-	-	-	-	-	-	-	2	-	1
		223286	111.5	200	1/1	8	-	-	-	-	-	-	-	23	-	-
		197144	111.0	200	1/1	1	-	-	-	-	-	-	2	3	-	-
		223285	110.5	100	1/1	5	-	-	-	-	-	-	1	5	-	-
		197143	110.0	200	1/1	2	4	-	8	-	-	-	2	1	-	1
		197142	109.0	200	1/1	18	1	-	6	-	-	-	-	22	-	-
		223284	108.5	200	1/1	8	15	-	2	-	-	-	-	3	-	-
		197141	108.0	200	5/9	3	16	-	11	-	-	-	1	2	10	-
		223283	107.0	100	4/9	-	69	-	-	-	-	-	2	11	-	-
		197139	106.0	200	4/9	-	78	-	-	-	-	-	4	2	-	-
		223282	105.5	200	1/1	3	37	-	-	-	-	-	4	4	-	-
		197138	105.0	200	2/3	-	98	-	-	-	-	-	-	2	-	-
		223281	104.5	100	1/1	-	15	-	-	-	-	-	-	-	-	-
		197137	104.0	200	5/8	-	75	-	-	-	-	-	-	-	-	-
		197136	103.0	160	1/1	-	59	-	-	-	-	-	1	-	2	-
		223280	102.5	200	1/2	-	30	18	-	-	-	-	2	9	2	-
	Elphidiella rolfi Zone	197135	102.0	160	1/1	-	83	-	-	-	-	-	63	-	-	-
		223279	101.5	100	2/9	-	93	-	1	-	-	-	65	-	-	-
		197134	101.0	160	1/2	-	14	-	-	-	-	1	39	-	-	-
		223278	100.6	100	1/1	-	54	-	-	-	-	3	21	17	-	-
		223277	100.3	160	1/1	-	35	-	-	-	-	-	-	34	-	-
		197133	100.0	160	1/1	-	93	-	-	-	-	5	16	37	-	-
		197130	98.5	200	1/1	-	-	-	-	-	-	1	17	12	-	-
		223275	95.0	200	1/1	-	55	-	-	-	-	1	6	8	-	-
	?	223273	93.0	200	1/1	-	-	-	-	-	-	-	-	-	-	-
			Hiatus													
	Elphidium funderi Zone?	197171	58.0	200	1/1	-	3	-	-	7	-	-	3	-	-	-
		223304	57.0	100	1/1	-	-	-	-	-	-	-	-	-	-	-
		223308	47.0	100	1/1	-	-	-	2	1	-	-	-	-	-	-
		223307	44.0	100	1/1	-	-	-	3	-	2	-	-	1	-	-
		197178	43.0	160	1/1	-	3	-	5	5	1	-	-	-	-	-

Sample No.	*Elphidium* cf. *excavatum*	*Elphidium excavatum*	*Elphidium funderi*	*Elphidium hallandense*	*Elphidium hughesi*	*Elphidium* sp.	*Elphidium subglobosum*	*Elphidium ustulatum*	*Eoponidella pulchella*	*Epistominella vitrea*	*Esosyrinx curta*	*Glandulina laevigata*	*Globulina* cf. *granulosa*	*Globulina inaequalis*	*Globulina minuta*	*Guttulina austriaca*	*Guttulina dawsoni*	*Guttulina lactea*	*Guttulina orientalis*	*Guttulina roemeri*	*Guttulina* sp.	*Lagena feildiana*
223293	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223292	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56882	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
197162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
197149	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223289	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
223288	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-	-
223287	72	50	-	2	-	-	-	1	-	2	3	8	-	-	-	-	-	-	-	-	-	1
197146	6	15	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-
197145	8	8	-	-	1	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1
223286	6	5	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-
197144	6	12	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
223285	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
197143	78	30	-	-	1	-	-	1	-	1	-	-	-	-	-	-	-	1	-	-	-	-
197142	20	51	-	-	-	-	-	1	-	1	-	-	2	-	-	-	-	-	-	-	-	-
223284	120	7	-	-	9	-	-	2	-	-	-	-	1	-	-	2	-	-	-	-	-	-
197141	210	52	-	-	2	-	-	14	-	2	-	1	-	-	1	-	-	-	-	-	-	-
223283	173	7	-	-	3	-	-	16	-	-	63	38	17	-	-	7	-	1	-	4	-	-
197139	110	6	-	-	1	-	-	9	-	-	11	7	38	6	13	2	-	6	2	2	-	-
223282	172	15	-	-	4	-	-	12	-	-	3	5	10	-	-	-	-	-	-	-	-	-
197138	34	-	-	-	6	-	-	19	-	-	14	1	17	-	5	2	-	2	-	2	-	-
223281	48	7	-	-	2	-	-	5	-	-	-	-	3	-	10	1	-	-	1	-	-	-
197137	82	12	-	-	6	-	-	15	-	-	30	7	4	2	14	-	-	-	-	4	-	-
197136	92	-	-	-	3	-	-	12	-	-	5	3	31	-	5	-	-	-	-	-	1	-
223280	95	5	-	-	2	-	-	2	-	-	13	7	6	-	-	1	-	2	1	-	4	-
197135	41	11	-	-	97	-	-	22	-	-	-	-	-	1	1	-	2	3	-	-	-	-
223279	26	-	-	-	17	-	-	3	-	1	-	1	-	-	2	1	-	5	2	6	-	-
197134	2	-	-	-	36	-	-	11	-	-	-	-	126	-	2	-	2	-	-	-	-	-
223278	10	-	-	-	59	-	-	15	-	-	-	2	39	-	-	3	-	14	-	7	-	-
223277	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
197133	14	8	-	-	30	-	-	5	1	-	-	-	6	-	1	-	-	-	-	-	-	-
197130	-	-	-	-	18	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223275	-	-	-	-	14	-	-	2	-	-	-	-	-	-	-	1	-	3	-	1	-	-
223273	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
197171	-	3	7	-	-	-	7	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-
223304	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223308	-	2	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
223307	5	3	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
197178	4	-	4	4	1	-	-	-	-	23	-	-	-	-	-	-	-	-	-	-	-	-

Sample No.	*Lagena laevis*	*Lagena mollis*	*Lagena substriata*	*Lenticulina* sp.	*Marginulina subbulata*	*Milliolinella subrotunda*	*Milliolinella valvulinaris*	*Nonion barleeanum*	*Nonion erucopsis*	*Nonion matchigaricus*	*Nonion niveum*	*Nonion orbiculare*	*Oolina caudigera*	*Oolina hexagona*	*Oolina laevigata*	*Oolina mackintoshiana*	*Oolina melo*
223293	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223292	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56882	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
197162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
197149	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223289	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223288	-	1	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-
223287	1	1	-	-	-	-	3	13	-	3	1	1	-	-	-	-	-
197146	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	1	-
197145	-	1	-	-	-	-	-	-	-	-	1	3	-	-	-	2	-
223286	-	4	-	-	-	1	-	-	-	2	-	5	-	-	-	-	-
197144	-	1	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-
223285	1	-	-	-	-	3	-	-	-	3	-	2	1	-	-	-	-
197143	1	1	-	-	-	-	-	-	-	5	13	7	-	1	-	-	-
197142	1	-	-	-	-	1	-	-	-	5	5	17	-	-	2	-	1
223284	-	1	-	-	-	-	-	-	-	7	-	12	-	1	-	-	-
197141	1	1	-	-	-	-	-	-	-	14	-	61	-	-	-	-	-
223283	3	1	-	-	-	10	-	-	-	18	14	29	-	-	-	-	-
197139	1	2	-	-	-	-	-	-	-	19	18	39	1	-	-	-	-
223282	-	-	-	-	-	-	-	-	-	11	3	8	-	-	-	-	-
197138	1	-	-	-	-	-	-	-	-	22	94	82	-	-	-	-	-
223281	-	-	-	-	-	2	-	-	-	17	6	8	-	-	-	-	-
197137	1	-	-	-	-	-	-	-	-	36	40	29	-	-	-	-	-
197136	-	1	-	-	1	-	-	-	-	21	54	17	-	-	-	-	-
223280	-	2	-	-	-	14	-	-	-	40	7	3	-	-	-	-	-
197135	-	-	1	-	-	-	-	-	-	16	150	82	-	-	-	-	-
223279	-	-	-	-	-	-	-	-	-	26	87	242	-	-	-	-	-
197134	-	-	-	-	-	-	-	-	-	8	143	115	-	-	-	-	-
223278	-	-	-	-	1	-	-	-	-	39	64	127	-	-	-	-	-
223277	-	-	-	-	-	-	-	-	-	-	16	14	-	-	-	-	-
197133	-	-	-	-	-	-	-	-	-	-	72	40	-	-	-	-	-
197130	-	-	-	-	-	-	-	-	-	-	5	17	-	-	-	-	-
223275	-	-	-	-	-	-	-	-	-	1	30	17	-	-	-	-	-
223273	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
197171	-	-	-	-	-	-	-	-	1	-	-	7	-	-	-	-	-
223304	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
223308	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
223307	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-
197178	-	-	-	-	-	-	-	-	3	-	-	5	-	-	-	-	-

Sample No.	*Oolina* sp.	*Parafissurina lateralis*	*Parafissurina* sp.	*Parafissurina tectulostoma*	*Polymorhina charlottensis*	*Pseudopolymorphina decora*	*Pseudopolymorphina dollfussi*	*Pullenia subcarinata*	*Pyrgo simplex*	*Pyrulina cylindroides*	*Quinqueloculina longa*	*Quinqueloculina seminulum*	*Quinqueloculina* sp.	*Scutoloris pyriformis*	*Trochammia* sp.	Indeterminate	Sample No.	Number of species	Faunal diversity	Faunal dominance	Number of specimens per 100 g
223293	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223293	2			2
223292	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223292				0
56882	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	56882	3			
197162	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	197162				0
197149	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	197149				0
223289	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223289	1			1
223288	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	223288	12			22
223287	-	3	-	-	-	-	-	-	3	-	4	-	-	4	-	-	223287	25	15	34	107
197146	-	1	1	3	-	-	-	-	5	-	1	1	-	3	-	9	197146	20			35
197145	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	197145	13			16
223286	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	223286	12			30
197144	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	197144	9			15
223285	-	-	-	-	-	-	-	-	-	1	-	-	-	10	-	-	223285	13			38
197143	1	-	-	-	-	2	1	-	-	1	-	-	-	-	-	2	197143	22	14	47	85
197142	-	-	-	-	-	-	-	1	2	2	1	-	-	-	1	9	197142	21	21	30	85
223284	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	223284	15	7	61	95
197141	1	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	197141	21	8	52	365
223283	-	-	-	-	-	2	-	-	-	2	-	5	-	60	-	-	223283	23	15	31	1250
197139	-	-	-	-	1	3	-	-	-	4	-	-	-	-	-	-	197139	25	15	29	430
223282	-	-	-	-	-	-	-	-	-	4	-	-	-	-	2	-	223282	16	11	58	150
197138	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	197138	17	9	24	300
223281	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223281	13	8	38	125
197137	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	197137	16	11	23	290
197136	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	2	197136	18	10	29	200
223280	-	-	-	-	-	-	1	-	-	5	-	-	-	-	-	-	223280	23	13	35	270
197135	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	1	197135	16	8	26	360
223279	-	-	-	-	-	-	-	-	-	4	2	-	-	-	-	-	223279	21	9	41	2600
197134	-	-	-	-	-	1	3	-	-	-	-	-	-	-	-	4	197134	15	8	28	640
223278	-	-	-	-	-	-	7	-	-	3	1	-	-	-	-	-	223278	19	14	26	486
223277	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223277	6			65
197133	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	9	197133	14	11	26	220
197130	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	197130	8			35
223275	-	-	-	-	1	-	-	-	-	8	-	-	-	-	-	-	223275	14	10	37	75
223273	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223273	2			1
197171	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	197171	8			14
223304	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	223304				0
223308	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	223308	6			10
223307	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	2	223307	14			26
197178	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	4	197178	13			40

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