A C T A P A L A E O N T O L O G I C A P O L O N I C A
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ANDRZEJ WIERZBOWSKI, CYPRIAN KULICKI and HALINA PUGACZEWSKA

FAUNA AND STRATIGRAPHY OF THE UPPERMOST TRIASSIC AND THE TOARCIAN AND AALENIAN DEPOSITS IN THE SASSENFJORDEN, SPITSBERGEN

WIERZBOWSKI, A., KULICKI, C. and PUGACZEWSKA, H.: Fauna and stratigraphy of the Uppermost Triassic and the Toarcian and Aalenian deposits in Sassenfjorden, Spitsbergen. Acta Palaeont. Polonica, 26, 3/4, 195—237. April 1982 (1981). Five sections of the De Geerdalen Formation (mostly the Wilhelmøya Member) and the Janusfjellet Formation (the Brentskardhaugen Bed) between Janusfjellet and Botneheia in Sassenfjorden (Spitsbergen) were studied stratigraphically and palaeontologically. The fauna of the Wilhelmøya Member indicates an uppermost Triassic age. The fauna from phosphatic nodules in the condensed Brentskardhaugen Bed is of Middle Toarcian to Early Aalenian age. Pelecypods assigned to 28 genera are described as well as ammonites representing five genera. *Harpoceras kopiki* Wierzbowski et Kulicki sp.n. is established.

K e y w o r d s: Upper Triassic, Toarcian, Aalenian, biostratigraphy, ammonites, pelecypods, Spitsbergen.

Cyprian Kulicki, Halina Pugaczewska, Zakład Paleobiologii, Polska Akademia Nauk, 02-089 Warszawa, Al. Żwirki i Wigury 93, Poland. Andrzej Wierzbowski, Instytut Geologii Podstawowej, Uniwersytet Warszawski, 02-089 Warszawa, Al. Żwirki i Wigury 93, Poland. *Received: November 1980.*

INTRODUCTION

Investigation of the Sassenfjorden area in central Spitsbergen was undertaken in the summer of 1979 by a palaeontological group directed by Professor Gertruda Biernat (Institute of Paleobiology, Polish Academy of Sciences); the group was part of the Polish Spitsbergen Expedition organized and sponsored by the Institute of Geophysics, Polish Academy of Sciences. The fieldwork between the Janusfjellet and Botneheia (fig. 1) was carried out by C. Kulicki and A. Wierzbowski, who studied the uppermost Triassic and the basal Jurassic deposits of this area.

The part of this paper giving the lithostratigraphic succession of the deposits, and their bio- and chronostratigraphic interpretation has been written by A. Wierzbowski, whereas C. Kulicki and A. Wierzbowski are responsible for the palaeontological determination of ammonites, and H. Pugaczewska for the determination of other groups of fossils (pele-

cypods, gastropods, serpulids and crinoids); list of determined species see table 1. All specimens described and illustrated are housed at the Institute of Paleobiology of the Polish Academy of Sciences, Warsaw (abbreviated as ZPAL).

Acknowledgements. — We wish to thank Professor G. Biernat, Dr. A. Baliński and K. Małkowski M.Sc. (Institute of Paleobiology, Polish Academy of Sciences), members of the palaeontological group working in the Sassenfjorden area, for help in the course of fieldwork. We also wish to thank Dr. A. Gaździcki of the same Institute, who identified the foraminifer *Schmidita hedbergelloides* and offered valuable comments on its stratigraphic range. We are grateful to Dr. J. Kopik (Geological Institute, Warsaw) for making his ammonite material available for comparison, and to Dr. R. Chlebowski (Institute of Mineralogy and Petrography, Warsaw University) for examining some thin sections.

Table 1

LIST OF FAUNA DESCRIBED

WILHELMØYA MEMBER

Pelecypods (pls. 5, 6, 9, 11, 12)

Nuculana (Nuculana) cf. *elliptica*
Eumorphotis bjona
Halobia zitteli
Unionites cf. *canalensis*
Curionia cf. *oblongata*
Cardinia sp.

BRENTSKARDHAUGEN BED

Ammonites (pls. 1—4)

Porpoceras polare
Porpoceras sp.
Mucrodactylites aff. *mucronatus*
Mucrodactylites sp.
Dactylioceratidae indet.
Harpoceras kopiki sp.n.
Pseudolioceras compactile
Pseudolioceras rosenkrantzi
Pseudolioceras cf. *alienum*
Leioceras opalinum
Leioceras ex gr. *costosum*

Pelecypods (pls. 5—10, 12)

Palaeonucula sp.
Modiolus (Modiolus) sp.
Pseudomytiloides cf. *dubius*
Oxytoma (Oxytoma) inequivalvis
Meleagrinella cf. *echinata*
Pseudopecten (Echinopecten) cf. *barbatus*
Propeamussium (Parvamussium) personatum
Camptonectes (Camptonectes) cf. *lens*
Trigonia sp.
Luciniola cf. *pumila*
Mactromya sp.
Neocrassina (Coelastarte) cf. *depressa*
Protocardia (Protocardia) striatula
Tancredia (Tancredia) cf. *donaciformis*
Isocyprina (Isocyprina) cf. *depressiuscula*
Ceratomyopsis sp.
Pachyrisma sp.
Pholadomya (Pholadomya) cf. *nodosa*
Pholadomya (Pholadomya) cf. *fidicula*
Goniomya (Goniomya) sp.
Pleuromya cf. *unioides*
Pleuromya cf. *liasina*
Pleuromya cf. *jurassi*
Plicatostylus sp.
Stalagmina sp.

Other fossils (pls. 5, 7)

Serpula (Cycloserpula) cf. *subcrispa*
Serpula (Cycloserpula) sp.
Discohelix (Discohelix) cf. *sinistra*
Acteonina cf. *peroskiana*
Pentacrinites cf. *basaltiformis*

LITHOLOGY AND LITHOSTRATIGRAPHY

The studied sequence (figs 1, 2, 3) is thin, attaining only about 30—35m, and consists of a variety of lithological types. For descriptive purposes and detailed correlation, it can be subdivided into 8 units A—H. Two of the sections (sections 3—4 in figs 1 and 2) have been previously investigated by Bjaerke and Dypvik (1977), who introduced most of the units recognized here, but who gave them different letter designations.

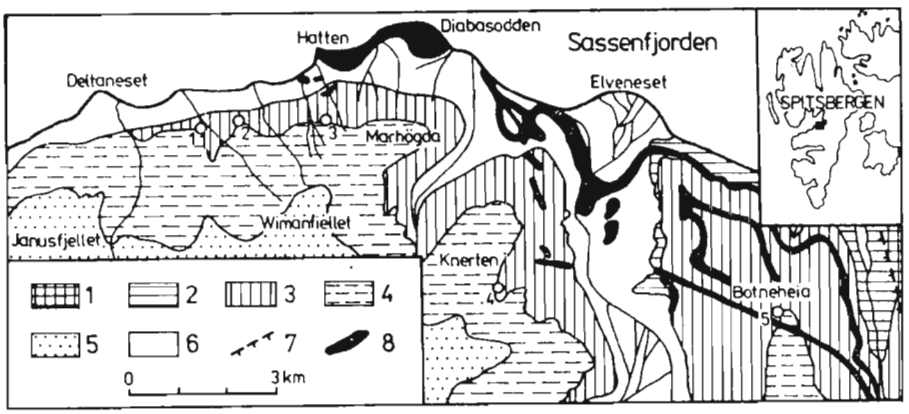

Fig. 1. Map of the Sassenfjorden area (after Major and Nagy 1972) showing the positions of the figured sections *1—5* (cf. fig. 2). *1* Kapp Starostin Fm. (Permian), *2* Sassendalen Gp. (Lower-Middle Triassic), *3* Tschermakfjellet Fm. — De Geerdalen Fm. (Upper Triassic-Lower Jurassic), *4* Janusfjellet Fm (Jurassic-Lower Cretaceous) *5* Helvetiafjellet Fm. — Carolinefjellet Fm. (Cretaceous), *6* surficial deposits (Quaternary), *7* fault, *8* diabase sill or dyke.

Unit A. — Unit A consists of grey shales and silty shales with subordinate intercalations of fine-grained sandstones ranging from a few up to 50 cm in thickness. The sandstones are white or grey (due to finely comminuted plant debris), usually ripple-laminated, the upper surfaces showing asymmetrical, sometimes linguoid ripple-marks. The material is well sorted, composed mostly of quartz grains together with some muscovite, quartzite and plagioclase. The full thickness of the unit is unknown; however, in the sections studied north of Wimanfjellet (sections 1—2, figs 1 and 2), the thickness exceeds 10 m.

Unit B. — Unit B is represented by a 3 meter thick sandstone series in the section between Marhögda and Knerten (sections 3—4 in figs 1 and 2; cf. also unit A in: Bjaerke and Dypvik 1977: fig. 3). The sandstones are light grey, fine- to very fine-grained, laminated and showing low-angle crossbedding; they consist of subangular to subrounded fragments of quartz, rock fragments and feldspar, with rare grains of glauconite, and quartz, dolomite and siderite cements (Bjaerke and Dypvik 1977). To the west, unit B seems to disappear; in sections 1—2, there occurs only a thin

sandstone horizon attaining only 30 cm in thickness and directly overlying the deposits of unit A. The sandstone is grey greenish, very fine-grained and strongly bioturbated; it consists of subangular grains of quartz and feldspar, laths of muscovite, and occasionally, some concentrations of heavy minerals (mostly tourmaline and zircon), and weathered grains of glauconite. The sandstones are hardened by both carbonate (dolomite and/or siderite) and siliceous cements.

Units C and D. — Unit B (fig. 2) wedges out towards the west and in sections 1—2 there occur grey and dark grey shales and silty shales forming unit C. The thickness of unit C is 4.30 m. Near the base of this unit is a thin horizon of brown weathering arenaceous ironstone containing a rich bivalve and ostracode fauna, and plant remains in the top.

Over the whole area studied, overlying sandstones of unit B, and shales of unit C, there is a prominent horizon of phosphorite conglomerate, here denoted as unit D. Its thickness varies from 0.5 cm in sections 1—2 at Wimanfjellet up to 10—40 cm in sections 3—4 at Marhögda and Knerten (figs 1, 2; cf. also Bjaerke and Dypvik 1977). The conglomerate is composed mainly of rounded phosphorite and dolomite-siderite pebbles, with some admixture of quartz, feldspar and glauconite. The pebbles may attain a diameter of up to 4 cm in places where the conglomerate is the thickest (i.e. in sections 3—4; cf. Bjaerke and Dypvik 1977), but only 0.5 cm where it is thin (i.e. in sections 1—2).

Unit E. — Unit E sandstones overlying the phosphorite conglomerate are widely distributed in the area; and crop out between Wimanfjellet and Marhögda and Knerten, and at the top of Botneheia (figs 1, 2). At Marhögda and Knerten, these deposits have been described previously by Bjaerke and Dypvik (1977: unit C). The unit is composed of horizontally bedded sandstones with a thickness of about 2 m. The thickness of beds varies from a few millimeters to several centimeters. The sandstones are often fine grained, but in upper part of the unit at Wimanfjellet (section 1—2) there occur also coarse-grained beds. The material is generally well-sorted; the grains vary from subangular to well-rounded. The sandstones are composed mainly of quartz and are rather rich in fresh glauconite; some rock fragments (fine-grained quartzites, cherts, phosphorites, arenaceous sideritic ironstones), micas and feldspars also occur. The cement consists of dolomite and siderite. Burrows (mostly vertical) are common throughout the unit. Body fossils are rare and comprise only poorly preserved pelecypods. In sections 1—2 at Wimanfjellet, there is a thin shaly layer occurring in the uppermost part of the unit. The upper surface of the main sandstone body is erosive, and penetrated by vertical burrows.

Unit F. — Unit F is composed of dark grey shales and grey silty shales with frequent concretions and some intercalations of distinctive red clay ironstones occurring mostly in the lower and middle parts of the unit. The concretions contain a relatively rich bivalve fauna (mostly *Halobia*).

The upper part of the unit distinguished in sections 3—4 at Marhögda and Knerten is coarser-grained and contains more continentally derived organic material (Bjaerke and Dypvik 1977); comparable deposits in sections 1—2 and 5 seem to be missing as indicated by the smaller thickness of unit F. The total thickness of the unit is 15 m in sections 3—4, whereas it attains 10—12.5 m in sections 1—2 and only about 7 m in section 5.

Unit G. — Unit G represents the well-known Brentskardhaugen Bed (= "Liassic conglomerate"; cf. Frebold 1929*a*, *b*, 1930; Parker 1967; Pchelina 1965*a*; Major and Nagy 1972); it is about 1m thick in the sections studied. The bulk of the unit is composed of conglomerates with abundant sandy matrix, and sandstones with sparse pebbles; phosphatic nodules are very common (fig. 3: 2—3). The sand grains, usually fine to medium in size, are chiefly quartz, but a rather high content of fresh glauconite is found. The pebbles are rounded, generally up to a few centimeters in diameter. They consist of quartz, fine-grained quartzite and chert (recognized radiolarian chert and chert with sponge spicules, possibly from the Permian deposits). Dolomite and siderite cements occur. The bed is normally structureless. The pebbles, however, show a preferred horizontal elongation. At the top of the unit is an uncemented band, several

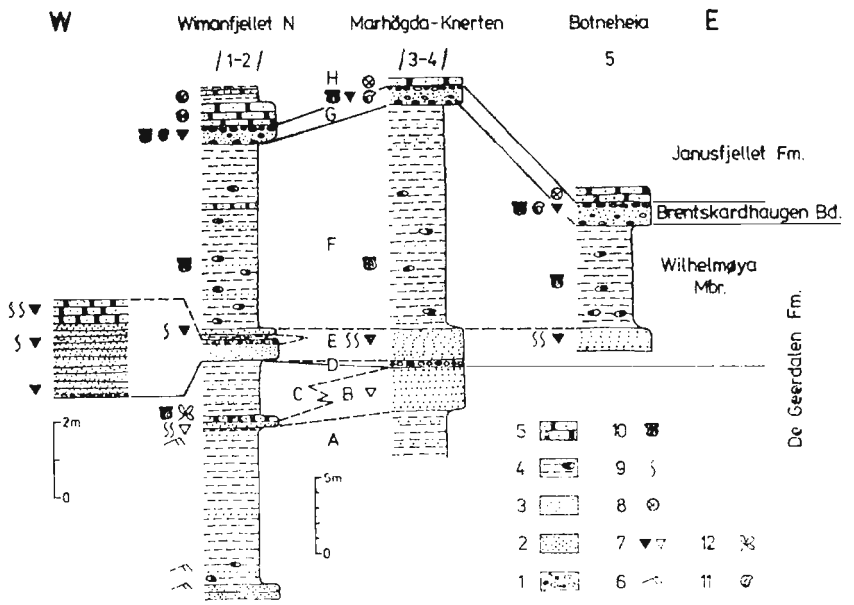

Fig. 2. Interpretative sections along W—E traverse from Wimanfjellet to Botneheia (cf. fig. 1); sections *3—4* after Bjaerke and Dypvik (1977). *1* conglomerate with phosphatic nodules (black), *2* coarse grained sandstone, *3* medium to fine grained sandstone, *4* shale and silty shale with ironestone nodules, *5* arenaceous ironestone, *6* ripple lamination, *7* glauconite (black — fresh and abundant, white-weathered and rare), *8* ferruginous oolites, *9* bioturbation, *10* pelecypods, *11* ammonites, *12* plant debris. The boundaries of the formal lithostratigraphic units are indicated by solid lines, the other lithostratigraphic boundaries by dashed lines. The letters A—H denote the small rock-units as described in this paper.

centimeters in thickness composed of rounded pebbles of quartz, quartzite and chert, and phosphatic nodules.

The phosphatic nodules occurring within the unit contain a rich and diversified fauna: ammonites, belemnites, pelecypods, gastropods, inarticulate brachiopods, crustaceans, as well as fossil wood.

Unit H. — Unit H is the youngest and contains arenaceous ironstones with abundant ferruginous oolites (cf. Pchelina 1965*a*) alternating in the upper part with dark shales. In the lowermost, 15 cm thick part of the unit, fairly abundant pebbles of quartz and chert, and phosphatic nodules are found. Higher in the section the pebbles and phosphorites occur occasionally. Belemnites and fossil wood are common throughout the unit. The thickness of the unit is about 2 m (2.35 m in sections 1—2; figs 1, 2).

Lithostratigraphic nomenclature and classification of the uppermost Triassic-Lower Jurassic deposits in the Sassenfjorden area, as well as their counterparts in other areas of Spitsbergen (and elsewhere in Svalbard) have been the matter of diverse interpretations (cf. Major and Nagy 1972; Worsley 1973; Smith 1975; Smith *et al.* 1975, 1976; Birkenmajer 1975, 1977; Bjaerke and Dypvik 1977; Worsley and Mork 1978; Edwards *et al.* 1979; Pickton *et al.* 1979).

The controversy concerns the Wilhelmøya Formation and its boundaries: whether it should be considered as an independent formation or as a member of the De Geerdalen Formation; it is also disputable whether the Brentskardhaugen Bed should be placed in Wilhelmøya unit or treated as the lowermost part of the younger Janusfjellet Formation.

In the Sassenfjorden area, above the typical sandstones and shales of the De Geerdalen Formation representing the non-marine to marginal marine environments (fig. 2: units A—B; Bjaerke and Dypvik 1977), there occurs the sequence of marine shales and sandstones with thin conglomeratic layer at the base similar to the lower part of the Wilhelmøya Formation from the Wilhelmøya (Bjaerke and Dypvik 1977; cf. also Worsley 1973). This sequence, about 15 m thick (sometimes even less) is only tentatively included here into the De Geerdalen Formation as the Wilhelmøya Member according to Pickton *et al.* (1979: 48; cf. also Bjaerke and Dypvik 1977). It should be stressed that the sections studied in the Sassenfjorden area give no new arguments for resolving the formal rank of the Wilhelmøya unit.

The Brentskardhaugen Bed (fig. 2: unit G) is usually included in the top of the De Geerdalen Formation, or of the Wilhelmøya unit (when distinguished), which is more convenient from a purely descriptive point of view. But possibly more correct from the sedimentological point of view is, however, to place the Brentskardhaugen Bed in the Janusfjellet Formation, as it usually represents the oldest preserved deposits of the Jurassic transgression (cf. Buchan *et al* 1965; Major and Nagy 1972; Birkenmajer 1972, 1975). The latter view is accepted in the present paper

(fig. 2). It may be noted that the problem remains to some degree still disputable, as a large stratigraphical gaps occurs not only below, but also above the Brentskardhaugen Bed, marking long periods of non deposition. Deposition started again with the ironstone and shale unit (fig. 2: unit H) containing at its base some pebbles and phosphorites reworked from the underlying Brentskardhaugen Bed.

Table 2

Zone and subzone division of the Toarcian in NW Europe (after Dean, Donovan & Howarth 1961, Howarth 1964 and Howarth 1978)

Sub-stage		Zones	Subzones
Upper	Yeovilian	*Dumortieria levesquei*	*Pleydellia aalensis* *Dumortieria moorei* *Dumortieria levesquei* *Phlyseogrammoceras dispansum*
		Grammoceras thouarsense	*Pseudogrammoceras struckmanni* *Grammoceras striatulum*
Middle	Lower-Whitbian	*Haugia variabilis*	
		Hildoceras bifrons	*Catacoeloceras crassum* *Peronoceras fibulatum* *Dactylioceras commune*
Lower		*Harpoceras falciferum*	omitted
		Dactylioceras tenuicostatum	

BIOSTRATIGRAPHY AND AGE

The oldest marine fossils come from units B and C, in sections 1 and 2, north of Wimanfjellet (figs 1 and 2). Pugaczewska (this paper) determined from unit B the pelecypods: *Curionia* cf. *oblongata* Kobayashi and Ichikawa, and *Unionites* cf. *canalensis* (Catullo), whose stratigraphical value is limited, but it can be noted that the former occurs in the Karnian and the Norian. Discovery of the planktonic foraminifer *Schmidita hedbergelloides* Fuchs in unit C by Gaździcki (pers. inf.) is more significant since it is known only from the Zlambach Beds in Austria (Fuchs 1967;

see also Zaninetti 1976), latest Norian (latest Sevatian) and Rhaetian age (Gaździcki *et al.* 1979).

The palynological assemblage derived from units D and F (except, locally, for its uppermost part; fig 2) (Bjaerke and Dypvik 1977), is indicative of the Rhaetian. The lower and middle parts of unit F yielded pelecypods, determined by Pugaczewska (this paper): *Halobia zitteli* Lindström, *Eumorphotis bjona* Lundgren and *Nuculana* cf. *elliptica* (Goldfuss). A similar pelecypod assemblage, with representatives of *Halobia*, obtained from the uppermost part of the Triassic sequence in the Sassenfjorden area, has been interpreted by Pchelina (1965*a*, 1967) as indicative of the Norian. However, according to the present data, the occurrence of *Halobia* in the Rhaetian deposits in Spitsbergen seems highly probable and the lack of adequate information in the literature reflects possibly only the poor knowledge of the Rhaetian marine faunas (see Smith *et al.* 1975:11).

The data presented shows that the marine deposits forming the Triassic sequence in the area studied (units B—F, except, locally, for the uppermost part of the latter; fig. 2) are not older than the uppermost part of the Norian (Sevetian) and most possibly belong only to the Rhaetian.[1)]

In the uppermost part of unit F, about 3—4 m below its top, in section 3 (fig. 2) there appears a quite new assemblage of definitely Jurassic palynomorphs (Bjaerke and Dypvik 1977). The beds are possibly absent locally as the total sequence of unit F varies in the area studied (fig. 2). It may indicate that sedimentation of the younger unit G (Brentskardhaugen Bed), was preceded by a period of local erosion.

The Brentskardhaugen Bed ("Liassic conglomerate"; fig. 2: unit G; fig. 3: 2—3) is a thin and strongly condensed layer occurring over vast areas of central and southern Spitsbergen. The phosphatic nodules from the bed have yielded ammonites of Toarcian age (recognized by Frebold 1929*a*, *b*; 1930; cf. also Kopik 1968), and the unillustrated ammonites of Early Aalenian age (Bodylevskij 1929; Pchelina 1967). The faunas and their correlations have been discussed by many authors, but there still remains some unresolved problems of a stratigraphical nature (see Frebold 1951, 1958, 1975; Różycki 1959; Dagis 1968, 1974; Kopik 1968; Birkenmajer 1972; Birkenmajer *in*: Birkenmajer and Pugaczewska 1975; Howarth 1978).

In the Sassenfjorden area the following ammonites (represented by 55 specimens) have been found in the Brentskardhaugen Bed: *Porpoceras polare* (Frebold) *Porpoceras* spp. (including form similar to *P. spinatum*),

[1)] However, recently M. W. Korchinskaya (М. В. Корчинская) *in*: „Ранненорийская фауна архипелага Свальбард" (Геология осадочного чехла архипелага Свальбард, Научно-исслед. Инст. Геол. Арктики Минист. Геол. СССР, 30—43. Ленинград, 1980) presents and discusses the rich fauna (ammonites and pelecypods) from the Flatsalen Formation of Hopen; she states that these deposits as well as their equivalents from Wilhelmøya and Spitsbergen (including the Sassenfjorden area) are of Early Norian age.

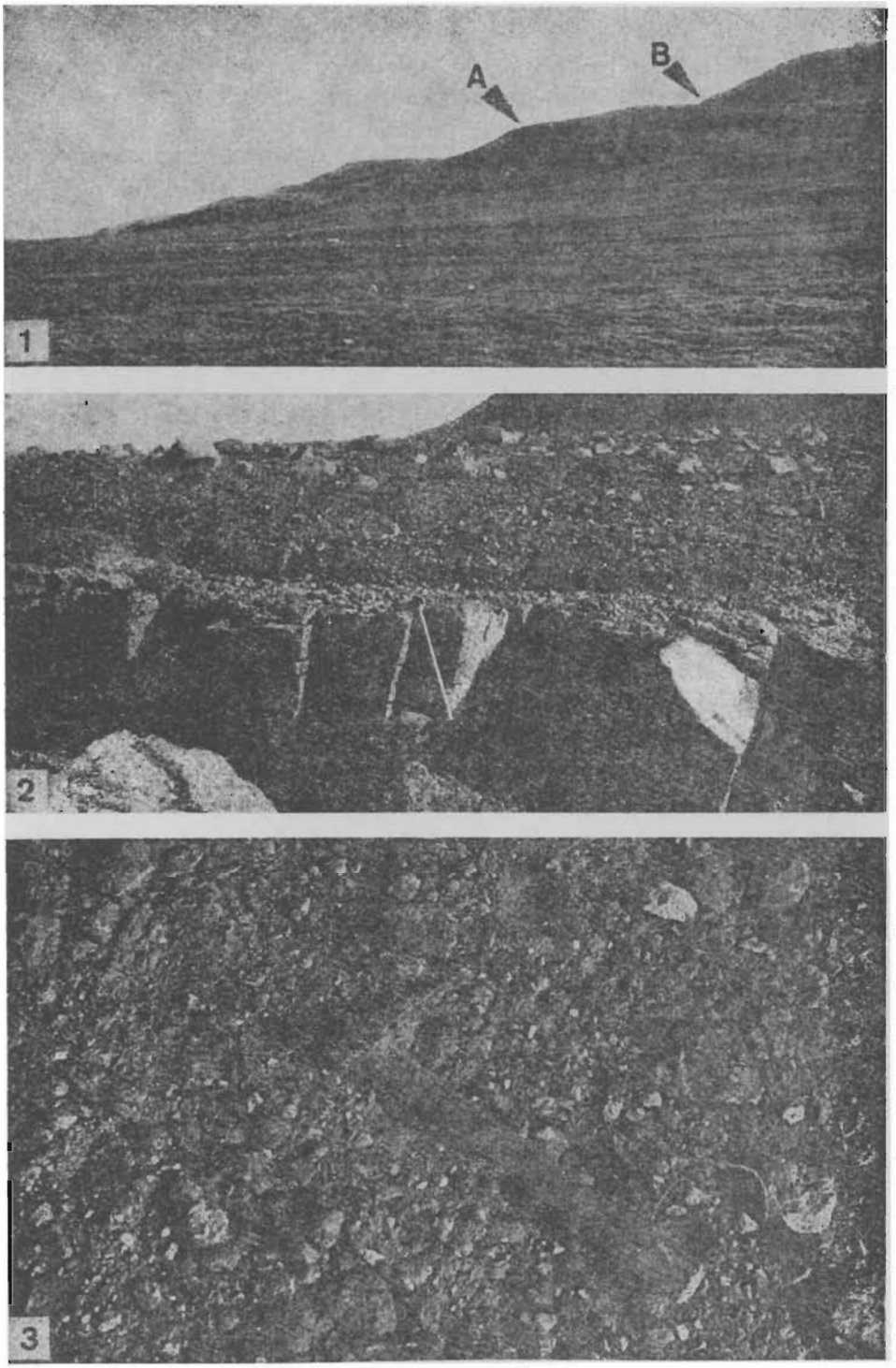

Fig. 3. Section No. 1 at Wimanfjellet (cf. fig. 1, 2): *1* general view towards the east (A and B denote position of the unit E and the Brentskardhaugen Bd., respectively), *2* Brentskardhaugen Bd., *3* concentration of phosphatic nodules and pebbles in the topmost part of Brentskardhaugen Bd.

Mucrodactylites aff. *mucronatus* (d'Orbigny), *Mucrodactylites* spp.,?*Zugodactylites* or ?*Dactylioceras* sp., *Harpoceras kopiki* sp.n., *Pseudolioceras compactile* (Simpson), *P. rosenkrantzi* Dagis, *P.* cf. *alienum* Dagis, *Pseudolioceras* spp., *Leioceras opalinum* (Rein.), *Leioceras* ex gr. *costosum* (Quenstedt).

The Hildoceratidae markedly predominate (50.9%) of which the contribution of *Pseudolioceras* equals 49%; Dactylioceratidae (21.8%) and Graphoceratidae (27.3%) are less common. The ammonites have been usually collected from the rubble, and their original position within the Brentskardhaugen Bed remains unknown; only a few specimens of *Leioceras opalinum* have been found *in situ*, in the topmost part of the bed.

There is no unequivocal evidence for the presence of the *commune* Subzone. A single, poorly preserved specimen, determined as *Dactylioceras* sp. or *Zugodactylites* sp., may be referred either to the *commune* Subzone or to the *fibulatum* Subzone of the *bifrons* Zone from the NW Europe (table 2; cf. also Howarth 1978).

The first well defined ammonite fauna in the collection consists of *Porpoceras polare* (Frebold), *Porpoceras* spp., *Mucrodactylites* aff. *mucronatus* (d'Orbigny), *Mucrodactylites* spp., *Pseudolioceras compactile* (Simpson); it is indicative of the *polare* Zone of the Russian geologists (see Dagis 1968; Saks *in*: Saks *et al.* 1976, and earlier papers cited therein) This fauna is rather uniformly and widely distributed in Arctic regions (Canadian Arctic, northern Siberia: Frebold 1958, 1975; Dagis 1968, 1974); and some differences in the occurrence of the ammonites in particular areas may result from failure in collecting (e.g. the absence of *Mucrodactylites* in the Canadian Arctic).

The correlation of the *polare* Zone with the standard zones and subzones of the Toarcian stage in NW Europe (table 2) is somewhat disputable. There is evidence for correlating the *polare* Zone at least partly with the top of the *fibulatum* Subzone where representatives of the genus *Porpoceras* are known to occur (Howarth 1978). Such correlation may be supported by the presence in the collection studied of the single specimen of *Harpoceras* (*H.kopiki* sp.n.), close to *H. subplanatum* (Oppel), a genus that is usually held to become extinct (with its last representative — *H. subplanatum*), at the top of *fibulatum* Subzone in Europe (Howarth 1978; cf. also Guex 1972). However, there is evidence for correlating the *polare* Zone with still younger zones in NW Europe, mostly with the *variabilis* Zone (see Saks *et al.* 1976 and earlier papers cited therein). This opinion may be supported by the finding of *Pseudolioceras compactile* (Simpson) and *Mucrodactylites* ("*Collina*") similar to *M. mucronatus* (d'Orbigny) in the material. The former possibly appears in the *variabilis* Zone in Europe (Guex 1972; cf. also Howarth 1978: table 2), whereas the latter occurs also

in that zone and probably somewhat below (see Dean, Donovan and Howarth 1961; Guex 1972; cf. Howarth 1978).

The correlations presented show that the *polare* Zone in the Arctic regions is possibly the equivalent to the topmost part of the *fibulatum* Subzone and to the *crassum* Subzone of the *bifrons* Zone, as well as to the *variabilis* Zone from NW Europe (table 2). Moreover, it may be suggested, that the genus *Porpoceras* occurs in the lower part of the *polare* Zone, whereas the genus *Mucrodactylites* with forms close to *M. mucronatus* (d'Orbigny), and *Pseudolioceras compactile* occur in its upper part. Unfortunately, the detailed sequence of ammonites in the *polare* Zone has not been established: in some areas (e.g. Canadian Arctic Archipelago, Spitsbergen; cf.: Frebold 1958) the ammonites were obtained from phosphatic nodules occurring in condensed beds, elsewhere the ammonites were not collected precisely enough. There is actually also no need to postulate a younger age for the discussed ammonite fauna of the *polare* Zone in the Arctic regions. Frebold (1958, 1960, 1975) has assigned tentatively this fauna to the *striatulum* Subzone of the *thouarsense* Zone taking into account the presence of *Pseudolioceras compactile* (Simpson). However, as has been indicated, this species is known to occur already in the *variabilis* Zone (or its equivalents) in Europe.

The youngest Toarcian ammonite fauna in the collection studied consists of *Pseudolioceras rosenkrantzi* Dagis, and may be also *Pseudolioceras compactile* (Simpson). It is indicative of the *rosenkrantzi* Zone as distinguished by Dagis and Dagis in northern Siberia (cf. Dagis 1968, 1974; Saks *in*: Saks *et al.* 1976). This zone is correlated by Russian geologists with the two ammonite zones (the *thouarsense* Zone and the *levesquei* Zone) corresponding to the Upper Toarcian in NW Europe (table 2). The correlation is based on the following assumptions (Dagis 1968, 1974):

i. the Dactylioceratidae became extinct in the Arctic regions, as in Europe, at the top of the Middle Toarcian;

ii. except for the genus *Pseudolioceras*, all other genera of the family Hildoceratidae as well as the family Hammatoceratidae typical of the Upper Toarcian in NW Europe, did not occur in the Arctic regions.

The possibility of an older age of the fauna with *Pseudolioceras* has been suggested by Frebold (1958, 1975), who believes that the equivalents of the *levesquei* Zone, and possibly also a part of the *thoursense* Zone are missing or are unknown in the Arctic regions. In this case the *rosenkrantzi* Zone could be considered only as a possible equivalent of the *striatulum* Subzone in NW Europe (cf. Frebold 1975:20). Such an approach may be, however, disputable as no proof can be given of the presence of any other ammonite fauna of Upper Toarcian age in the Arctic regions; whereas, the presence of the stratigraphic gap in the Upper Toarcian in all these regions seems rather improbable.

The lowermost Aalenian *opalinum* Zone is indicated by the presence of *Leioceras opalinum* (Rein.) and *Leioceras* ex gr. *costosum* (Quenstedt). It is the youngest ammonite fauna collected in the Brentskardhaugen Bed in the area studied.

The stratigraphic position of *Pseudolioceras cf. alienum* Dagis is difficult to establish. The range of *Pseudolioceras alienum* Dagis, as indicated recently by N.G. Krimholz (*fide* Saks *in*: Saks *et al.* 1976: 188) should be revised: the species shows close resemblance to *Pseudolioceras mclintocki* (Haughton) and possibly occurs in the lowermost Aalenian and eventually in the uppermost Toarcian; the specimens referred to as *P. alienum* by Dagis (1974: pl. 17) from the *braunianum* (= *fibulatum*) Subzone of the Middle Toarcian in fact belong to a separate species. It may be also noted that some Early Aalenian representatives of the genus *Pseudolioceras*, i.e. *P.* cf. *mclintocki* and *P.* cf. *beyrichi* (Schl.) have been mentioned from various places of Spitsbergen but, unfortunately, without any illustration given (Bodylevskij 1929; Pchelina 1967).

All the faunas collected so far in the Brentskardhaugen Bed in various parts of central and southern Spitsbergen (Frebold 1929*a*, *b*, 1930; Bodylevskij 1929; Różycki 1959; Pchelina 1965*a*, *b*, 1967; Kopik 1968; Birkenmajer and Pugaczewska 1975) seem to be the same or nearly the same as in the studied area in Sassenfjorden. A few comments can only be made.

The specimens from the Dunerbukta compared originally by Frebold (1929a:pl. 2:6—7) with *Grammoceras saemanni* (Dum.) have been recently assigned (Frebold 1975) to *Pseudolioceras* and distinguished as a new species — *Pseudolioceras spitsbergense* Frebold. The species is known from the Canadian Arctic where it occurs together with *Porpoceras polare* (Frebold) (see Frebold 1960, 1975).

The specimens from the Hornsund area assigned by Kopik (1968: pl. 1) to the genus *Dactylioceras*, in fact do not belong to this genus. The species *Dactylioceras boreum* of Kopik (1968: pl. 1:1—2) has a strongly depressed whorl section, single and biplicate ribbing with small ventrolateral tubercles which is characteristic of the genus *Catacoeloceras*. The representatives of this genus occur in the *crassum* Subzone of the *bifrons* Zone and in the *variabilis* Zone in NW Europe (Howarth 1978; see also table 2). Hence, the presence of this ammonite in the Brentskardhaugen Bed strongly supports the correlation suggested here. It may be also noted that no undisputable ammonites of the genus *Dactylioceras* have been found anywhere in the Brentskardhaugen Bed.

The pelecypods and other fossils except ammonites found in the Brentskardhaugen Bed (Frebold 1929*a*; Pchelina 1965*a*, *b*; Birkenmajer and Pugaczewska 1975) have a wider stratigraphic range and are generally indicative of the upper Lower Jurassic and/or of the lower Middle Jurassic. The two forms cited but not illustrated by Pchelina (1965*a*, *b*)

as *Cardinia* cf. *concinna* (Sowerby) and *Myophoria* cf. *lingonensis* (Dum.) in her opinion resemble the Pliensbachian species; however, there are no further records of this species from Spitsbergen and the forms cited need better documentation. On the other hand, there are very few species of pelecypods known from the Brentskardhaugen Bed which may eventually suggest post-Early Aalenian age (see Birkenmajer 1975). The most important is *Goniomya literata* (Sowerby) which seems to appear in Europe in the Bathonian (see Pugaczewska *in*: Birkenmajer and Pugaczewska 1975). At present it is difficult to say unequivocally whether this species or very close forms may also occur in older deposits in other areas.

The data presented show that the oldest undisputable fauna from the Brentskardhaugen Bed in Spitsbergen is indicative of the *fibulatum* Subzone of the *bifrons* Zone, and the youngest is indicative of the *opalinum* Zone. It can be stated that the bed has been formed over a long period, from a Middle Toarcian up to the earliest Aalenian. A similar opinion that the bed has been formed over a long period, is presented by many authors; however, some of them indicate a shorter time interval for its formation (a late Middle and/or early Upper Toarcian; e.g. Frebold 1929 *a,b* 1958, 1975; Kopik 1978), whereas others propose a longer time interval (?Pliensbachian and Toarcian to Early Aalenian; see Pchelina 1965*a,b*, 1967). As evidence for a younger, post-Early Aalenian age of the Brentskardhaugen Bed is strongly disputable, it is also difficult to accept the opinion of Birkenmajer (1972, 1975:52) that "the faunal assemblage of the Brentskardhaugen Bed is a mixed one derived from various faunal horizons of the Liassic and Middle Jurassic age accumulated as secondary deposits in the basal conglomerate... of the Janusfjellet Formation", and hence, that the bed is of uppermost Bathonian or Callovian age.

The top surface of the Brentskardhaugen Bed has a clearly erosional character (cf. section on lithology and lithostratigraphy). The younger unit H (fig. 2) is composed of arenaceous ironstones containing ferruginous oolites and alternating upwards with dark shales typical of the Janusfjellet Formation. The Upper Bathonian-Lower Callovian fauna with *Kepplerites* has been found about 4m above the top of the Brentskardhaugen Bed, in the thin ironstone layer within the shales. A similar ammonite fauna with *Kepplerites* is found in some sections in Spitsbergen "immediately" above the Brentskardhaugen Bed (Parker 1967). These data show that the top of the Brentskardhaugen Bed marks a long ranging stratigraphical gap which corresponds to the most of the Aalenian, the whole Bajocian, and at least part of the Bathonian. The gap indicates most likely a period of non deposition in the marine environement, rather than a period of uplift and/or marine regression, and a subsequent erosion; in the second case it could be difficult to explain the persistence of occurrence of the thin Brentskardhaugen Bed in the vast areas of Spitsbergen.

DESCRIPTIONS

AMMONITES

Family **Dactylioceratidae** Hyatt, 1867
Genus *Porpoceras* Buckman, 1911
Porpoceras polare (Frebold, 1929)
(pl. 1: 5, 6)

1975. *Peronoceras polare* (Frebold); Frebold: 14—15, pl. 5:2a—d (with synonymy).

Material. — Two specimens (ZPAL AmIV/3.5; 3.6). The inner whorls of the larger specimen are preserved as imprint.

Dimensions (in mm):

Specimen No	Diameters	Umbilical width	Whorl height	Whorl thickness
ZPAL AmIV/3.6	55	c.28.5(0.52)	14(0.25)	c.15(0.27)
	34	15 (0.44)	11(0.32)	c.15(0.44)
ZPAL AmIV/3.5	46	25 (0.54)	13(0.28)	14.5(0.31)
	35	17.5(0.50)	10(0.28)	c.14(0.40)

Description. — The ventral side of the whorl is broad and slighty arched; the maximum whorl thickness is near the mid-height. The primary ribs are very weakly prorsiradiate; the number of ribs per whorl changes along with shell size (about 30 ribs at 20—30 mm diameter, 40 at 40 mm, and about 50 at 50—55 mm); they split at the ventrolateral margin into 2—3 secondary ribs, some ribs remain undivided. At the point of division the distinct tubercles bearing spines are developed. The secondary ribs are somewhat inclined forward and cross the ventral side without any weakening. At the final part of the body chamber there appear the single, somewhat flexuous ribs preceding the collar peristome.

Remarks. — The lectotype and other specimens of the species hitherto figured from Spitsbergen (Frebold 1929*a*: pl. 2: 11—13; Frebold 1930: pl. 22: 4—4*a*) are small, incomplete and represent the inner whorls. The specimens described here are the first more complete from this area, well comparable to the larger specimen described recently by Frebold (1975: pl. 5: 2*a*—*d*) from the Canadian Arctic. All these specimens show only occasionally the presence of the looped ribs on the outer whorl. On the other side, some large specimens assigned to *P. polare* by Dagis (1968: pl. 12:1,7) from Siberia show strong development of the looped ribs on the outer whorls; the Siberian specimens have many features of *P. polare* but their identity with this species is somewhat doubtful (see also Frebold 1975).

The appearance of looped ribs in the studied species and in its close ally *Porpoceras spinatum* (Frebold), suggests that these species do not belong to the genus *Catacoeloceras* as it have been previously assumed, but to *Peronoceras* or *Porpoceras* (cf. Dagis 1968 and Frebold 1975). There are many similarities between *Peronoceras* and *Porpoceras*, and some authors (e.g. Arkell 1957; Schmidt-Effing 1972; Frebold 1975) have regarded *Porpoceras* as a junior synonym of *Peronoceras*, while others (e.g. Dagis 1968; Guex 1971, 1973; Howarth 1978) recognized them as separate genera. Such distinction can be justified on morphological ground, and is accepted in the present paper.

Occurrence in Svalbard. — Brentskardhaugen Bed at Knerten; and at Dunerbukta and Kroghfjellet on the eastern coast of Spitsbergen (Frebold 1929*a*); Tumlingodden in the Wilhelmøya (Frebold 1930).

Porpoceras sp.

(pl. 1: 2)

Material. — One fragmentary specimen (ZPAL AmIV/1.2) representing inner whorls.

Description and remarks. — The maximum diameter is about 35 mm; the umbilicus is very wide and attains about 53% of the diameter. The ribbing is rather distant and strong; the number of primary ribs gradually increases along with shell size from 21 ribs per whorl at 15 mm diameter to about 30 at 30 mm diameter. There are distinct tubercles (?spines) at the ventrolateral margin of the whorls, and ribs are looped to them in fibulate style on the last whorl preserved.

The fragmentary state of preservation of the specimen does not allow detailed comparison with any known species. A certain similarity in the type of ornamentation may be noted with the specimen of *Porpoceras spinatum* (Frebold) figured by Frebold (1975 pl. 5:1).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Genus *Mucrodactylites* Buckman, 1927, emend. Guex, 1971

Mucrodactylites aff. *mucronatus* (d'Orbigny 1844)

(pl. 1:1)

1968. *Collina mucronata* (d'Orbigny); Dagis: 63—64, pl. 11: 9—12.

Material. — One specimen (ZPAL AmIV/3.3).

Dimensions (in mm):

Diameters	Umbilical width	Whorl height	Whorl thickness
35	19.5(0.56)	9(0.255)	
23	11.5(0.50)	6(0.26)	8.5(0.37)

Description. — The specimen is fully grown with the collar peristome preserved; the last two sutures being closer. It is apparently septate to 23 mm, with a body chamber almost whorl long.

The cross-section of the last whorl is depressed with whorl sides flattened; the venter can be observed at the phragmocone/body-chamber boundary where it is wide and slighty arched. The inner whorls are very poorly preserved, possibly with a cadicone cross-section. Ribbing on the inner whorls visible only fragmentary; it is sharp and rather distant; no distinct tubercles can be observed. The last whorl has about 40 ribs that are more closely spaced in its anterior part. The ribs are weakly prorsiradiate, somewhat concave; at the ventrolateral side of whorl subdivided into two and rarely three secondaries. Some ribs are simple. At the point of division are small nodes elongated into long spines (up to 5 mm in length).

Remarks. — The style of the ornament of the studied specimen is typical of *Mucrodactylites*. This name has been treated by some authors as a junior synonim of *Collina*, but recently *Mucrodactylites* is sometimes considered as the separate genus (cf. Guex 1971, 1972, 1973), differing from *Collina* in weaker development of the ventrolateral tubercles on the inner whorls.

The studied specimen is similar to *Mucrodactylites mucronatus* (d'Orbigny) which however has generally more distant ribbing, and more compressed outer whorl (d'Orbigny 1842—49: pl. 104: 4—8; see also Guex 1972: pl. 10: 20; 1973: pl. 2: 1—4; Schlegelmilch 1976:80, pl. 40: 3). The specimens described as *Collina mucronata* (d'Orbigny) by Dagis (1968 pl. 11: 9—12) from the northern Siberia are similar or even conspecific with the studied specimen.

Occurrence. — Spitsbergen: Brentskardhaugen Bed at Knerten.

Mucrodactylites sp.
(pl. 1: 3)

Material. — Two specimens (ZPAL AmIV/2.23 and 2.24) preserved as fragmentary imprints.

Description. — Maximum diameter about 40 mm; at 25—30 mm diameter, the umbilical width equals 12—13.5 mm (0.48—0.50), and the whorl height 7—8.5 mm (0.29—0.30). Umbilicus flat and shallow; whorl sides flattened. The ventral side is not preserved except one fragment representing the transition to the whorl side; the transition is abrupt. The ribbing is fairly dense; there are 29—32 primary ribs per whorl at 25 mm diameter. The ribs become crowded close to the end of the last whorl which shows the proximity of the aperture. The primary ribs are rectiradiate and slightly flexuous. At the ventrolateral margin they split into two prorsiradiate secondaries (as seen on the preserved fragment of the ventral side in the specimen ZPAL AmIV/2.23). There are fine tubercles developed at the point of division.

Remarks. — Because of the abrupt transition of the whorl side into the ventral side, the flattened whorl sides, and the prorsiradiate secondary ribs, the studied specimens are assigned to *Mucrodactylites*. The studied specimens differ from *Mucrodactylites* aff. *mucronatus* (d'Orbigny) described in this paper in shape of primary ribs and the more regular tuberculation.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Dactylioceratidae indet.
(pl. 1: 4)

Material. — One specimen (ZPAL AmIV/2.22) representing incomplete and slightly corroded cast.

Description. — The maximum diameter is about 50—60 mm. The whorl sides are weakly convex narrowing towards the venter. The transition to the venter is gradual, but the character of the ventral side is not known. Umbilicus wide and shallow. Ribbing dense; there are 69 primary ribs on the outer whorl (the ribs are especially densely spaced at the end of the whorl), and 53 ribs on the next inner whorl. The primary ribs are generally rectiradiate becoming slightly prorsiradiate on the last half-whorl. No tubercles could be seen and the secondary ribs are nowhere preserved.

The unsatisfactory preservation of this specimen does not permit its unequivocal generic identification. However, only two genera can be taken into account: *Dactylioceras* or *Zugodactylites*.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Hildoceratidae** Hyatt, 1867

Genus *Harpoceras* Waagen, 1869

Harpoceras kopiki Wierzbowski and Kulicki sp.n
(pl. 2: 1*a*, *b*; fig. 4)

Holotype: Specimen ZPAL AMIV/3.4; pl. 2: 1*a*, *b*.

Type horizon: Brentskardhaugen Bed, possibly *bifrons* Zone of the Middle Toarcian.

Type locality: Knerten in the Sassenfjorden area (figs 1, 2: section 4).

Derivation of the name: in honour of Dr. Janusz Kopik, the student of Lower and Middle Jurassic faunas of Poland and Spitsbergen.

Diagnosis: Strongly involute; ventral side with bordering edges, becoming gradualy more tabulate towards the aperture; ornamentation consisting of falcoid ribbing, weak in dorsolateral area, but strongly developed on the outer part of whorl.

Material. — One perfectly preserved specimen.

Dimensions (in mm):

Diameters	Umbilical width	Whorl height	Whorl thickness
56	10(0.18)	27.5(0.49)	12(0.215)
45	7.5(0.165)	23(0.51)	10(0.22)

Description. — The specimen is septate up to 33 mm diameter; the sutures are well denticulate (fig. 4) and rather densely arranged, however, no distinct approximation of the suture lines at the end of phragmocone can be stated. The body chamber comprises about two thirds of a whorl.

The specimen is strongly involute; the umbilicus is narrow and rather deep with steep walls and distinct umbilical edge. The flanks are laterally compressed, very slightly convex. The lateral groove is very poorly visible at the end of the last whorl. The ventral side becomes gradually more tabulate towards the aperture; it is delineated by two ventrolateral edges, and has a high keel bordered by sulci. The ornamentation consists of falcoid ribs, rather strongly developed on the outer part of whorl side, but being very fine towards the umbilicus. At the mid-height of whorl or somewhat below, each 2—3 outer ribs join indistinctly together forming the fine, sometimes almost unrecognizable inner rib.

Remarks. — The new species is very similar to *Harpoceras subplanatum* (Oppel) differing in a more tabulate ventral side and possibly in a smaller size (see Gabilly 1976). The tabulate-tricarinate ventral side is found in the representatives of the genus *Osperiolioceras* Krimholtz, 1957 (= *Pseudopolyplectus* Mattei, 1969). Representatives of this genus show however very early decline of the *Maconiceras*-type of ribbing. The holotype of the *Harpoceras kopiki* sp.n. seems to represent a macroconch as evidenced by its size and complicated suture line (fig. 4).

Occurrence. — Type horizon and locality.

Genus *Pseudolioceras* Buckman, 1899

Pseudolioceras compactile (Simpson 1855)

(pl. 2: 2—5; fig. 4)

v. 1968. *Pseudolioceras compactile compactile* (Simpson); Kopik: 46—48, pl. 2: 3—4; fig. 5 (with synonymy).

Material. — Six specimens, four of which preserved as imprints (ZPAL AmIV/1.1; 2.2; 2.10; 3.2; 3.8; 3.9); as well as three other specimens (ZPAL AmIV/2.7; 4.1; 4.2) fragmentary preserved and assigned to the species tentatively.

Dimensions (in mm):

Specimen No	Diameters	Umbilical width	Whorl height	Whorl thickness
ZPAL AmIV/3.2	c.77	7.5(0.10)	43.5(0.565)	19(0.245)
	c.57	7 (0.12)	30 (0.53)	15(0.26)
ZPAL AmIV/2.2	80	11 (0.14)	42 (0.525)	—
	65	9.5(0.145)	34 (0.525)	—
ZPAL AmIV/3.8	c.68	10 (0.145)	34 (0.50)	—
ZPAL AmIV/2.10	c.44	7 (0.16)	23.5(0.535)	—
ZPAL AmIV/3.9	c.32	6.5(0.20)	15 (0.47)	—
ZPAL AmIV/1.1	30	6 (0.20)	16 (0.53)	8(0.265)

Description. — Most of the specimens have body-chamber preserved; however, one of the biggest specimens (ZPAL AmIV/3.2) attaining 80 mm in diameter is septate up to the end of the last whorl.

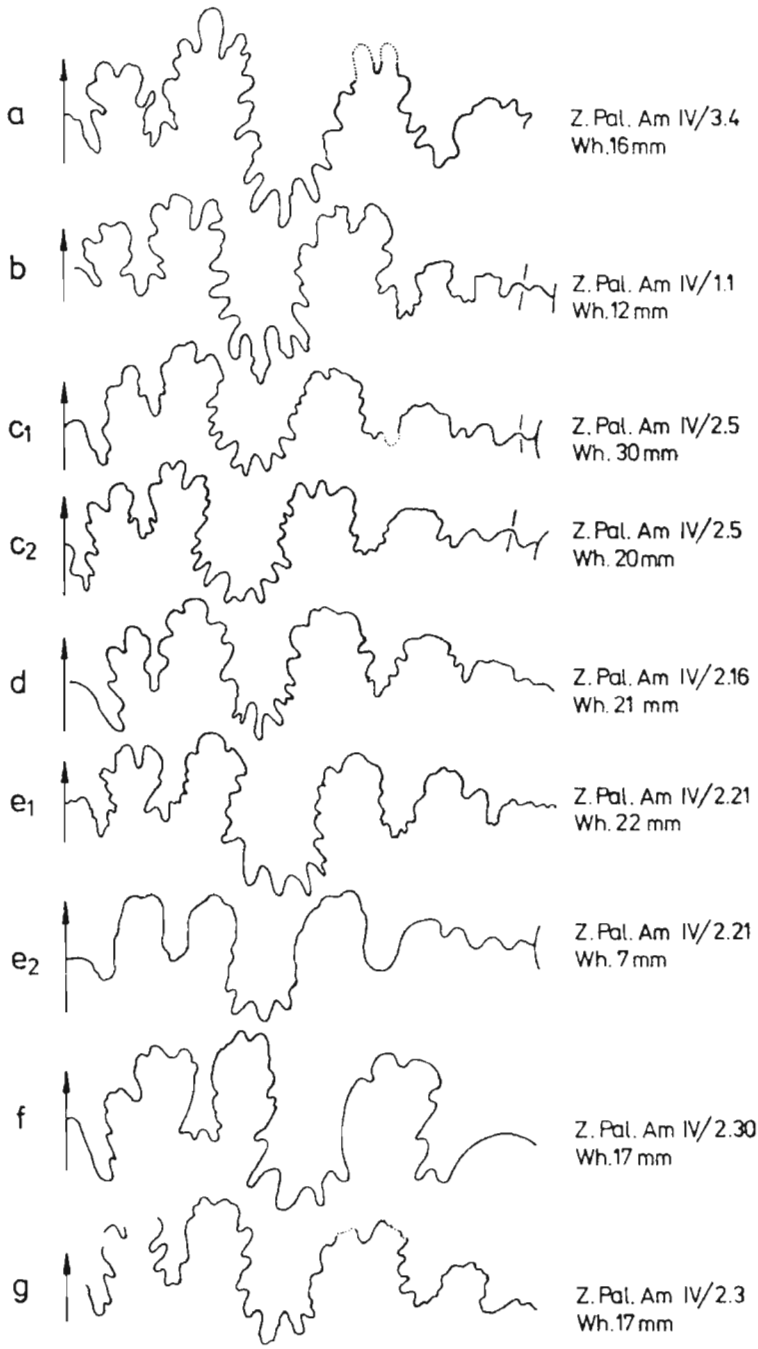

Fig. 4. Suture lines of some ammonites studied: *a Harpoceras kopiki* sp.n., holotype; *b Pseudolioceras compactile* (Simpson); *c—d Leioceras opalinum* (Reinecke); *e—g Leioceras* ex gr. *costosum* (Quenstedt).

Whorl section oval; whorl sides slightly convex. The maximum thickness is somewhat below the mid-height of the whorl. Umbilicus narrow, with steep umbilical wall. The smaller specimens has usually the wider umbilicus than the big specimens. Ribbing falciform. The ribs are weakly marked and prorsiradiate in the dorsolateral part of whorl; they become thick and more or less concave in the ventrolateral area. The number of ribs in the ventrolateral part of whorl equals about 30—40 per whorl. The ventral side of whorl is rather narrow with distinct median keel bordered by flat and smooth sulci. The suture line is shown in fig. 4.

Occurrence in Svalbard. — Brentskardhaugen Bed at Knerten, Botneheia, Wimanfjellet, and at Dunerbukta and Kroghfjellet on the eastern coast of Spitsbergen (Frebold 1929*a*), and Hyrnefjellet in the Hornsund area (Kopik 1968).

Pseudolioceras rosenkrantzi Dagis, 1965

(pl. 2: 6; pl. 3: 1,2)

?1929. *Pseudolioceras* cf. *württenbergeri* Denckmann; Frebold: 262, pl. 2: 5—5a.

1974. *Pseudolioceras rosenkrantzi* A. Dagis; Dagis: 52—54, pl. 18: 2—7; ?pl. 14: 4 (with synonymy).

Material. — Two small fairly well preserved specimens (ZPAL AmIV/2.1, and 2.11) and one larger fragmentary specimen (ZPAL AmIV/3.1).

Dimensions (in mm):

Specimen No	Diameters	Umbilical width	Whorl height	Whorl thickness
ZPAL AmIV/3.1	c.50	8.5(0.17)	25(0.50)	—
ZPAL AmIV/2.1	33	5.5(0.165)	17(0.515)	9(0.27)
ZPAL AmIV/2.11	27	c.5.5(0.20)	13(0.48)	—

Description. — Two small specimens have partly preserved body-chambers. The larger, wholly septate specimen reached about 70 mm.

Whorl section oval; whorl sides slightly convex. The maximum whorl thickness is somewhat below the midheight. Umbilicus narrow; umbilical wall rather steep. The ornamentation is strongly developed only in the ventrolateral part of whorls; it consists of distant, rursiradiate, straight or almost straight ribs; the number of ribs per whorl equals about 30—35. In the dorsolateral part of whorls the ornamentation is very weak; there are thin, prorsiradiate riblets and striae. The ventral side of whorls is rather narrow. The keel is low and bordered from each side by smooth, flat sulci.

Remarks. — *Pseudolioceras rosenkrantzi* Dagis is similar to *P. compactile* (Simpson) differing mostly in the ornamentation of the ventrolateral area. The former species is characterized by straight ribs, whereas the ribs of *P. compactile* are more or less concave.

The specimen described as *Pseudolioceras* cf. *wuerttenbergeri* (Denckmann) by Frebold (1929*a*: pl. 2: 5—5a) belongs possibly to *Pseudolioceras rosenkrantzi* Dagis. This specimen shows strong, straight ribs in the ventrolateral area similarly as in *P. rosenkrantzi*; it differs from *Pseudolioceras wuerttenbergeri* (Denckmann) in wider ventral side of the whorls (cf. Denckmann 1887: 65—66; pl. 1: 1; pl. 4: 7).

Occurrence in Svalbard. — Brentskardhaugen Bed at Knerten and Wimanfjellet; the single specimen illustrated by Frebold (1929*a*) as *P.* cf. *wuerttenbergeri* (Denckmann) was found at Dunerbukta on the eastern coast of Spitsbergen.

Pseudolioceras cf. *alienum* Dagis, 1967
(pl. 3: 6,7)

Material. — Two fragmentary specimens (ZPAL AmIV/2.9; 2.26) including one preserved as imprint.

Description. — The two studied specimens are moderately involute 40 and 50 mm in diameter. Umbilicus width equalling about 10.5—11.5 mm (0.24—0.26) at 40—50 mm diameter; umbilical wall steep. Whorl section oval with flattened sides. The ventral side is not preserved in studied specimens except the bordering flat zones observable in specimen ZPAL AmIV/2.26. Ribbing falciform; the ribs are weak and prorsiradiate in the dorsolateral area, becoming strong and concave in the outer part of whorl. The last whorl in specimen ZPAL AmIV/2.26 has 36 ribs as counted in the ventrolateral area.

Remarks. — The specimens studied are similar to the holotype of *P. alienum* Dagis (see Dagis and Dagis 1967: pl. 1: 8*a*-*b*). The characteristic features of the species include: rather wide umbilicus, the weak ornamentation in the dorsolateral area, and occasionally occurring biplicate ribs (the last feature being rather not typical for *Pseudolioceras*). It may be suggested that some specimens described originally as *Harpoceras* cf. *eseri* (Opp.) by Frebold (1929a, especially pl. 2: 10) from Spitsbergen actually may belong to *P. alienum* Dagis.

Occurrence in Svalbard. — Brentskardhaugen Bed, Wimanfjellet, Hornsund (J. Kopik, pers. inf.); the specimens identified as *H.* cf. *eseri* by Frebold (1929*a*) are derived from the Agardhbukta on the eastern coast of Spitsbergen.

Family **Graphoceratidae** Buckman, 1905

Genus *Leioceras* Hyatt, 1867

Leioceras opalinum (Reinecke 1818)
(pl. 3: 3,4,5; pl. 4: 3,4; fig. 4)

1958. *Leioceras opalinum* (Reinecke); Frebold: 6, pl. 4: 1—5; pl. 5: 1—2 (with synonymy).

1960. *Leioceras opalinum* (Reinecke); Frebold: 25, pl. 6: 1—4; pl. 7: 1.

1963. *Leioceras opalinum* Reinecke; Rieber: 31, pl. 8: 11—13; figs 13, 16 (with synonymy).

Material. — Nine specimens (ZPAL AmIV/1.3; 2.5; 2.6; 2.16; 2.17; 2.18; 2.19; 2.20; 2.28), all more or less incomplete; the peristome is nowhere preserved.

Dimensions (in mm):

Specimen No	Diameters	Umbilical width	Whorl height	Whorl thickness
ZPAL AmIV/2.17	71.5	13.5(0.19)	35 (0.49)	—
	56	11 (0.195)	27.5(0.49)	
ZPAL AmIV/2.5	66	14.5(0.22)	32.5(0.49)	14 (0.21)
	51	11 (0.215)	23.5(0.46)	12 (0.235)
ZPAL AmIV/1.3	67	13.5(0.20)	—	13.5(0.20)
	46	8.5(0.185)	22 (0.48)	9.5(0.205)
	59	11 (0.185)	28 (0.475)	10.5(0.18)
ZPAL AmIV/2.16	49	9.5(0.19)	23.5(0.48)	9.5(0.19)
ZPAL AmIV/2.18	52	10 (0.19)	26.5(0.49)	—

Description. — Whorl section lanceolate with slightly convex sides and very sharp ventral side bearing the keel; the maximum whorl thickness is somewhat below the mid-height. The venter is scarcely differentiated from whorl sides and the flattened zones bordering the keel are entirely absent. Keel high and prominent;

it is solid on the phragmocone. The umbilicus is narrow with oblique umbilical wall and the distinct umbilical edge, especially well marked on the outer whorl. The ornamentation consists of very weak falciform, single ribs and striae. They continue sharply bent forward over the ventral side. Suture line complex (fig. 4) and very similar to that of *Leioceras opalinum* figured by Frebold (1960).

Occurrence in Svalbard. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Leioceras ex gr. *costosum* (Quenstedt, 1886)

(pl. 4: 1, 2*a*, *b*; fig. 4)

Material. — Two specimens (ZPAL AmIV/2.3; 2.30) poorly preserved; one specimen (ZPAL AmIV/2.21) fairly well preserved representing the phragmocone.

Dimensions (in mm):

Specimen No	Diameters	Umbilical width	Whorl height	Whorl thickness
ZPAL AmIV/2.21	46	10 (0.215)	22 (0.48)	11 (0.24)
	27	6.5(0.24)	12 (0.445)	7.5(0.275
ZPAL AmIV/2.3	c.48	10 (0.21)	23 (0.48)	—
ZPAL AmIV/2.30	36	c.9(0.25)	15.5(0.43)	10.5(0.29)

Description and remarks. — Specimens from 40 mm to 60 mm in diameter, involute; whorl section lanceolate with sharp ventral side bearing the keel. The transition of the whorl sides into the venter is gradual, and no ventrolateral edges can be observed. The umbilicus is narrow; the umbilical edge appears at a greater diameter. The inner whorls are well ribbed; the ribs are falciform, single and biplicate; the point of division is about the mid-height of the whorl. In the subsequent stage of growth, at diameters of more than 30—35 mm (specimens ZPAL AmIV/2.21 and 2.3) the ornamentation becomes fainter.

The specimens studied seem to be closely related. However, they show some differences. The specimens ZPAL AmIV/2.21 and 2.3 are more involute, have slightly more slender whorls and the weaker ribbing than the specimen ZPAL AmIV/2.30.

The incomplete preservation of the specimens studied, and the lack of adequate comparative material preclude the specific determination. The specimen ZPAL AmIV/2.30 strongly resembles *Leioceras costosum* (Quenstedt) as figured by Quenstedt (1886: pl. 55: 20—21) and Buckman (1899: pl. 6: 1—4), whereas the specimens ZPAL AmIV/2.21 and 2.3 are similar to *Leioceras subcostosum* (Buckman) of Buckman (1899: pl. 6: 5—7). The specific identity of the two forms is not excluded (Dorn 1935).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

PELECYPODS

Family **Nuculidae** Gray, 1824

Genus *Palaeonucula* Quenstedt, 1930

Palaeonucula sp.

(pl. 8: 1*a*-*b*; 2*a*-*b*)

Material. — One internal mould with fragments of valves. ZPAL Mo XVI/1, 1a.

Dimensions (in mm):

H	L	Th
25.0	29.0	14.5

Description. — An internal mould of an inequilateral shell, the thickest in the subumbonal part. Anterior adductor scars, 8 by 6 mm in size, larger than posterior, projecting posterodorsally for 1 mm. Their surfaces are covered with distinct, oblique growth lines (pl. 8: 2*b*). Pallial line simple, composed of many small pits. Short,

perpendicular striae, constituting traces of the attachment of pallial fibers (pl. 8: 2*b*) come off this line. Umbones opistogyric, slightly shifted posteriorly. Posterior pedal retractor scars situated anterodorsally in relation to posterior adductors, parallel to commissure, marked in the form of smooth areas. Anterior pedal retractor scars posterodorsal to anterior adductors, projecting, tubercle-like (pl. 8: 1*a*). Hinge taxodont, its anterior branch shorter, wider than posterior and undulating, posterior branch rectilinear (pl. 8: 1*a*). External surface of shell ornamented by irregular, concentric growth striae (pl. 8: 2*b*).

Remarks. — Muscle scars are of taxonomic value within the family (Duff 1978: 25) and, in the representatives of *Nucula s.s.* (Speden 1970: 30) and *Palaeonucula*, differ from each other in position and outline. The specimen described from Spitsbergen is most similar in this respect to a specimen of *P. triangularis* Duff from the Lower Oxford Clay, Stewartby, south-eastern England (Duff 1978: 23, fig. 6; pl. 1: 23), from which it differs considerably in a smaller thickness of internal mould, in tubercle-like anterior pedal retractor scars, which are shorter and more projecting than those of the English specimen, and relatively larger adductor scars.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Nuculanidae** Adams and Adams, 1858
Genus *Nuculana* Link, 1807
Nuculana (*Nuculana*) cf. *elliptica* (Goldfuss, 1840)
(pl. 5: 5*a-b*)

Material. — One internal mould with fragments of valves. ZPAL Mo. XVI/2. Dimensions (in mm):

H	L	Th
5.0	8.0	2.0

Description. — Posterior end elongated and slightly rostrate, anterior short, rounded. The largest thickness in the umbonal area. Umbones low, swollen, somewhat opistogyric, shifted anteriorly. Hinge margin long, slightly angular. Its anterior part almost a half as long as posterior. Teeth, 8 to 9 of which are visible on the anterior part of hinge (on the posterior part they are invisible), are situated, alternately with sockets, on both sides of the hinge margin. Thin growth lines occur on the surface of valve and thickened striae — near the ventral margin.

Remarks. — The specimen under study is most similar to those of *Nucula elliptica* Goldfuss from the Triassic and Liassic of the Alps described by Goldfuss (1840: 153, pl. 124: 16*a-d*) but differs in thickened striae occurring in the periventral part of shell. In this character, it also differs from specimens described by Bittner (1895: 142, pl. 16: 26—31) from the Alpine Triassic of St. Cassian which are marked by thin, homogeneous growth lines.

Occurrence. — Spitsbergen: Wilhelmøya Member (unit F), Wimanfjellet.

Family **Mytilidae** Rafinesque, 1815
Genus *Modiolus* Lamarck, 1799
Modiolus (*Modiolus*) sp.
(pl. 6: 2; pl. 10: 1*a-c*)

1929*a*. *Modiola* sp. Frebold: 265, pl. 3: 2.

Material. — Two specimens: a fragmentary distal end of shell and an internal mould of shell of an adult individual with a partly preserved valve. ZPAL Mo.XVI/3-4.

Dimensions (in mm):

H	L	Th
28.0	58.0	28.0

Description. — An internal mould of an equivalve, inequilateral, strongly convex shell, thickest anteromedially. Anterior margin convex, narrow, projecting anteriorly to obtuse umbones. Posterior margin wide, rounded (pl. 6: 2; pl. 10: 1*a*-*b*). Dorsal margin long, slightly convex and somewhat oblique. Ventral margin anteromedially concave. A rounded, oblique ridge runs from umbonal apexes towards the ventral margin. On the anteroventral side, it is accompanied by a depression (pl. 10: 1*a*). The surface of the internal mould is ornamented by thin growth lines and striae, as well as by thin radial striae, strongly developed in its dorsomedial part (pl. 10: 1*c*).

Remarks. — In regard to its dimensions, outline and ornamentation, the specimen described resembles that of *Modiola* sp. illustrated by Frebold (1929*a*: 265, pl. 3: 2) from the Upper Liassic of Dunérbay, western Spitsbergen. From a similar specimen of *Modiolus bipartitus* Sowerby, described by Duff (1978: 41, pl. 2: 28—33), the above described specimen differs in a considerably larger convexity of shell, more oblique position of ridge and the presence of radial ornamentation.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Inoceramidae** Giebel, 1852
Genus *Pseudomytiloides* Koshelkina, 1963
Pseudomytiloides cf. *dubius* (Sowerby, 1818)
(pl. 7: 11)

1929*a*. *Inoceramus* cf. *dubius* Sowerby; Frebold: 264, pl. 3: 8.

Material. — One internal mould damaged in its posteroventral part. ZPAL Mo.XVI/5.

Dimensions (in mm):

H	L	Th
ca 14.0	ca 15.0	ca 8.0

Description. — An internal mould of an inequivalve shell; left valve more convex. Umbones small, pointed, medial. Apical angle amounting to about 100°. Concentric, arcuate folds visible on the surface. Spaces between them increasing together with the growth of shell.

Remarks. — The specimen from Wimanfjellet differs from that from Kroghberg in larger apical angle.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Aviculopectinidae** Meek and Hayden, 1864
Genus *Eumorphotis* Bittner, 1901
Eumorphotis bjona Lundgren, 1887
(pl. 9: 6—9)

1939. *Pseudomonotis* (*Eumorphotis*) sp. indet.: Frebold: 11, pl. 1: 4 and 5.
1939. *Pseudomonotis* (*Eumorphotis*) *bjona* Lundgren; Frebold: 12, pl. 1: 6—12.

Material. — Four internal and external moulds of left and one internal mould of right valve. ZPAL Mo.XVI/6—10.

Description. — Moulds of rounded, inequilateral and inequivalve shells to 15 mm in height. The left convex, in particular anteriorly and subumbonally, the right almost quite flat. The umbo of left valve convex, prosogyric, slightly projecting above the hinge margin. The umbo of right valve low, convex and not projecting above the hinge margin. The number of radial ribs increases by intercalation. Near the ventral margin, ribs are slightly undulating, locally discontinuous, nodular and, on the right valve, less numerous and thicker (pl. 9: 8). Posterior auricles, larger than anterior, pass into a valve in the form of a gentle depression. Thin, radial ribs are visible on the surface of auricles. Growth lines unequally thickened (pl. 9: 7, 8).

Remarks. — The specimens described differ from specimens of *Pseudomonotis (Eumorphotis) bjona* Lundberg from the Upper Triassic of the Nordfjord, Spitsbergen (Frebold 1939: 12—14, pl. 1: 6—12) in the lack of a byssal incision under the anterior auricle. This difference may, however, result from a poor state of preservation.

Occurrence. — Spitsbergen: Wilhelmøya Member (unit F), Wimanfjellet. Other localization at Svalbard: eastern coast of Nordfjord, Bellsund, Akseløya (Frebold 1939), Upper Triassic.

Family **Posidoniidae** Frech, 1909
Genus *Halobia* Bronn, 1830
Halobia zitteli Lindström, 1865
(pl. 11: 1—6; pl. 12: 7, 8)

1883. *Halobia zitteli* Lindström; Lundgren: 19, pl. 2: 13.
1961. *Halobia zitteli* Lindström; Tozer: 104, pl. 29: 4.
1964. *Halobia zitteli* Lindström; Vozin and Tikhomirova: 21, pl. 9: 1—2.

Material. — Many internal and external moulds of shells in various growth stages. ZPAL Mo.XVI/11—18.

Dimensions (in mm):

H	L
3.0 to 14.0	5.0 to 16.0

Description. — Moulds of rounded, equivalve, subequilateral shells. Umbones small, pointed, convex, somewhat prosogyric, slightly projecting above the hinge margin (pl. 11: 2, 4—6; pl. 12: 7, 8). Hinge margin long, rectilinear. The convexity, largest in the subumbonal part, decreases toward ventral margins. Anterior auricle triangular in outline and equalling in length a half of that of hinge margin does not project above this margin. It is divided by a furrow into a convex and wide lower part and a flat or slightly depressed and narrow upper part, the latter bordered externally by a thickened list. Auricle ornamented by growth lines and striae (pl. 11: 4—6). Valves covered with radial ribs and concentric folds, the distribution of which allows one to distinguish the following three areas: (1) a posterior area in which a concentric ornamentation predominates, with wide and usually projecting folds (pl. 11: 1—6) and very numerous, thin, radial ribs; (2) a central area in which a radial ornamentation predominates (pl. 11: 1, 2, 4—6), with few (6—7) ribs divided periventrally by short, radial striae (pl. 11: 6); (3) an anterior area with very numerous, thin ribs divided by thin striae over their whole length. In this latter area, the number of ribs increases from 20 in the umbonal part to more than 60 near the ventral margin. In the anterior area, folds are barely visible (pl. 11: 1, 5, 6).

Three growth stages may be distinguished. A juvenile stage is marked by more strongly and more uniformly convex valves than those of subsequent stages. Its umbo is convex and incurved and its valves are covered with few ribs and about

6 concentric, equally spaced and relatively convex folds. Further (adult and gerontic) growth stages result in the decreasing convexity of valves and folds and in the differentiating of ornamentation.

Remarks. — The specimens described occur abundantly, in the form of aggregates and, less frequently, as solitary specimens, in siderites. Particularly numerous are juvenile stages.

Other species of *Halobia* are only sporadically recorded in the Upper Triassic deposits of Spitsbergen. The specimens described correspond to the diagnosis of *Halobia zitteli*. From those mentioned in the synonymy, they differ in the number of ribs, their more or less undulating course (Tozer 1961, pl. 29: 4; Vozin and Tikhomirova 1964, pl. 2: 13) and a less projecting umbo. These differences are within the limits of individual variability.

Occurrence. — Spitsbergen: Wilhelmøya Member (unit F), Wimanfjellet; Carnian of Kapp Thordsen, Kapp Lee, Mohnbukta, Siegelfjellet, Stensiöfjellet, Duckwitzbreen, Hahnfjellet, Botneheia, Kongressfjellet, Tschermakfjellet (see Lundgren 1883; Buchan et al. 1965); Ladinian-Carnian (Kapp Toscana Formation) of Edgeöya (Buchan *et al.* 1965). Carnian of East Greenland and other parts of Arctic region (Frebold 1929c; Tozer 1961; Vozin and Tikhomirova 1964).

Family **Oxytomidae** Ichikawa, 1958

Genus *Oxytoma* Meek, 1864

Oxytoma (*Oxytoma*) *inequivalvis* (Sowerby, 1819)

(pl. 7: 5—7)

1819. *Avicula inequivalvis* Sowerby: 78, pl. 244: 2—3.

1975. *Oxytoma* (*Oxytoma*) *inaequivalvis* (J. Sowerby, 1819); Birkenmajer and Pugaczewska: 61, pl. 3: 1—6 (with synonymy).

1978. *Oxytoma* (*Oxytoma*) *inequivalve* (J. Sowerby, 1819); Duff: 54, pl. 4: 7, 9, 11, 13, 15—19, 21—23, fig. 17 (with synonymy).

Material. — Numerous internal and external moulds. ZPAL Mo.XV/19—21.

Remarks. — The specimens described are similar to those described from Brentskardhaugen Bed in Spitsbergen (Birkenmajer and Pugaczewska 1975: 61, pl. 3: 1—6).

Occurrence. — Spitsbergen: Brentskardhaugen Bed at Wimanfjellet and Hyrnefjellet, and probably Ingebrigtsenbukta Member of the Janusfjellet Formation of Treskelen. USSR (Kamushska River), Africa (Tanganyika): Callovian — Upper Kimmeridgian. Canada (Rocky Mts.): Sinemurian — Lotharingian. Afghanistan (Karkar), India, Somalia, Japan, Central Europe: Liassic — Kimmeridgian.

Genus *Meleagrinella* Whitfield, 1885

Meleagrinella cf. *echinata* (Smith, 1817)

(pl. 8: 6—8)

Material. — Four specimens including two internal and two external moulds of both valves from a phosphoritic concretion. ZPAL Mo. XVI/22—25.

Description. — Specimens rounded, inequivalve, equilateral, reaching 20 mm in height and length. Left valve considerably convex, right flattened. Posterodorsal part of left valve extended and distally pointed in the form of a wing, anterodorsal part rounded, devoid of wing. An anterior small auricle and a deep, slit-like notch are visible in the right valve (pl. 8: 7). A ligamental area of the right valve forms

a right angle with the posterior margin. Ornamentation composed of radial and squamous striae of the I and II order. The number of striae increases from 20 to more than 50.

Remarks. — The specimens described are most similar to these of *Meleagrinella echinata* (Smith), a species known worldwide from the Toarcian to Callovian, including Spitsbergen (Birkenmajer and Pugaczewska 1975: 62, pl. 3: 9), but differ from them in more rounded valves, almost twice as large dimensions and a less projecting and submedial umbo.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Pectinidae** Rafinesque, 1815
Genus *Pseudopecten* Bayle, 1878
Subgenus *Pseudopecten* (*Echinopecten*) Brasil, 1895
Pseudopecten (*Echinopecten*) cf. *barbatus* (Sowerby, 1819)
(pl. 7: 13)

Material. — One internal mould of a right valve. ZPAL Mo.XVI/71.

Description. — Mould rounded, equilateral, about 25 mm high and convex except for its umbonal part. Umbo small, pointed, not projecting. Umbonal angle amounting to about 110°. Anterior auricle larger than posterior, separated from the valve by a narrow and long furrow; byssal notch poorly visible. Radial ribs about 28 in number, projecting, narrow, smooth. In the posterior and anterior parts of valve, they are sharp and separated from each other by wide intervals. In the remaining parts of the surface these spaces are narrower than ribs. Ribs start about 5 mm from the umbo. Swollen, rounded traces, probably of spines, occur on some ribs. Concentric folds and furrows are visible on umbonal part. The juvenile stage of growth is separated by a furrow (pl. 7: 13).

Remarks. — The specimen described resembles, in many characters, those of *Pseudopecten* (*E.*) *barbatus* (see: Goldfuss 1836: 48, pl. 90: 12; Dechaseaux 1936: 58; Greppin 1899: 120, pl. 12: 5), but has more ribs, is devoid of spines and its radial ribs are variously developed. *P.* (*E.*) *barbatus* (Sowerby) is known from Western Europe (France, Switzerland and the Federal Republic of Germany), as well as from Great Britain and South America where it occurs from the Hettangian to the Bajocian. A specimen similar to this here described has been cited by Frebold from Spitsbergen as *Pecten* sp. aff. *barbatus*, occurring with the fauna characteristic of the Upper Liassic (Frebold 1929*a*: 264, pl. 3: 6).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Genus *Propeamussium* de Gregorio, 1884
Subgenus *Propeamussium* (*Parvamussium*) Sacco, 1897
Propeamussium (*Parvamussium*) *personatum* (Zieten, 1830)
(pl. 7: 10*a*-*b*)

1830. *Pecten personatus* Zieten: 68, pl. 52: 2.
1973. *Variamussium personatum* (Zieten); Okuneva: 54, pl. 6: 15 (with synonymy).
1975. *Variamussium personatum* (Zieten); Birkenmajer and Pugaczewska: 63, pl. 3: 8 (with synonymy).

Material. — One internal and one external mould of a right valve. ZPAL Mo.XVI/26—27.

Dimensions (in mm):

H	L
40.0	37.0

Description. — Specimens rounded, equivalve, most inflated in subumbonal part. Umbo small, not projecting beyond the hinge margin, incurved. Thirteen internal radial ribs terminate in a small depression at some distance from the ventral margin. Intervals about three times as wide as ribs, usually with two second order ribs present in each interval. The first order ribs start at a certain distance from umbo and those of the second order below the largest convexity of a valve. Auricles triangular in outline. Their rectilinear dorsal margin is 10 mm long. Anterior auricle larger than posterior and with a poorly visible byssal notch (pl. 7: 10b).

Remarks. — The specimen under study, approximately equal in size to that described by Okuneva (1973) differs from it in a larger number of ribs, and from that described by Sibiryakova (1961) in a smaller number of ribs. A 5 mm high specimen previously described by the present writer from Spitsbergen has seven radial ribs and represents a juvenile stage of growth (Birkenmajer and Pugaczewska 1975).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet. North Caucasus and Donets Basin, USSR: Upper Liassic. Turkmenistan, USSR: Bajocian. North and South America, Western Europe and Morocco: Aalenian to Bajocian.

Genus *Camptonectes* Agassiz in Meek, 1864
Subgenus *Camptonectes (Camptonectes)* Agassiz in Meek, 1864
Camptonectes (Camptonectes) cf. *lens* (Sowerby, 1818)
(pl. 10: 3)

Material. — One, ventrally damaged, right valve. ZPAL Mo.XVI/28.

Description. — Valve rounded, more than 100 mm long. Hinge margin straight, ligamental pit shallow. Anterior auricle somewhat larger than posterior, covered with undulating growth lines and bordered dorsally by an undulating margin. Posterior auricle with a straight dorsal margin which forms, with posterior margin an angle of about 125°. Internal surface of valve covered with thick, irregular growth folds and radial striae visible near anterior auricle.

Remarks. — The imperfect specimen above described is most similar to that of *Camptonectes (Camptonectes) lens* (Sowerby) described by Sibiryakova from the Middle Jurassic of the Upper Amur region, USSR (Sibiryakova 1973: 168, pl. 6: 8b). This cosmopolitan species is also known from Western (Great Britain, France, Switzerland, the Federal Republic of Germany) and Central (Poland) Europe, as well as from India, Japan, numerous regions of the USSR, Africa and Australia where it occurs from the Liassic to the Kimmeridgian.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Pachycardiidae** Cox, 1961
Genus *Unionites* Wissmann, 1841
Unionites cf. *canalensis* (Catullo, 1848)
(pl. 9: 5a-c)

Material. — One damaged internal mould of shell with a partially preserved valve. ZPAL Mo.XVI/29.

Dimensions (in mm):

H	L	Th
14.0	21.0	10.0

Description. — Specimen elongated, equivalve, inequilateral, the thickest in the subumbonal part. Posterior margin narrower, more elongated and less convex than anterior. Umbones wide, projecting, prosogyric, situated at one-third of the length of shell from the anterior margin. Behind umbo, dorsal margin is slightly concave. A slightly convex keel runs from the posterodorsal to posterior margin. Growth lines and irregular growth striae occur on the surface of shell (pl. 9: 5*b*). Adductor scars slightly projecting, with concentric growth lines, the anterior one larger (5 by 3.5 mm) and bordered posteriorly by a furrow. This furrow may correspond to a buttress known in some representatives of the *Unionites* (Cox 1969, N 468; pl. 5: 5*c*).

Remarks. — The specimen is similar to those described as *Anodontophora canalensis* by Vozin and Tikhomirova (1964: 36, pl. 15: 5) from the Lower Triassic of the Asian and Caspian areas of the USSR, but differs from them in a smaller keel and more anteriorly situated umbones. *Unionites canalensis*, widely distributed, both stratigraphically and geographically, is known from the Lower Triassic to the Rhaetian (Nakazava 1971: 126—127, pl. 24: 14—15; pl. 25: 1—4).

Occurrence. — Spitsbergen: Wilhelmøya Member (unit B), Wimanfjellet.

Family **Trigoniidae** Lamarck, 1819
Genus *Trigonia* Bruguiere, 1789
Trigonia sp.
(pl. 8: 3—4)

Material. — Six internal moulds of shells and single valves. ZPAL Mo.XVI/ /30—35.

Description. — Internal moulds of shell triangular, almost identical in height and length which equal 25 to 37 mm, medium-convex, especially in the subumbonal part. Prismatic layer thick. Posterior adductor scars large. Concentric striae are visible near the ventral margin. An anterior tooth is visible in the hinge part.

Remarks. — Due to its poor state of preservation, the material studied can be only vaguely determined. Frebold (1929*a*: 265, pl. 3: 9) described from the Brentskardhaugen Bed of Dunérbay, Spitsbergen *Trigonia* sp. indet., similar in dimensions but having a radial ornamentation, not concentric as that of the specimen described. *Trigonia* sp. and *T. V-costata* (Pchelina 1967: 138) has been mentioned from the Brentskardhaugen Bed of southern and eastern areas of Spitsbergen.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Lucinidae** Fleming, 1828
Genus *Luciniola* Skeat and Madsen, 1898
Luciniola cf. *pumila* (Goldfuss, 1840)
(pl. 9: 3)

1975. *Luciniola* cf. *pumila* (Goldfuss, 1840, pl. 5: 2); Birkenmajer and Pugaczewska: 68, pl. 5: 4.

Material. — Two poorly preserved internal moulds. ZPAL Mo.XVI/36—37.

Description. — Internal mould of a rounded shell, almost identical in length and height reaching about 26 mm. Umbo small, prosogyric, submedial. Ornamentation

composed of thin growth lines and swollen growth striae. Striae are closely spaced near umbo, and toward the ventral margin the spaces between them widen gradually.

Remarks. — The specimen is similar to those of *Luciniola pumila* (Goldfuss 1840: 243, pl. 150: 7*a*) from the Liassic of Franconia, FRG and Denmark (Cox 1969: N 498, figs. 3 and 12), from which it differs, however, in larger dimensions.

Occurrence. — Spitsbergen: Brentskardhaugen Bed of S Fonnrygen, Wimanfjellet.

Family **Mactromyidae** Cox, 1929
Genus *Mactromya* Agassiz, 1843
Mactromya sp.
(pl. 9: 4)

Material. — An internal mould of a right valve with a destroyed surface. ZPAL Mo.XVI/70.

Dimensions (in mm):

H	L	Th
26.0	31.0	15.0

Description. — An internal mould of a rounded, considerably thick valve. Umbo wide, obtuse submedially situated and not projecting above the hinge margin. Thin, closely-spaced, concentric striae are visible along the ventral margin. Anterior adductor scar oval, 2 by 4 mm in size. Posterior margin of valve elongated and less convex than anterior.

Remarks. — Of the Liassic species, the specimen here described resembles *Mactromya euterpe* (d'Orbigny) from the Toarcian of France (Thevenin 1908: 195, pl. 14: 11) from which it differs, however, in a less projecting umbo and less square outline.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Permophoridae** v. de Poel, 1959
Genus *Curionia* Ronchetti, 1965
Curionia cf. *oblongata* (Kobayashi et Ichikawa, 1950)
(pl. 12: 1—5)

1950. *Pleurophorus oblongatus* Kobayashi et Ichikawa: 212, pl. 1: 10.
1964. *Palaeophorus oblongatus* (Kob. et Ichikava); Vozin and Tikhomirova: 40, pl. 22: 1—4.

Material. — Five internal moulds of shells in various growth stages. ZPAL Mo.XVI/38—43.

Dimensions (in mm):

H	L	Th
9—22	13—35	5.5—15

Description. — Internal moulds of elongated shells which are trapezoidal in outline and with a higher and rounded posterior, and lower, obliquely truncate anterior margin. Umbones small, subterminal, prosogyric. A keel, with a rounded upper surface, runs from umbo toward the posteroventral margin. Adductor scars unequal,

pallial line simple, composed of small tubercles, slightly depressed halfway its length. Posterior lateral teeth elongated (pl. 12: 4, 5).

Remarks. — In the characters mentioned above the specimens are most similar to *Curionia oblongata* (Kobayashi and Ichikawa, 1950) from the Lower Carnian of Japan and from the Carnian and Norian of the Asian part of the USSR (Vozin and Tikhomirova 1964). From the Japanese specimens they differ, however, in a smaller elongation of the shell and in its larger posterior part.

Occurrence. — Spitsbergen: Wilhelmøya Member (unit B), Wimanfjellet.

Family **Astartidae** d'Orbigny, 1844
Genus *Neocrassina* Fischer, 1886
Subgenus *Neocrassina* (*Coelastarte*) Böhm, 1893
Neocrassina (*Coelastarte*) cf. *depressa* (Sibiryakova, 1960)
(pl. 7: 12*a*-*b*)

Material. — An internal mould of a right valve. ZPAL Mo.XVI/44.

Description. — Specimen subtriangular, about 25 mm in length and height. Anterior and posterior margins rounded, posterodorsal obliquely sloping. Ventral margin widely rounded. As for a representative of the family Astartidae, this internal mould is rather little convex. The largest convexity (9 mm) includes its subumbonal part (pl. 7: 12*a*). Umbo prosogyric, subterminal, slightly overhanging. Lunula relatively wide, shallowed, bordered by margins. Widely and uniformly spaced (spaces amounting to 4 mm), concentric growth striae are visible on the surface of the internal mould (pl. 7: 12*b*).

Remarks. — The specimen is similar to those of *Neocrassina* (*Coelastarte*) *depressa* described from the Upper Bajocian of Western Turkmenistan, USSR (Sibiryakova 1960: 92, pl. 20: 4) which are, however, more than twice as large.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Cardiniidae** Zittel, 1881
Genus *Cardinia* Agassiz, 1841
Cardinia sp.
(pl. 6: 6)

Material. — A fragmentary internal mould of a left valve. ZPAL Mo.XVI/45.

Dimensions (in mm):

H	L	Th
30	23	14

Description. — Dorsal margin wide, somewhat convex and incurved. Anterior margin subrectilinear, obliquely sloping and, in the subumbonal part, slightly concave. Ventral margin widely arcuate. Many (34) concentric, uniformly spaced, striae occur on the surface. On the umbo, they are subhorizontal and on the remaining part of surface slightly arcuate. A slight elongate convexity runs from the anterodorsal margin toward the posteroventral margin.

Remarks. — The features of this specimen mentioned in the description, in particular its incurved dorsal margin, subrectilinear anterior margin, pattern of ornamentation and oblique convexity of the internal mould are characteristic of *Cardinia*

Agassiz, a cosmopolitan genus known from the Carnian to the Toarcian (Bajocian?). The specimen described differs from similar ones of *Cardinia listeri* Agassiz from the lowermost Liassic of Cheltenham, England (Waagen 1907: 130, pl. 38: 10—14) in the rectilinear striae on the umbonal surface of the internal mould.

Occurrence. — Spitsbergen: Wilhelmøya Member (unit F), Wimanfjellet.

Family **Cardiidae** Lamarck, 1809
Genus *Protocardia* von Beyrich, 1845
Subgenus *Protocardia* (*Protocardia*) von Beyrich, 1845
Protocardia (*Protocardia*) *striatula* (Phillips, 1835)
(pl. 6: 5*a*-*c*)

1957. *Protocardia striatula* (Phillips); Frebold: 13, pl. 3: 11—12.
1975. *Protocardia* (*Protocardia*) *striatula* (Phillips, 1835); Birkenmajer and Pugaczewska: 69, pl. 6: 5—8.

Material. — An internal mould of a shell. ZPAL Mo.XVI/46.

Dimensions (in mm):

H	L	Th
16	17	14

Remarks. — The specimen described differs from those cited in the synonymy in its larger dimensions. *Protocardia* (*P.*) *striatula* is a characteristic component of the Upper Liassic faunal assemblage of the southern and eastern regions of Western Spitsbergen (Pchelina 1967:138).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet, Hyrnefjellet. Prince Patrick Island, Canada and Württemberg, FRG: Toarcian.

Family **Tancrediidae** Meek, 1864
Genus *Tancredia* Lycett, 1850
Subgenus *Tancredia* (*Tancredia*) Lycett, 1850
Tancredia (*Tancredia*) cf. *donaciformis* Morris et Lycett, 1854
(pl. 12: 6*a*-*b*)

Material. — Six specimens including shells, internal moulds and one external mould. ZPAL Mo.XVI/47—52.

Dimensions (in mm):

H	L	H/L
26	40	0.65

Description. — Specimens subtrigonal, elongate. Anterior and posterior margins convex, posterior shorter, wider and higher than anterior. Posterodorsal margin oblique, anterodorsal concave. Umbones low, pointed, prosogyric, submedial. A rounded keel runs from the umbo towards posteroventral margin, being separated from posterior margin by a depression. Pallial line simple, with a small sinus near the posterior adductor.

Remarks. — The above described imperfect specimens are similar to specimens of *Tancredia* (*T.*) *donaciformis* Morris et Lycett (1854: 90). They display an identical height index as specimens of this species described from the Middle and Upper Jurassic of Asia (Sibiryakova 1973: 185, pl. 13: 1—33). This cosmopolitan species

is also known from Europe where it is recorded from the Toarcian to the Upper Jurassic.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Arcticidae** Newton, 1891
Genus *Isocyprina* Röder, 1882
Subgenus *Isocyprina* (*Isocyprina*) Röder, 1882
Isocyprina (*Isocyprina*) cf. *depressiuscula* (Morris et Lycett, 1854)
(pl. 9: 1*a*-*b*)

Material. — An internal mould of a right valve. ZPAL Mo.XVI/53.

Dimensions (in mm):

H	L
23	25

Description. — Internal mould subtriangular, most convex in the umbonal part. Anterior and posterior margins oblique, converging near umbo at an almost right angle (pl. 9: 1*a*). Relatively high and short keel runs from umbo toward the postero-ventral margin, disappearing halfway the height of mould. Umbo obtuse, medial, slightly prosogyric. A small concavity is visible in its anterior part (pl. 9: 1*b*).

Remarks. — In regard to the characters presented above, the specimen described resembles to the greatest extent specimens of *Isocyprina depressiuscula* (Morris and Lycett) from the Bathonian of Minchinhampton, Dorset and Somerset, England (Morris and Lycett 1854: 90, pl. 13: 4) and of Garetel-Bellaa, Tripolitania, Libya (Desio and Ronchetti 1960: 183, pl. 17: 8—9). It differs from the latter in almost twice as large dimensions, smaller umbonal angle and smaller concavity in the anterior part of umbo. These differences are within the limits of individual variability.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Ceratomyopsidae** Cox, 1964
Genus *Ceratomyopsis* Cossmann, 1915
Ceratomyopsis sp.
(pl. 7: 8)

Material. — One damaged internal mould of a right valve. ZPAL Mo.XVI/54.

Dimensions (in mm):

H	L	Th
about 30	33	17

Description. — Specimen subtriangular. Umbo swollen, considerably shifted anteriorly, incurved. Anterior margin of mould lobulate, extended, elongated, low and passing into dorsal margin in the form of a wide concavity. Posterior margin high, slightly convex. Numerous, irregularly swollen growth striae occur on the surface. In the anteroventral part, they are arcuate and, on the remaining part of the surface — subhorizontal.

Remarks. — In the characters presented above, this specimen resembles those described as *Isocardia tenera* Sowerby, 1821 from the Middle and Upper Jurassic of Europe (Morris and Lycett 1853: 66, pl. 7: 1; Stoll 1934: 13, pl. 1: 39; Makowski 1952: 12, pl. 5: 7).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Megalodontidae** Morris et Lycett, 1853
Genus *Pachyrisma* Morris et Lycett, 1850
Subgenus *Pachyrisma* (*Pachyrisma*) Morris et Lycett, 1850
Pachyrisma (*Pachyrisma*) sp.
(pl. 8: 5)

Material. — A fragmentary hinge (hinge plate?) from phosphoritic concretions. ZPAL Mo.XVI/55.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Pholadomyidae** Gray, 1847
Genus *Pholadomya* Sowerby, 1823
Subgenus *Pholadomya* (*Pholadomya*) Sowerby, 1823
Pholadomya (*Pholadomya*) cf. *nodosa* Goldfuss, 1840
(pl. 10: 2*a*-*b*)

Material. — An internal mould damaged near the ventral margin. ZPAL Mo.XVI/56.

Dimensions (in mm):

H	L	Th
45	97	47

Description. — Internal mould of a strongly elongated, equivalve and inequilateral shell, most strongly inflated halfway its height. Umbones wide, convex, incurved, occurring about one-third of the length of mould from anterior margin. Anterior margin shorter and lower than posterior. Dorsal margin arcuate, obliquely descending toward anterior and posterior ones, widely depressed on the posterior side of umbo. Ventral margin rectilinear halfway its length. Radial ribs few (9—10), diverging radially from umbo. Growth lines and swollen folds are developed on the posterior surface of mould where they run subangularly.

Remarks. — The characters mentioned above make the specimen described close to that of *Pholadomya* (*Ph.*) *nodosa* Goldfuss (1840: 268, pl. 156: 5*a*-*b*) from the Oolite of Würtemberg, from which it differs in its lunula distinctly bordered by sharp margins and deeper escutcheon having smooth edges. These differences seem to depend on the state of preservation of specimens and may be due to the individual variability.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Pholadomya (*Pholodomya*) cf. *fidicula* (Sowerby, 1812—1823)
(pl. 5: 9*a*-*b*)

Material. — An internal mould of a shell. ZPAL Mo.XVI/57.

Dimensions (in mm):

H	L	Th
44	75	33

Description. — An internal mould of a considerably elongated, equivalve and inequilateral shell which is most strongly swollen in the anterior part. Umbones wide, slightly convex, incurved, occurring at more than a quarter of the length of mould from the anterior margin. Anterior margin short, strongly convex, posterior long,

lobulate, enlarged. Ventral margin widely arcuate. Dorsal margin slightly depressed on the posterior side of umbo and terminally elevated (pl. 5: 9*a*). Surface covered with arcuate, radial ribs increasing in number from eleven on the umbo to about sixteen near the ventral margin. The first three ribs are thicker, more projecting and more widely spaced than the rest of them. Growth striae are better visible in the posterior area of mould. At their intersection with radial ribs growth striae form irregular nodiform swellings, particularly strongly developed on umbones (pl. 5: 9*b*).

Remarks. — The characters presented above make the specimen described close to those of *Pholadomya* (*Ph.*) *fidicula* (Sowerby), described from the Dogger of England, France and the FRG. It differs from a specimen from Württemberg, described by Roemer (1836: 128, pl. 15: 2*a-b*) in longer and more numerous radial ribs, wider and less projecting umbo and dorsal outline of shell which is clavate in the anterior part, while in the specimen from Württemberg it is more regularly oval (Roemer 1836, pl. 15: 2*b*).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Genus *Goniomya* Agassiz, 1841
Subgenus *Goniomya* (*Goniomya*) Agassiz, 1841
Goniomya (*Goniomya*) sp.
(pl. 5: 8)

Material. — A fragmentary subumbonal part of a shell. ZPAL Mo.XVI/58.

Remarks. — Due to a very small fragment of shell, with only three horizontal and five diagonal ribs preserved, forming an angle of about 130°, it is impossible to assign this specimen to any of the numerous species of the *Goniomya* (*G.*) known from the Toarcian to Callovian of Spitsbergen.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Pleuromyidae** Dall, 1900
Genus *Pleuromya* Agassiz, 1842
Pleuromya cf. *unioides* (Goldfuss, 1840)
(pl. 9: 2)

Material. — An internal mould damaged in its anteroventral part. ZPAL Mo.XVI/59.

Dimensions (in mm):

H	L	Th
25	40	16

Description. — An internal mould of an oval, elongate, inequilateral and equivalve shell. Umbo wide, slightly projecting above the hinge margin, occurring at about one-third of the length of specimen from the anterior margin. Ornamentation concentric, composed of growth striae, closely spaced on umbo and less so on the remaining parts of surface. These striae are parallel to the rectilinear ventral margin.

Remarks. — The specimen described is most similar to *Pleuromya unioides* (Goldfuss), a species known from the Upper Liassic of Württemberg, Bavaria and the environs of Hannover, FRG (Goldfuss 1840: 256, pl. 152: 12; Quenstedt 1858: 190, pl. 23: 30), from the Toarcian of Spitsbergen (Pchelina 1967: 138), from the Aale-

nian of the FRG, Switzerland and the Caucasus and Donets Basin, USSR, as well as from the Aalenian to the Lower Bajocian of the Central Pamirs (Andreeva 1977: 151, pl. 27: 1—3).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Pleuromya cf. *liasina* (Zieten, 1830)

(pl. 6: 3; pl. 7; 9*a*-*b*)

Material. — Two internal moulds of shell in various stages of growth. ZPAL Mo.XVI/60—60a.

Dimensions (in mm):

H	L	Th
11; 16	17; 21	about 10; 14

Description. — Internal moulds subquadrate in outline, rather weakly convex, most so in the umbonal part. Umbo wide, rounded, submedial, more or less projecting above the hinge margin (pl. 6: 3). Anterior and posterior margins high, truncate. Ornamentation composed of growth lines and striae forming a subquadrate pattern. Ventral margin subrectilinear.

Remarks. — The specimens described are most similar to those of *Pleuromya liasina* (Zieten) from the Lower Jurassic of FRG (Zieten 1830: 81, pl. 61: 2) and those known from the Aalenian to Lower Bajocian of the Pamirs, USSR (Andreeva 1977: 150, pl. 25: 4; pl. 26: 1—4), but are considerably smaller. The specimens described differ from that cited from the Upper Liassic of south-western Spitsbergen in a less projecting umbo (Frebold 1929*a*: 265, pl. 3: 5).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Pleuromya cf. *jurassi* (Goldfuss, 1836)

(pl. 6: 4)

1975. *Pleuromya* cf. *jurassi* (Goldfuss, 1836); Birkenmajer and Pugaczewska: 78, pl. 7: 8—9 (with synonymy).

Material. — Three internal moulds of shells. ZPAL Mo.XVI/61—63.

Remarks. — The specimens described are identical with those mentioned in the synonymy from the Brentskardhaugen Bed, Spitsbergen. A well preserved pallial line, with a deep siphonal sinus, are visible in the specimen described in the present paper (pl. 6:4).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Class, Order and Family uncertain

Genus *Plicatostylus* Lupher and Packard, 1930

Plicatostylus sp.

(pl. 5: 6*a*, *b*, 7)

Material. — A fragmentary outer part of shell and some aggregates of prisms from the internal layer of a shell. ZPAL Mo.XVI/64—67.

Remarks. — The specimens illustrated resemble to the greatest extent part of the shell of a representative of a colonial bivalve *Plicatostylus* Lupher and Packard, 1930. A representative of this genus, *P. gregarius*, has so far been known from the Pliensbachian of the State of Oregon, USA and Peru (Cox 1969: 866).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Genus *Stalagmina* Denckmann, 1887
Stalagmina sp.
(pl. 5: 1—2)

Material. — Several shells and internal moulds. ZPAL Mo.XVI/68—69.
Dimensions (in mm):

H	L	Th
about 3	about 2	about 2

Description. — Shells obliquely oval in outline, inequilateral, equivalve, very small. Umbo prosogyric, scarcely protruding. The largest convexity runs obliquely from umbo towards the posteroventral margin. Thin growth lines are visible on the surface.

Remarks. — The characters presented above correspond to the greatest extent to those of *Stalagmina koeneni* Denckmann (Cox 1969: 867, figs. H2, 3*a*-*b*) recorded from the Toarcian of Goslar, FRG. The specimens of this species are very small and reach merely 8 mm in height. They have a taxodont hinge composed of three identical short teeth and one long lateral tooth.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

ANNELIDS

Family **Serpulidae** Burmeister, 1837

Genus *Serpula* Linnaeus, 1758
Subgenus *Serpula* (*Cycloserpula*) Parsch, 1956
Serpula (*Cycloserpula*) cf. *subcrispa* Parsch, 1956
(pl. 5: 4)

1982. *Serpula* (*Cycloserpula*) cf. *subcrispa* Parsch; Pugaczewska: pl. 38:7.

Material. — A fragmentary tube. ZPAL A.IV/1.

Remarks. — In a round transverse section of its tube, about 2.5 mm in diameter and numerous concentric striae (ten per 1 mm), the specimen described resembles *Serpula* (*Cycloserpula*) cf. *subcrispa* Parsch recorded (Pugaczewska 1982) from the Upper Jurassic of Spitsbergen. It differs from it in having half its diameter.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet and Upper Jurassic at Myklegardfjellet.

Serpula (*Cycloserpula*) sp.
(pl. 5:3)

Material. — A fragmentary tube. ZPAL A.IV/2.

Remarks. — A round transverse section of tube (0.7 mm in diameter), slightly arcuate shape and smooth outer surface are characteristic features of *Serpula* (*Cycloserpula*) known from the Liassic to the Malm. The lack of ornamentation on the surface of this specimen precludes specific determination.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

GASTROPODS

Family **Eumophalidae** de Koninck, 1881
Genus *Discohelix* Dunker, 1848
Discohelix (*Discohelix*) cf. *sinistra* (d'Orbigny, 1850)
(pl. 8:9)

Material. — Numerous internal and external moulds of shells embedded in rock. ZPAL Ga.II/1—2.

Description. — Shell discoidal, with a flat upper and convex lower surface, sinistral. The diameter of a shell with four whorls amounts to about 6 mm and the height of the last whorl reaches about 2 mm. Whorl slightly convex, umbilicus relatively wide. Transverse section of whorls and aperture subquadrate in outline. Surface of whorls ornamented by many opistocyrtic striae. Whorls bordered by a fine-nodular upper surface.

Remarks. — The specimen described is most similar to *Discohelix sinistra* (d'Orbigny) from the Liassic of France (Thevenin 1908: 37, pl. 11: 6—7; Vostokova 1960: 79, 82, pl. 7: 5), from which it differs, however, in being almost four times smaller, having half the number of whorls and small tubercles on keels. It may represent a juvenile growth stage.

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

Family **Acteonidae** d'Orbigny, 1845
Genus *Acteonina* d'Orbigny, 1850
Acteonina cf. *peroskiana* d'Orbigny, 1845
(pl. 7: 4*a*-*b*)

Material. — Three internal moulds of shells. ZPAL Ga.II/3—5.

Description. — Globular specimens with a low coil and high last whorl (more than 3.5 mm in height). The largest transverse diameter of shell, occurring halfway the last whorl, amounts to about 2.5 mm. The height of the last whorl is almost eight times as large as that of the remaining whorl. Shell oval in transverse section in which three whorls of earlier growth stages are visible (pl. 7: 4*b*). Ornamentation composed of transverse striae, better visible in the lower part of the last whorl. Sutures between whorls are somewhat oblique. Aperture elongate, narrowing upwards, rounded in the lower half and about 1.2 mm in transverse diameter (pl. 7: 4*a*).

Remarks. — In its dimensions, shape and ornamentation, the specimen described resembles *Acteonina peroskiana* d'Orbigny, 1845 from the European regions of the central part of the USSR and from Greenland, a species known from the Middle Callovian to Upper Volgian (Gerasimov 1955: 197, pl. 41: 1—2).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

CRINOIDS

Family **Pentacrinidae** d'Orbigny, 1851
Genus *Pentacrinites* (d'Orbigny, 1852)
Pentacrinites cf. *basaltiformis* Miller, 1821
(pl. 7: 1—3)

Material. — Numerous fragments of stems and isolated columnals. ZPAL CA.II/1—3.

Description. — Stems pentagonal in transverse section, 1—1.5 mm in diameter. The height of the columnals amounts from 0.5 to 0.7 mm. Lateral walls of stems flat or concave, converging at an angle of about 110° (pl. 7: 3). Edges of particular columnals more or less sharp (pl. 7: 1—2). A round opening of axial canal is visible (pl. 7: 1). Areola pentastellate crenularium triangular in outline. Crenulate suture of each side of columnals composed of 4—7 culmina and crenellae.

Remarks. — The specimens are similar to *Pentacrinites basaltiformis* Miller from the Delta Liassic of Hechingen, FRG (Quenstedt 1858: 158, 195, pl. 19: 43; pl. 24: 20—31). This species has been cited from the "Kattslösa Stage" Beds of southern Sweden, corresponding to the Beta and Gamma Liassic (Troedsson 1951: 143, pl. 15: 1—10), and from the Hettangian of the environs of Jamoigue, Belgium (Joly 1907: 140) and from the Oxford Clay of Bavaria and Württemberg, FRG (Goldfuss 1826: 172, pl. 52:5).

Occurrence. — Spitsbergen: Brentskardhaugen Bed, Wimanfjellet.

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ANDRZEJ WIERZBOWSKI, CYPRIAN KULICKI i HALINA PUGACZEWSKA

FAUNA NAJWYŻSZEGO TRIASU ORAZ TOARKU I AALENU Z SASSENFJORDEN (SPITSBERGEN) I JEJ ZNACZENIE STRATYGRAFICZNE

Streszczenie

W lecie 1979 roku prowadzone były przez dwóch autorów niniejszego artykułu (C. Kulicki, A. Wierzbowski) badania terenowe w centralnej części Spitsbergenu, w rejonie Sassenfjorden, pomiędzy Janusfjellet i Botneheia (fig. 1). Badania te stanowiły część programu grupy paleontologicznej kierowanej przez prof. Gertrudę Biernat z Zakładu Paleobiologii Polskiej Akademii Nauk, działającej w ramach Polskiej Wyprawy PAN na Spitsbergen, organizowanej i finansowanej przez Instytut Geofizyki PAN.

Badaniami objęto osady najwyższego triasu reprezentujące górną część formacji z De Geerdalen zwłaszcza ogniwo z Wilhelmøya oraz najniższą część formacji z Janusfjellet zwłaszcza warstwę z Brentskardhaugen. Przy opisie pięciu zbadanych profilów (fig. 2, 3) wydzielono ponadto drobne nieformalne jednostki oznaczone literami alfabetu, w zbliżony sposób jak przeprowadzili to uprzednio w części badanego obszaru Bjaerke i Dypvik (1977).

Jednostki A—F odpowiadające górnej części formacji z De Geerdalen należą do najwyższego triasu o czym świadczy fauna małżów (tabela 1), w jednostce C znaleziono ponadto otwornicę *Schmidita hedbergelloides* Fuchs charakterystyczną dla

najwyższego noryku i retyku. W jednostce G (warstwa z Brentskardhaugen), w fosforytach, występuje liczna fauna m.in. małże i amonity (tab. 1; fig. 4). Wśród amonitów oznaczonych z tej warstwy wymienić należy: *Porpoceras polare* (Frebold), *Mucrodactylites* aff. *mucronatus* (d'Orbigny), *Harpoceras kopiki* sp.n., *Pseudolioceras compactile* (Simpson), *P. rosenkrantzi* Dagis, *P.* cf. *alienum* Dagis, *Leioceras opalinum* (Reinecke), *L.* ex gr. *costosum* (Quenstedt). Wymienione amonity są charakterystyczne dla poziomów *polare* i *rosenkrantzi* wydzielanych w wyższym toarku Arktyki (przy czym poziomy te mogą być korelowane z poziomami amonitowymi wyższej części środkowego oraz górnego toarku w północno-zachodniej Europie; por. tabelę 2), oraz dla najniższego aalenu. Inne skamieniałości (zwłaszcza małże) zebrane z warstwy z Brentskardhaugen mają z reguły szerszy zasięg stratygraficzny i mogą być uznane jako charakterystyczne dla wyższej jury dolnej oraz niższej jury środkowej.

Warstwa z Brentskardhaugen wykazuje objawy silnej kondensacji stratygraficznej i reprezentuje znaczny przedział czasu od najniższego środkowego toarku do najniższego aalenu. Przykrywająca omawianą warstwę jednostka H należy już do wyższego batonu lub najniższego keloweju o czym świadczy pojawienie się w jej obrębie, lub bezpośrednio powyżej, amonitów z rodzaju *Kepplerites*. W stropie warstwy z Brentskardhaugen istnieje znaczna luka stratygraficzna obejmująca prawie cały aalen, bajos i przynajmniej część batonu. Luka ta wytworzyła się najprawdopodobniej w warunkach podmorskich.

EXPLANATION OF THE PLATES 1—12

Plate 1

1. *Mucrodactylites* aff. *mucronatus* (d'Orbigny): ZPAL AM.IV/3.3; Knerten, lateral view of fully grown specimen.
2. *Porpoceras* sp.: ZPAL AM.IV/1.2; Wimanfjellet, lateral view of inner whorls.
3. *Mucrodactylites* sp.: ZPAL Am.IV/2.23; Wimanfjellet, lateral view.
4. Dactylioceratidae: ZPAL Am.IV/2.22; Wimanfjellet, lateral view.
5, 6. *Porpoceras polare* (Frebold): ZPAL Am.IV/3.5; 3.6; Knerten, 5*a* ventral view, 5*b* lateral view, 6*a* lateral view of whole specimen, 6*b* lateral view of inner whorls, 6*c* ventral view of inner whorls.

All figures of natural size

Plate 2

1. *Harpoceras kopiki* sp.n.: ZPAL Am.IV/3.4; Knerten, *a* lateral view, *b* ventral view.
2, 3, 4, 5. *Pseudolioceras compactile* (Simpson); *2* ZPAL Am.IV/2.10; Wimanfjellet,

lateral view of cast, *3* ZPAL Am.IV/2.2; Wimanfjellet, lateral view of cast., *4* ZPAL Am.IV/3.2; Knerten, lateral view of the phragmocone, *5* ZPAL Am.IV/1.1; Wimanfjellet, lateral view of cast.

6. *Pseudolioceras rosenkrantzi* Dagis: ZPAL Am.IV/3.1; Knerten, lateral view of the phragmocone.

All figures of natural size

Plate 3

1, 2. *Pseudolioceras rosenkrantzi* Dagis: *1* ZPAL Am.IV/2.1; Wimanfjellet, *a* lateral view, *b* ventral view, *2* ZPAL Am.IV/2.11; Wimanfjellet.

3, 4, 5. *Leioceras opalinum* (Reinecke): *3* ZPAL Am.IV/2.18; Wimanfjellet, lateral view of cast, *4* ZPAL Am.IV/2.17; Wimanfjellet, lateral view of cast, *5* ZPAL Am.IV/1.3; Wimanfjellet, *a* lateral view, *b* cros-section.

6, 7. *Pseudolioceras* cf. *alienum* Dagis: *6* ZPAL Am.IV/2.9; north of Wimanfjellet, lateral view of specimen with destroyed ventral side, *7* ZPAL Am.IV/2.26; Wimanfjellet, lateral view of cast.

Plate 4

1, 2. *Leioceras* ex gr. *costosum* Quenstedt: *1* ZPAL Am.IV/2.30; Wimanfjellet, lateral view of the phragmocone, *2* ZPAL Am.IV/2.21; Wimanfjellet, *a* lateral view, *b* lateral view of opposite side.

3, 4. *Leioceras opalinum* (Reinecke): *3* ZPAL Am.IV/2.5; Wimanfjellet, *a* lateral view of specimen with preserved initial part of living chamber, *b* opposite side, *c* ventral side, *4* ZPAL Am.IV/2.16; Wimanfjellet, lateral view of specimen with broken apertural part.

All figures of natural size

Plate 5

1. *Stalagmina* sp. ZPAL Mo.XVI/68, left valve with small, protruding umbo, x 10. Brentskardhaugen Bed.
2. *Stalagmina* sp. ZPAL Mo.XVI/69, left valve with large, not protruding umbo, x 10. Brentskardhaugen Bed.
3. *Serpula* (*Cycloserpula*) sp. ZPAL A.IV/2, fragment of tube with smooth external surface, x 10. Brentskardhaugen Bed.
4. *Serpula* (*Cycloserpula*) cf. *subcrispa* Parsch ZPAL A.IV/1, fragment of tube with concentric striated external surface, x 10. Brentskardhaugen Bed.
5. *Nuculana* (*Nuculana*) cf. *elliptica* (Goldfuss) ZPAL Mo.XVI/2: *a* side view, × 2; *b* dorsal view, × 10. Wilhelmøya Formation.
6. *Plicatostylus* sp. ZPAL Mo.XVI/64; *a* fragment of left valve, external view, × 2; *b* prisms of external layer of valve, perpendicular to surface, × 10. Brentskardhaugen Bed.
7. *Plicatostylus* sp. ZPAL Mo.XVI/65, prisms of internal layer of valve, parallel to surface, × 10. Brentskardhaugen Bed.
8. *Goniomya* sp. ZPAL Mo.XVI/58, diagonal and horizontal ribs on surface of a fragment of valve, × 10. Brentskardhaugen Bed.
9. *Pholadomya* (*Pholadomya*) cf. *fidicula* (Sowerby) ZPAL Mo.XVI/57, shell: *a* side view, *b* dorsal view, nat. size. Brentskardhaugen Bed.

Plate 6

1. Siderite pebble ZPAL Mo.XVI/72 with moulds of *Unionites* Wissmann and *Curionia* Ronchetti, × 2. Wilhelmøya Formation.
2. *Modiolus* (*Modiolus*) sp. ZPAL Mo.XVI/4, distal fragment of shell, × 3. Brentskardhaugen Bed.
3. *Pleuromya* cf. *liasina* (Zieten), subquadrate specimen ZPAL Mo.XVI/60a, × 2. Brentskardhaugen Bed.
4. *Pleuromya* cf. *jurassi* (Goldfuss), ZPAL Mo.XVI/61, deep pallial sinus is visible, nat. size. Brentskardhaugen Bed.
5. *Protocardia* (*Protocardia*) *striatula* (Phillips), mould of shell ZPAL Mo.XVI/46: *a* side view, *b* dorsal view, *c* left valve; arrow indicates imprints of radial ribs in form of small pits; × 3. Brentskardhaugen Bed.
6. *Cardinia* sp., mould with concentric ornamentation ZPAL Mo.XVI/45; concentric striae on umbo almost horizontal, × 2. Brentskardhaugen Bed.

Plate 7

1. *Pentacrinites* cf. *basaltiformis* Miller, crinoid columnal ZPAL Ca.II/1, × 20.
2. *Pentacrinites* cf. *basaltiformis* Miller, crinoid columnal ZPAL Ca.II/2, × 20.
3. *Pentacrinites* cf. *basaltiformis* Miller, fragment of crinoid stem ZPAL Ca.II/3 in side view, × 20.
4. *Acteonina* cf. *peroskiana* d'Orbigny, mould of shell ZPAL Ga.II/3: *a* side view, *b* dorsal view, × 6.
5. *Oxytoma* (*Oxytoma*) *inequivalvis* (Sowerby), mould of shell ZPAL Mo.XVI/19: *a* right valve, *b* left valve, × 6.
6. *Oxytoma* (*Oxytoma*) *inequivalvis* (Sowerby), right valve ZPAL Mo.XVI/20, long and straight dorsal margin visible, × 6.
7. *Oxytoma* (*Oxytoma*) *inequivalvis* (Sowerby), imprint of left valve ZPAL Mo.XVI/21, radial ornamentation well preserved, × 6.
8. *Ceratomyopsis* sp. mould of right valve ZPAL Mo.XVI/54, × 1.
9. *Pleuromya* cf. *liasina* (Zieten), mould ZPAL Mo.XVI/60: *a* viewed from umbo, *b* side view, × 2.
10. *Propeamussium* (*Parvamussium*) *personatum* (Zieten), mould of right valve ZPAL Mo.XVI/26, internal surface with narrow, radial ribs and its negative, ZPAL Mo.XVI/27, with narrow, radial furrows passing ventrally into small pits, × 1.
11. *Pseudomytiloides* cf. *dubius* (Sowerby), mould ZPAL Mo.XVI/5, well preserved concentric folds visible, × 3.
12. *Neocrassina* (*Coelastarte*) cf. *depressa* (Sibiriakova), mould of right valve ZPAL Mo.XVI/44: *a* side view, *b* external view, irregularly spaced folds visible, × 2.
13. *Pseudopecten* (*Echinopecten*) cf. *barbatus* (Sowerby), mould of right valve ZPAL Mo.XVI/71, × 2.

Brentskardhaugen Bed

Plate 8

1. *Palaeonucula* sp. mould of shell ZPAL Mo.XVI/1: *a* dorsal view, *b* side view, × 2.
2. *Palaeonucula* sp. fragment of shell ZPAL Mo.XVI/1a: *a* large adductor scar, *b* pallial line (to the right) and concentric surface ornamentation, negatives (to the left) visible, × 2.

3. *Trigonia* sp. mould of shell ZPAL Mo.XVI/30, viewed from umbones, × 2.
4. *Trigonia* sp. mould of shell ZPAL Mo.XVI/31, imprint of anterior tooth of right valve visible, × 2.
5. *Pachyrisma* sp. fragment of hinge plate ZPAL No.XVI/55, × 2.
6. *Meleagrinella cf. echinata* (Smith), left valve ZPAL Mo.XVI/24, × 2.
7. The same species ZPAL Mo.XVI/22, below: imprint of left valve, with small posterior wing; above: hinge part of right valve with small anterior auricle and narrow, deep subauricular notch, × 1.5.
8. The same specimen: plasticine cast.
9. *Discohelix* (*Discohelix*) cf. *sinistra* (d'Orbigny), plasticine cast of shell ZPAL Ga.II/1, angular outline of whorls, large umbilicus and oblique pattern of ornamentation visible, × 10.

Brentskardhaugen Bed

Plate 9

1. *Isocyprina* (*Isocyprina*) cf. *depressiuscula* (Morris and Lycett), mould of right valve ZPAL Mo.XVI/53: *a* external view, *b* dorsal view; short, relatively high keel visible, nat. size. Brentskardhaugen Bed.
2. *Pleuromya* cf. *unioides* (Goldfuss), mould of shell ZPAL Mo.XVI/59, nat. size. Brentskardhaugen Bed.
3. *Luciniola* cf. *pumila* (Goldfuss), mould of shell ZPAL Mo.XVI/36, nat. size.
4. *Mactromya* sp., mould ZPAL Mo.XVI/70, × 2. Brentskardhaugen Bed.
5. *Unionites* cf. *canalensis* (Catullo), mould of shell ZPAL Mo.XVI/29: *a* left valve, *b* right valve, *c* dorsal side; × 2. Wilhelmøya Formation.
6. *Eumorphotis bjona* Lundgren, imprint of left valve ZPAL Mo.XVI/5, × 2. Wilhelmøya Formation.
7. Same specimen, mould of left valve ZPAL Mo.XVI/7, × 5. Wilhelmøya Formation.
8. Same specimen, mould of right valve ZPAL Mo.XVI/10, thickened, tuberculated and slightly undulated ribs visible, × 4. Wilhelmøya Formation.
9. Same specimen, imprint of left valve ZPAL Mo.XVI/8, radial, locally paired ribs visible, × 5. Wilhelmøya Formation.

Plate 10

1. *Modiolus* (*Modiolus*) sp. mould of shell ZPAL Mo.XVI/3: *a* side view (left valve), *b* dorsal view, × 1.5, *c* medio-dorsal fragment of valve, thin radial treads visible, × 4.
2. *Pholadomya* (*Pholadomya*) cf. *nodosa* Goldfuss, mould of shell ZPAL Mo.XVI/56: *a* left valve, *b* dorsal side; broad lunule, bordered with sharp edges and moderately deep escutcheon visible × 1.
3. *Camptonectes* (*Camptonectes*) cf. *lens* (Sowerby), internal surface of right valve ZPAL Mo.XVI/28: concentric external folds, lateral auricles above are visible, × 2.

Brentskardhaugen Bed

Plate 11

Halobia zitteli Lindström, Wilhelmøya Formation

1. Left valve of adult specimen ZPAL Mo.XVI/13, ornamentation most differentiated, × 3.

2. Left valve of young individual ZPAL Mo.XVI/14, ornamentation slightly differentiated, hinge margin straight, long, anterior auricle low, × 5.
3. Siderite pebble ZPAL Mo.XVI/15, with shells of young individuals, × 5.
4. Shell of young individual ZPAL Mo.XVI/16, ornamentation slightly differentiated, auricle undulated, × 5.
5. Siderite pebble ZPAL Mo.XVI/17, moulds of shells on different growth stages, × 3.
6. Mould of gerontic shell ZPAL Mo.XVI/18, ornamentation differentiated, radial ridges undulated, auricle high, × 3.

Plate 12

Curionia cf. *oblongata* (Kobayashi and Ichikawa), Wilhelmøya Formation

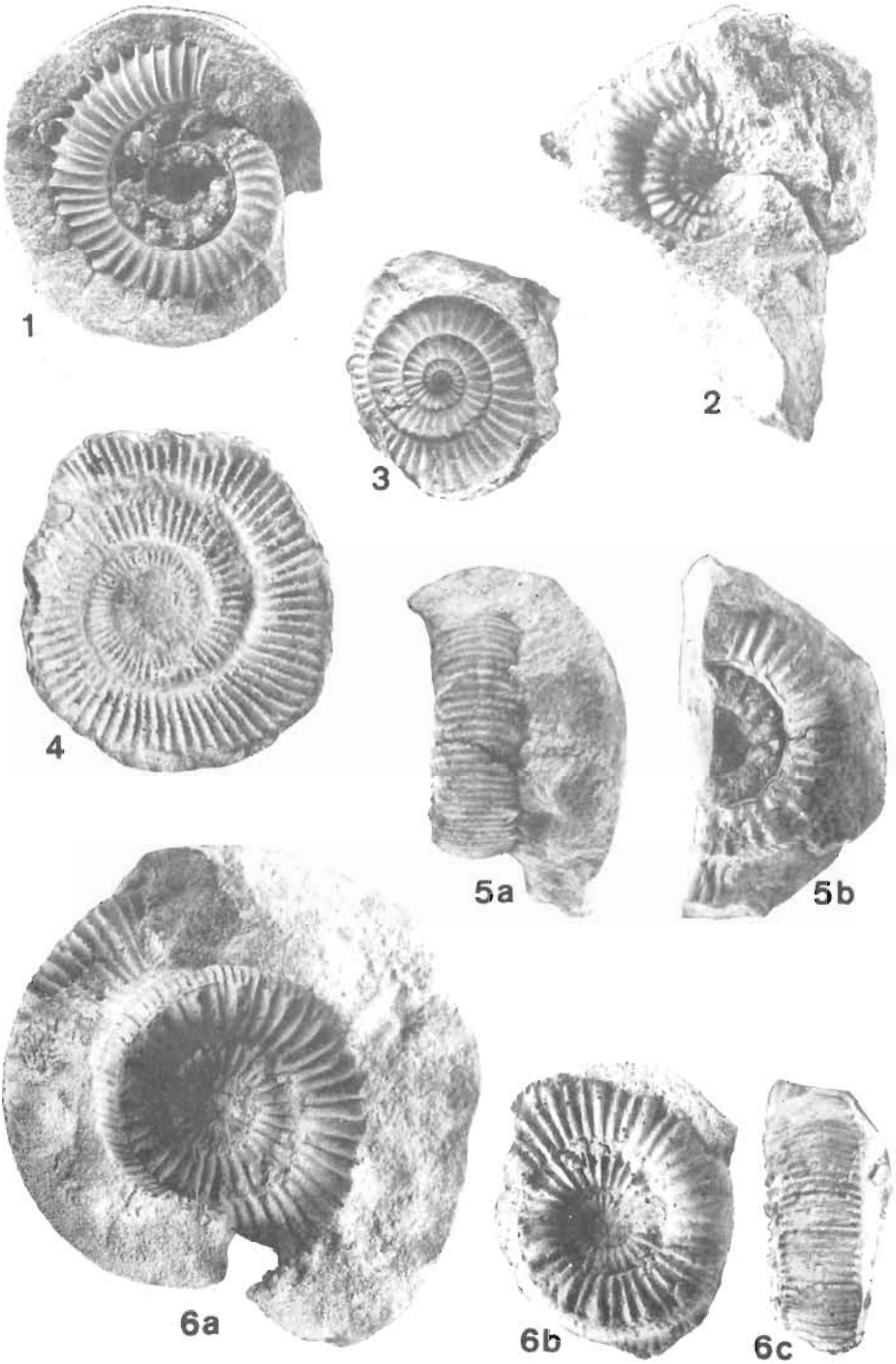
1. Mould of shell ZPAL Mo.XVI/38, anterior view, × 2.
2. Mould of shell ZPAL Mo.XVI/40, left valve; ventral sinus shallow, × 5.
4. Internal surface of left valve ZPAL Mo.XVI/41 with partly preserved hinge, × 2.
5. Mould of shell ZPAL Mo.XVI/42 with small, inflated umbo and hinge area; deep ligament groove and long, lateral teeth visible, × 6.

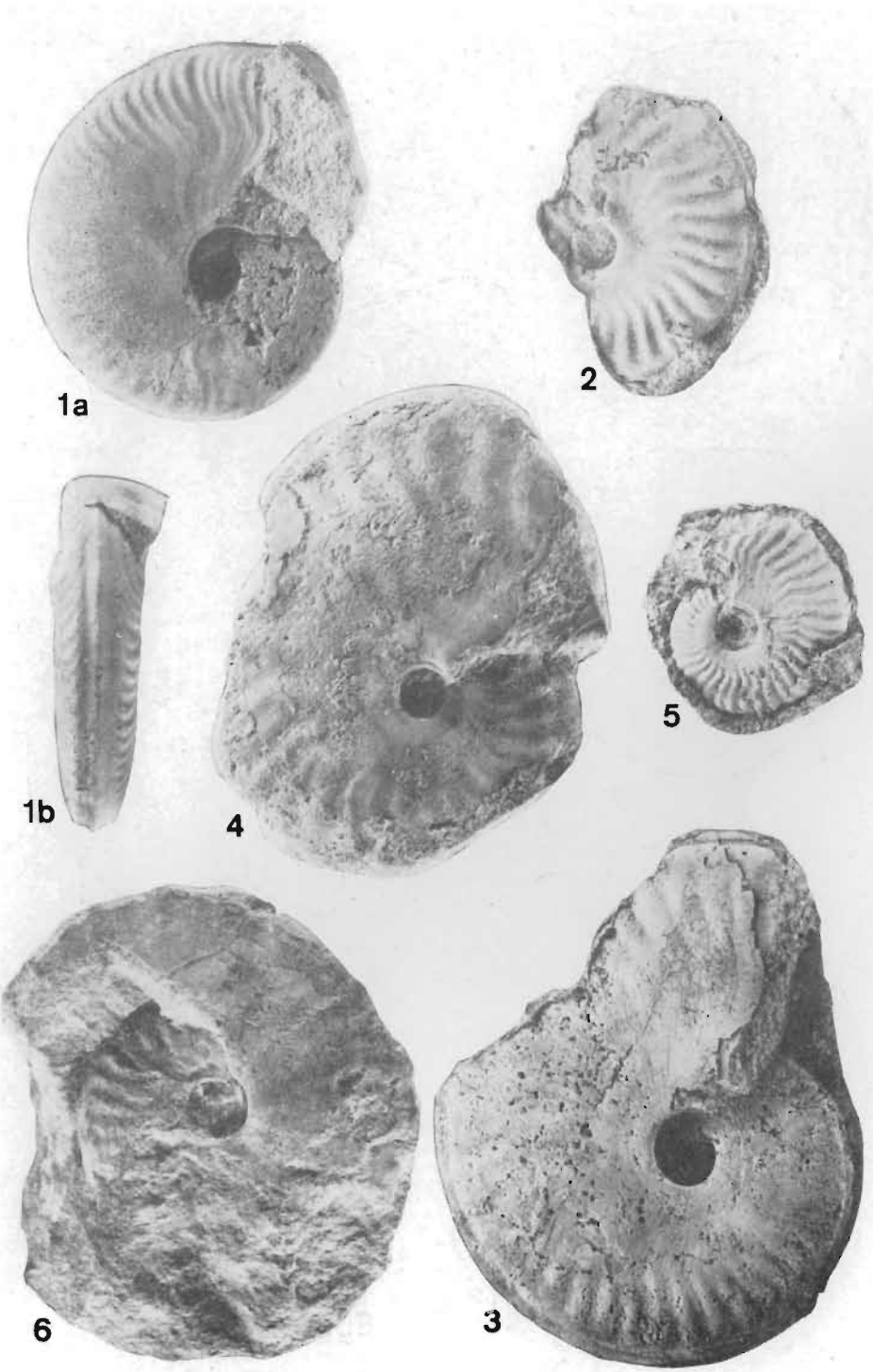
Tancredia (*Tancredia*) cf. *donaciformis* Morris et Lycett, Brentskardhaugen Bed

6. Mould of shell ZPAL Mo.XVI/47: a dorsal view, b posterior side of left valve visible, × 1.

Halobia zitteli Lindström, Wilhelmøya Formation

7. Mould of left valve of a young individual ZPAL Mo.XVI/11, concentric folds on posterior part well developed, × 5.
8. Mould of shell of a young individual ZPAL Mo.XVI/12: symmetric, ovate valves with uniformly inflated folds visible, × 5.


1
2
3
4
5a
5b
6a
6b
6c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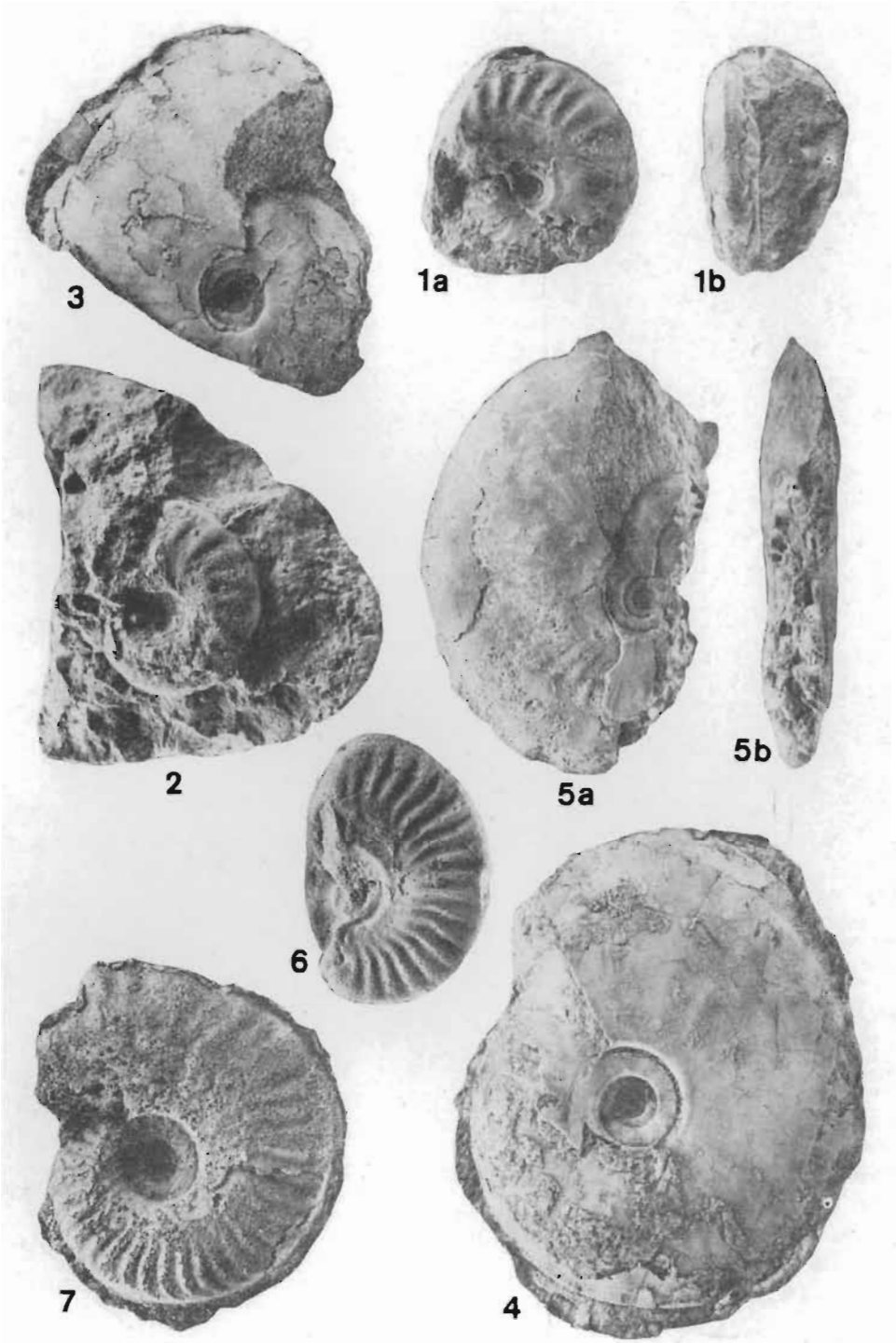
2
1b
4
5
6
3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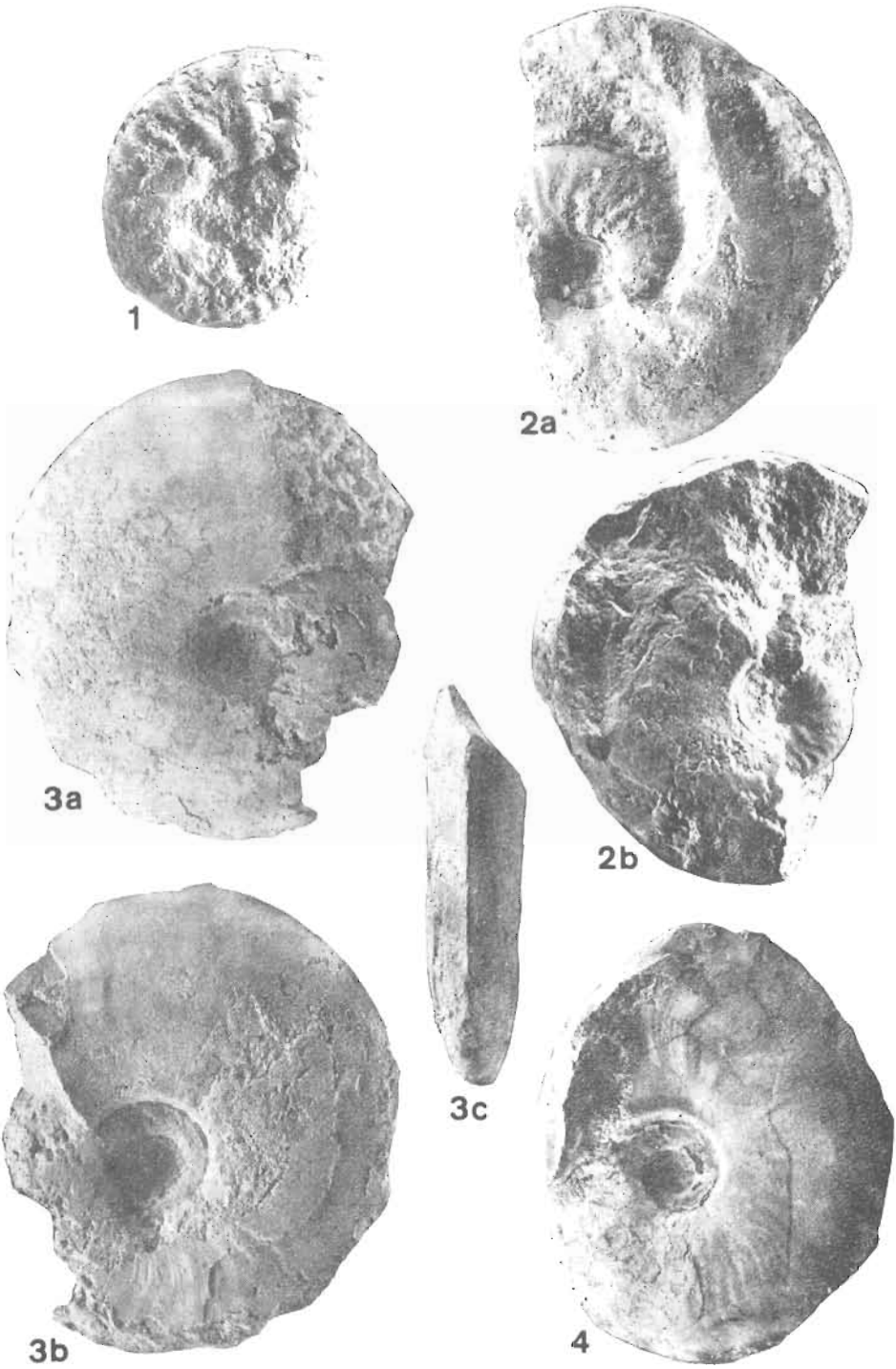
1a
1b
2
5a
5b
6
7
4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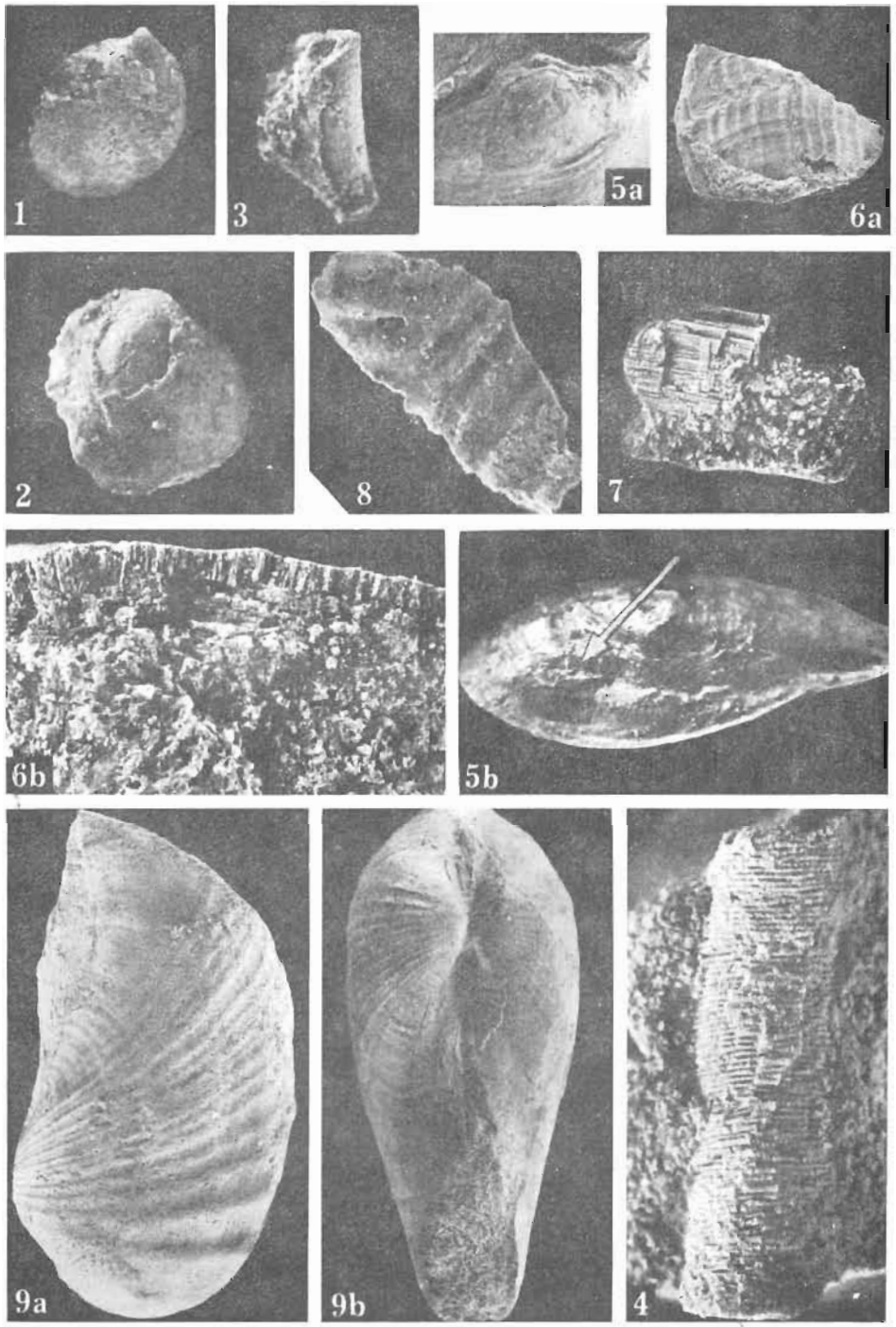
2a
3a
2b
3c
3b
4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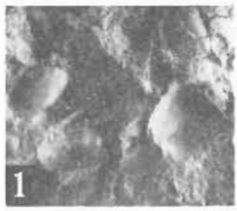
3
5a
6a
2
8
7
6b
5b
9a
9b
4


2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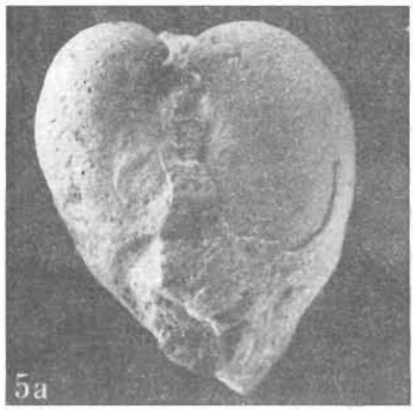
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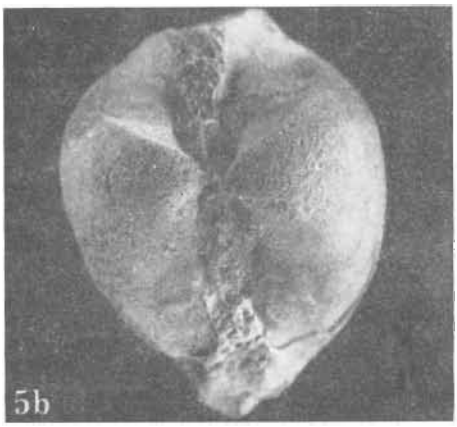
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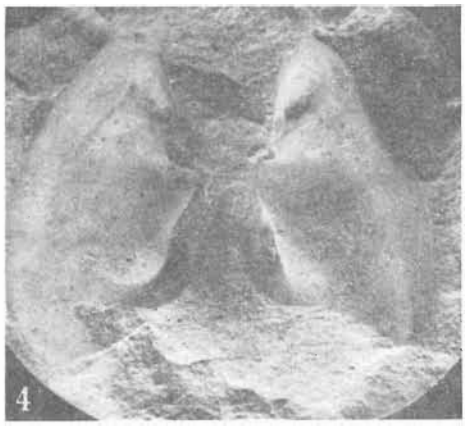
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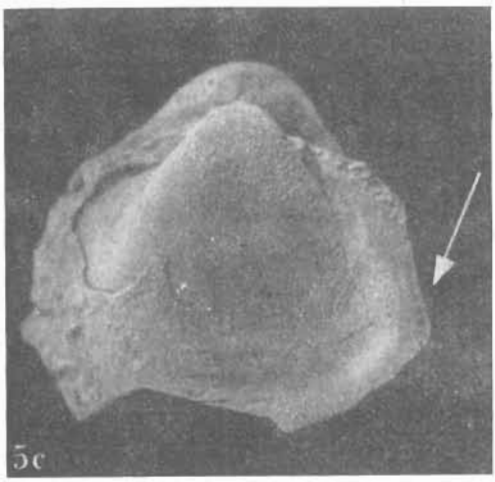
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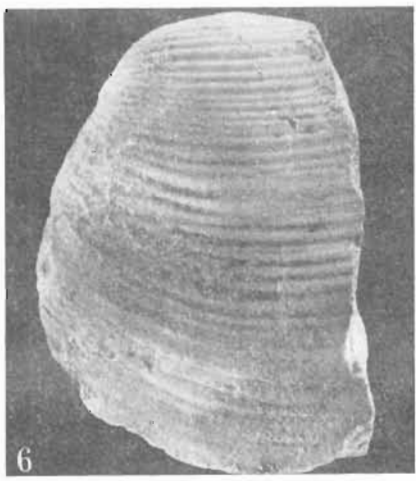
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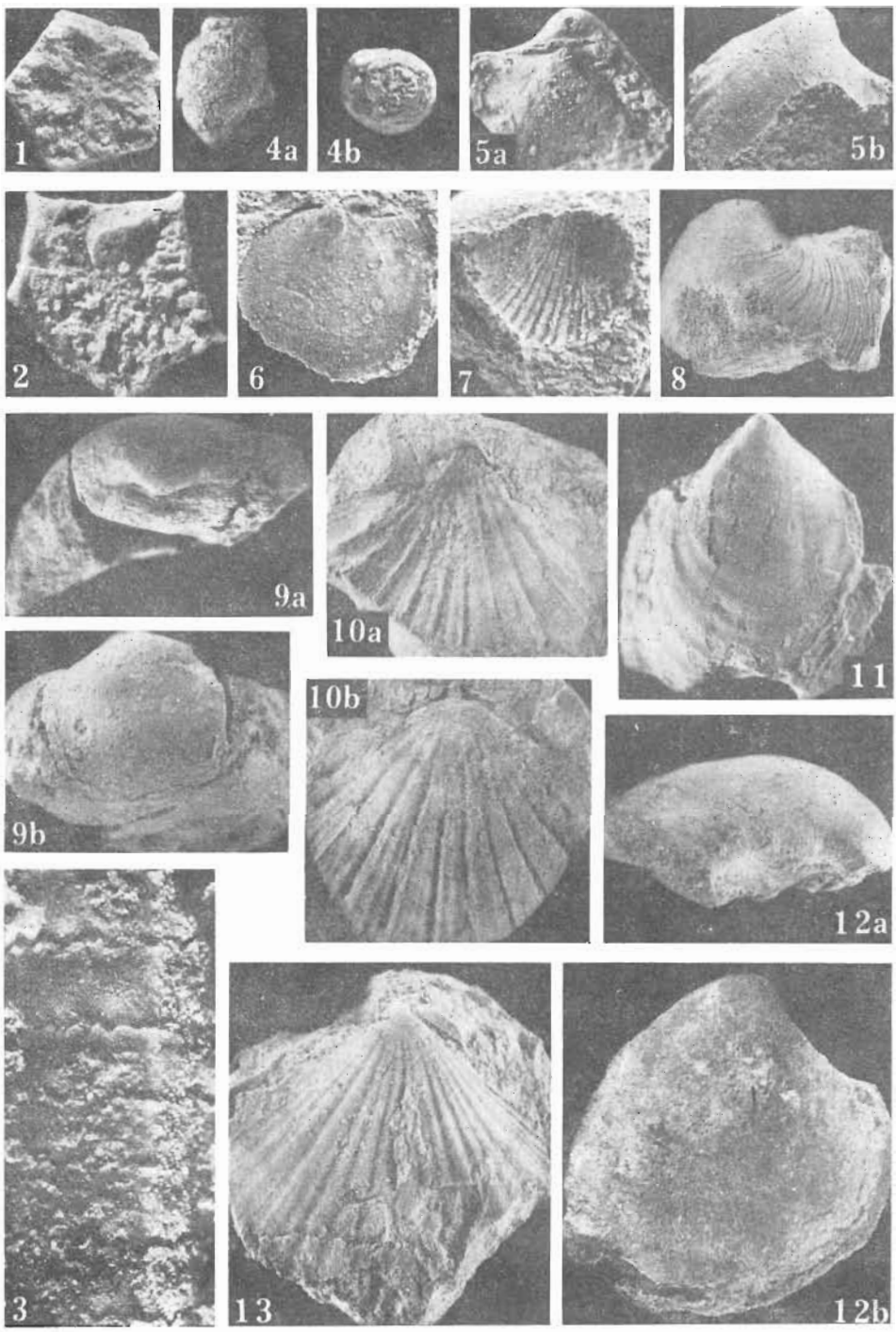
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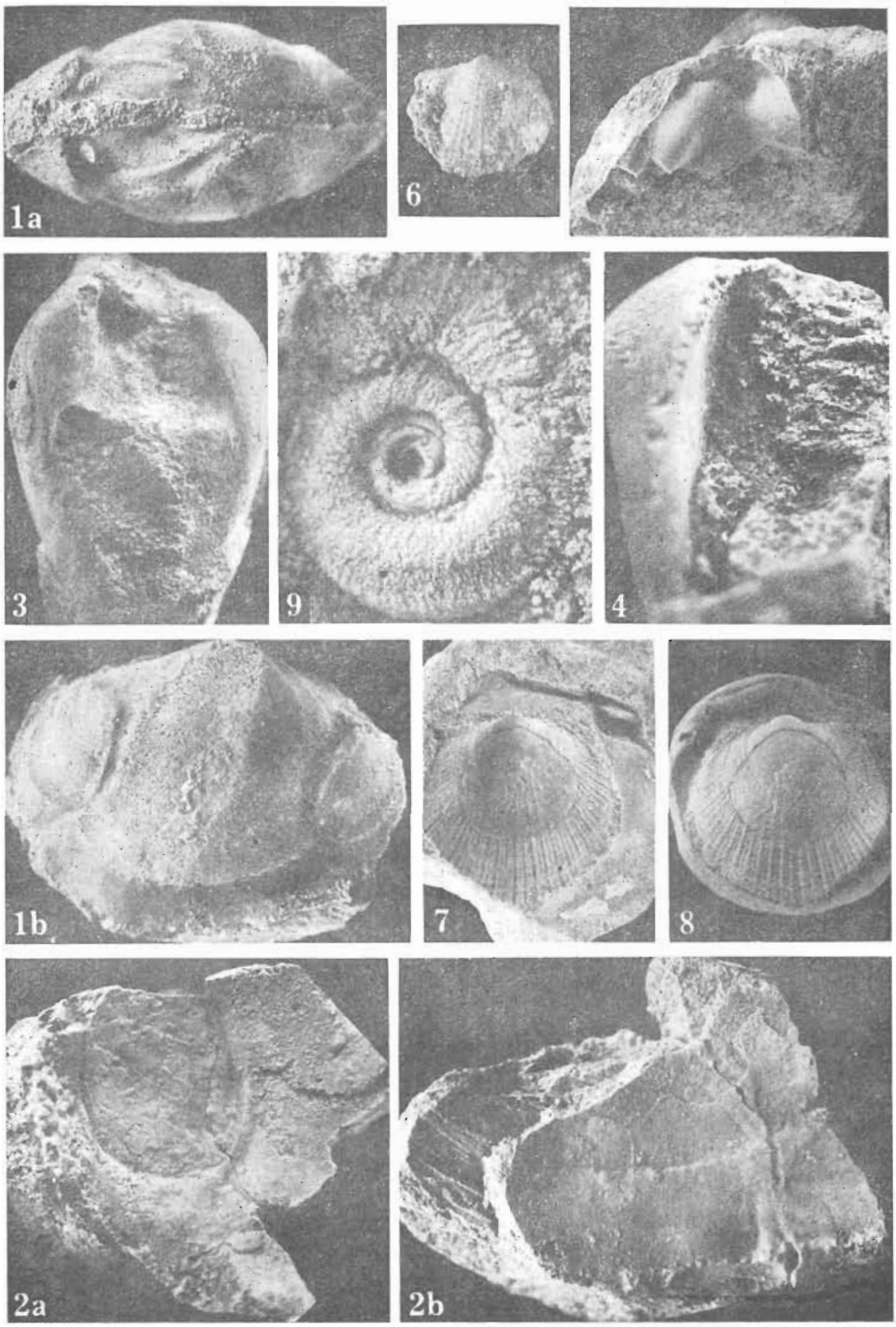
10a
11
9b
10b
12a
3
13
12b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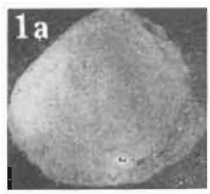
4
1b
7
8
2a
2b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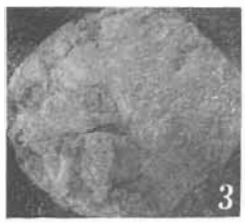
1b


5c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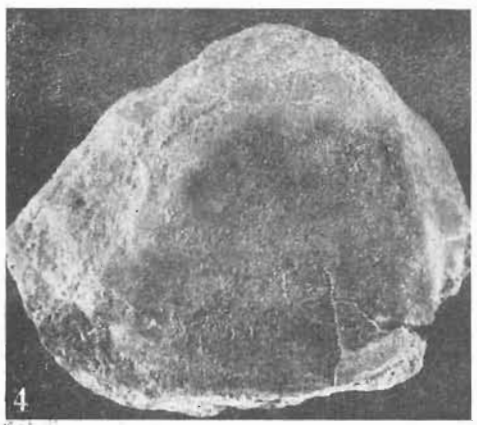
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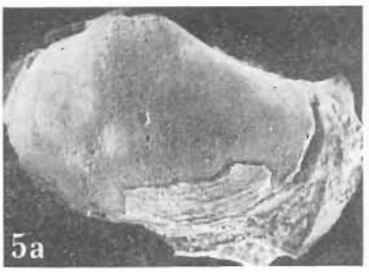
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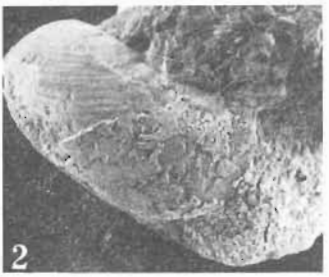
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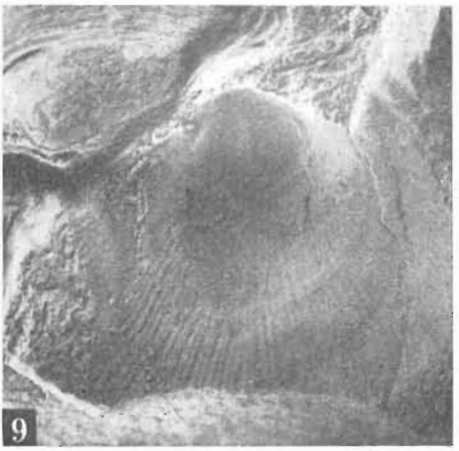
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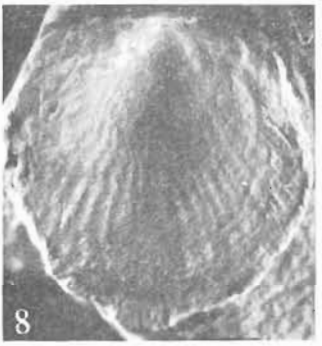
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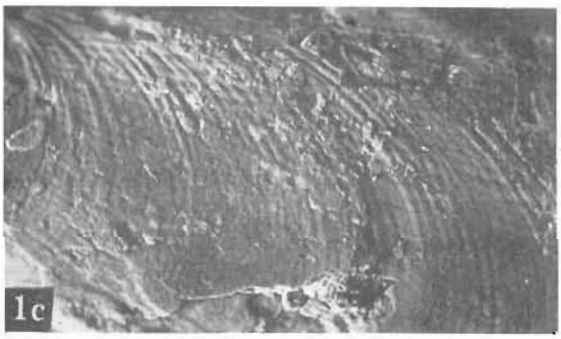
1a


1b


2a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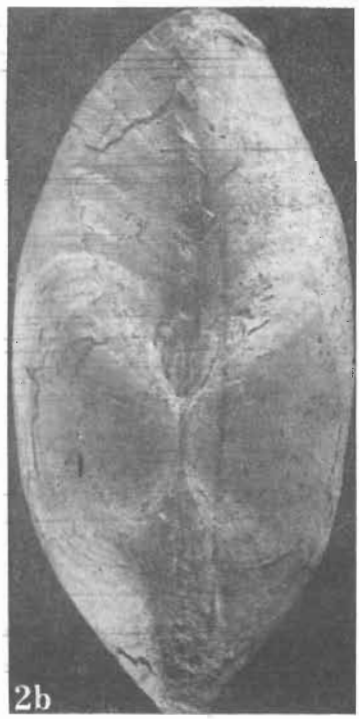
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3


1


2

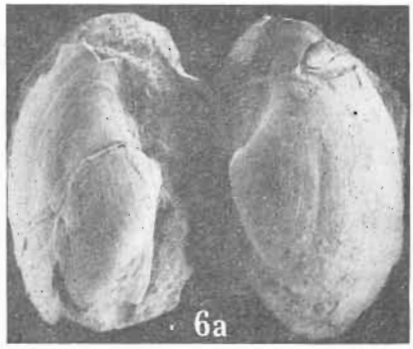

5


3


4


6


1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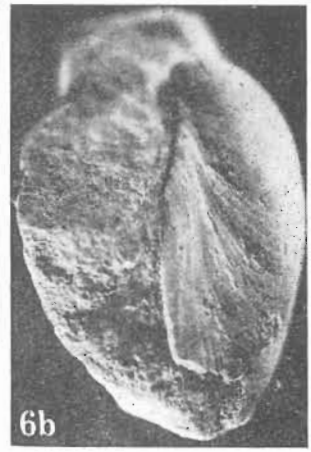
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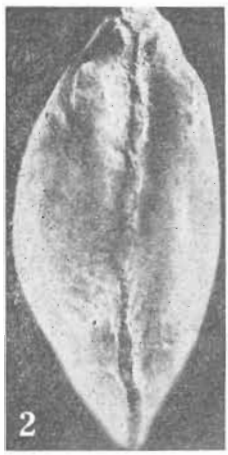
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3


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5


7


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