Acta Palaeontologica Polonica
Vol. 33, No. 2 pp. 145—168; pls. 20—24 Warszawa, 1988

JANUSZ KOPIK and ANDRZEJ WIERZBOWSKI

AMMONITES AND STRATIGRAPHY OF THE BATHONIAN AND CALLOVIAN AT JANUSFJELLET AND WIMANFJELLET, SASSENFJORDEN, SPITSBERGEN

KOPIK, J. and WIERZBOWSKI, A.: Ammonites and stratigraphy of the Bathonian and Callovian at Janusfjellet and Wimanfjellet, Sassenfjorden, Spitsbergen. Acta Palaeont. Polonica, 33, 2, 145--168, 1988.

Three ammonite faunas in the lower part of the Janusfjellet Fm., in the southern Sassenfjorden area have been recognized. The first fauna is correlated with the *Stephanoides* (= *Fasciculatus* Subzone) of the *Cranocephaloides* Zone Upper Bathonian, the second one — with the *Calyx* Zone of the uppermost Bathonian, and probably also with the *Apertum* Zone of the lowermost Callovian, and the third one — with the upper part of the Middle Callovian and/or the lower part of the Upper Callovian. The co-occurrence of Cardioceratidae and Kosmoceratidae in the Upper Bathonian in Spitsbergen is indicative of the Subboreal province, whereas the presence of Cardioceratidae and the absence of Kosmoceratidae found in the Middle/Upper Callovian characterize the Boreal province. Thus, within the Boreal Realm the boundaries of the Boreal and the Subboreal provinces shifted through the Spitsbergen area during the Early/Middle Callovian time. In the paleontological part are described the representatives of *Kepplerites* (subgenera: *Seymourites*, *Toricellites*), *Costacadoceras*, *Cadoceras* (*Paracadoceras*), *Stenocadoceras*, *Pseudocadoceras* and *?Longaeviceras*; a new species, *Kepplerites* (*Toricellites*) *birkelundae* Kopik, has been established.

Key words: biostratigraphy, biogeography, ammonites, Middle Jurassic, Bathonian, Callovian, Boreal Realm.

Janusz Kopik, Zakład Stratygrafii, Tektoniki i Paleogeografii, Państwowy Instytut Geologiczny, ul. Rakowiecka 4, 00-975 Warszawa; Andrzej Wierzbowski, Instytut Geologii Podstawowej, Uniwersytet Warszawski, Al. Żwirki i Wigury 93, 02-089 Warszawa, Poland. *Received: November 1987.*

INTRODUCTION

The paper presents results of the geological studies and fossil collecting commenced in the summer of 1979 in the Sassenfjorden at Janusfjellet and Wimanfjellet (fig. 1) by the paleontological group of the Polish Spitsbergen Expedition organized and sponsored by the Institute of Geophysics, Polish Academy of Sciences. The present paper is the second of a planned issue dealing with the Jurassic ammonites and stratigraphy of this area; the paper already published (Wierzbowski *et al.* 1981) has presented the Toarcian and the Aalenian faunas of the Brentskardhaugen Bed.

The field studies have been undertaken by A. Wierzbowski who is along with J. Kopik responsible also for the biostratigraphic section of the present paper, whereas the paleontological descriptions have been prepared by J. Kopik.

The collection consisting of 33 specimens is housed at the Museum of Geological Faculty, University of Warsaw (IGPUW).

The following abbreviations are used in descriptions: D diameter (in mm), Wh whorl height (in D%), Ud umbilicus diameter (in D%), Wt whorl thickness (in D%).

Acknowledgements. — The author (A.W.) expresses his thanks to Professor Gertruda Biernat the leader of the paleontological group in the Sassenfjorden, as well as to the members of the group: Dr. A. Baliński, Dr C. Kulicki and Dr. K. Małkowski (Institute of Paleobiology, Polish Academy of Sciences) for their help and good companionship in the field. The authors thank Dr. K. Krajewski (Institute of Geological Sciences, Polish Academy of Sciences) for making available the manuscripts of his papers and observations of his own concerning the section at Wimanfjellet. The authors are also grateful to Professor J. H. Callomon (University College London) for discussion and to Professor R. Wyrwicki (Institute of Geology, Warsaw University) for closer mineralogical identification of ironstones.

THE LITHOLOGIC SUCCESSION AND THE AMMONITE FAUNAS

The main exposure studied lies about 2 km east of Deltaneset on the left bank of the stream flowing down from the north-eastern slopes of Wimanfjellet (fig. 1, locality 1; see also Wierzbowski *et al.* 1981: fig. 1,

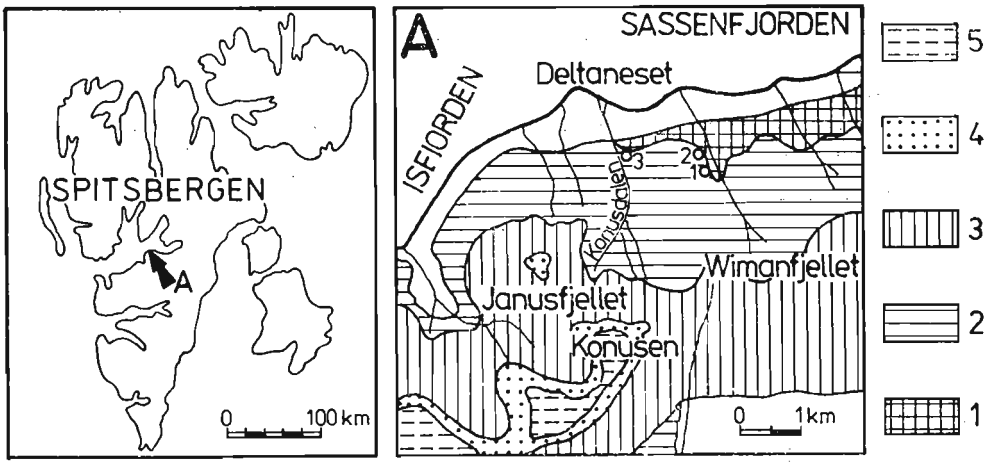


Fig. 1. Geological map of the Sassenfjorden area (after Major and Nagy 1972) showing the positions of the studied localities 1—3. *1* Tschermakfjellet Formation — De Geerdalen Formation (Upper Triassic — Lower Jurassic), *2* Janusfjellet Formation (Jurassic — Lower Cretaceous), *3* Helvetiafjellet Formation — Carolinafjellet Formation (Cretaceous), *4* Firkanten Formation (Tertiary), *5* Basilika Formation — Sarkofagen Formation (Tertiary)

locality 1). The succession of the lower part of the Janusfjellet Formation (cf. Major and Nagy 1972) exposed there seems to be remarkably constant over the whole area between Wimanfjellet and Janusfjellet which is evidenced by the findings in other exposures of particular lithologies and faunas in a very similar stratigraphic position.

The lowermost part of the succession represents the well known Brentskardhaugen Bed — the conglomeratic sandstone unit about 1 m thick with abundant fauna occurring in the phosphatic nodules. The ammonites are indicative of the Middle and Upper Toarcian, as well as the Lower and eventually Middle Aalenian (Wierzbowski *et al.* 1981 and the earlier papers cited therein; cf. also Bäckström and Nagy 1985). At the top of the unit there occurs a thin uncemented band composed of the same clasts as those in the underlying Brentskardhaugen Bed including the phosphorites, but without a sandy matrix. This band passes gradually upwards, but rather on a small distance, into arenaceous ironstones with abundant ooids; towards the top of the unit the ironstones are alternating with dark shales. The thickness of the discussed ironstones with shale intercalations is about 2.50 m. The rock unit corresponds approximatively to the Marhøgda Bed distinguished recently in the studied area by Bäckström and Nagy (1985). No ammonites have been found here, the only macrofossils are represented by poorly preserved belemnites which do not allow to recognize an exact age of the unit.

The sedimentological interpretation of the two lithostratigraphic units — the Brentskardhaugen Bed and the Marhøgda Bed is disputable, even if one takes into account the papers published recently. Some authors believe that the Brentskardhaugen Bed together with overlying Marhøgda Bed have been deposited in the studied area during a single, transgressive event, most probably in the Late Bathonian, and that the Brentskardhaugen Bed presents the basal conglomerate of the transgression from the reworking of older, phosphorite-bearing deposits (Bäckström and Nagy 1985, see also Birkenmajer 1972, 1975, 1980). However, some of the authors (Mørk *et al.* 1982) point to the original smaller thickness of the phosphorite-bearing deposits in the studied area when compared with areas lying eastwards — and especially east of the Billefjorden fault-zone. On the other hand, Wierzbowski *et al.* (1981) have regarded the Brentskardhaugen Bed in the studied area as a condensed layer formed over a long period in the Toarcian and Aalenian due to some episodes of sedimentation and reworking. According to them the unit is separated from the overlying deposits (Marhøgda Bed) by a band composed of loose pebbles indicating the erosion which followed a long stratigraphical break — most likely in marine environment. The studies of the lowermost — phosphorite-bearing — part of the Janusfjellet Formation undertaken recently at Wimanfjellet (Krajewski, in press) have revealed that the Brentskardhaugen Bed is a highly condensed unit containing several generations of phosphatic nodules, at

least one of which is developed *in situ* and preserved in growth position. Moreover, the overlying Marhøgda Bed shows the petrographic evidence for the primary calcium phosphate composition of the ooids, commonly occurring here, and thus it indicates that the unit should be placed within the phosphorite-bearing part of the sequence. The presence of stromatolites and foraminiferal mats is also indicative of a very slow sedimentation (Dr. K. Krajewski, personal information). Thus, the interpretation of the Brentskardhaugen Bed as a basal conglomerate of a single transgression seems disputable and longer period is necessary to explain the formation of the units in question.

The Marhøgda Bed passes gradually upwards into sequence of dark-grey shales containing siderite intercalations usually several centimeters in thickness. The three successive intercalations occurring respectively 1.60 m, 4.45 m, and 9.20 m above the top of the Marhøgda Bed, and 4.10 m, 6.95 m and 11.70 m above the top of the Brentskardhaugen Bed in locality 1 (figs. 1—2), have yielded the majority of late Middle Jurassic faunas discussed and described in the present paper.

The lowest layer, 15 cm thick, contains: *Costacadoceras* sp., *Kepplerites* (*Seymourites*) *fasciculatus* Spath and *K.* (*S.*) sp. Much more abundant ammonite fauna have been collected from the middle siderite layer about 25 cm thick. It comprises: *Cadoceras* cf. *apertum* Callomon et Birkelund, *Cadoceras* (*Paracadoceras*) sp., *Kepplerites* (*Seymourites*) *svalbardensis* Bodylevsky, *Kepplerites* (*Toricellites*) *birkelundae* Kopik sp. n., *Kepplerites* (*Toricellites*) aff. *zortmanensis* Imlay. Moreover, some ammonites found in the rubble, somewhat downslope from the middle siderite layer, are most likely to come from the same horizon; these are: *Cadoceras* (*Paracadoceras*) cf. *victor* Spath, *C.* (*P.*) cf. *multiforme* Imlay, *Kepplerites* (*Seymourites*) *svalbardensis* Bodylevsky.

In the upper siderite layer, 15 cm thick, abundant cadoceratids have been collected, whereas keppleritids are absent; here occur: *Stenocadoceras multicostatum* (Imlay), *Stenocadoceras* sp., ?*Longaeviceras* cf. *pomeroyense* (Imlay), *Pseudocadoceras nanseni* (Pompeckj).

About 0.5 km north, in the locality 2 (fig. 1), in the siderites on the left bank of the stream and probably corresponding to the middle siderite layer from the exposure 1, the following ammonites have been found: *Cadoceras* (*Paracadoceras*) sp., *Kepplerites* (*Seymourites*) *svalbardensis* Bodylevsky, *Kepplerites* (*Toricellites*) *birkelundae* Kopik sp. n.

In the locality 3, in the Konusdalen, north of Janusfjellet (fig. 1) *Kepplerites* (*?Toricellites*) sp. have been collected from the siderite layer occurring about 1.50 m above the top of the Marhøgda Bed, and probably corresponding to the lower siderite layer from the exposure 1.

BIOSTRATIGRAPHY AND AGE

Among the existing zonal subdivisions of the upper Middle Jurassic worked out in areas corresponding to the different parts of the Boreal province, especially two may be adopted for the examined ammonite succession from Spitsbergen, i.e. the zonation from East Greenland (Callomon 1985 and earlier papers cited therein) and the one from Siberia (Meledina 1987, Meledina *et al.* 1987, and earlier papers cited therein). However, the problem of the correlation between these subdivisions, as well as their correlation with the standard European Subboreal zonal scheme from Britain have been the subject of conflicting opinions. The crucial point of the discussion is the interpretation within these Boreal ammonite successions of the base of the Callovian stage as defined in Europe, which, due to the scarcity of the ammonites in common, has to rely mostly on fragmentary arguments. The boundary is drawn at the base of the *Apertum* Zone in East Greenland, which is considered as corresponding approximately to the base of the *Macrocephalus* Zone in Britain, on the basis of the few common ammonites — *Kepplerites keppleri* (Oppel) and its very close relatives (Callomon 1975, 1984*ab*, 1985, Callomon and Birkelund 1985). In Siberia the lower boundary of the Callovian stage is drawn a little lower — within the broadly understood *Kochi* Zone (Meledina *et al.* 1987, cf. also Meledina 1972, 1977, 1987). This interpretation, however, is based on the disputable assumption that the genus *Kepplerites* appeared simultaneously in different areas of Europe and Arctics. Most probably the ammonites of the genus *Kepplerites* migrated from North America to Greenland and Spitsbergen, and only later to Europe (Callomon 1984*a*). This indicates that the stratigraphical correlation should disregard the time of the genus appearance and take into account the succession of the given species. The present paper adopts the first of the presented stratigraphical interpretations, according to which the lower boundary of the Callovian stage is drawn at the base of the *Apertum* Zone in East Greenland zonation, as well as respectively within the broadly understood *Elatmae* Zone from Siberia (Callomon 1985, Callomon and Birkelund 1985; cf. also Meledina *et al.* 1987; see fig. 2).

The oldest ammonite fauna from Spitsbergen described in the present paper (fig. 2) is very poor and composed only of *Kepplerites* (*Seymourites*) *fasciculatus* Spath (= *K. stephanoides* Callomon), *K.* (*Seymourites*) sp. and *Costacadoceras* sp. The former one is indicative of the *Stephanoides* Subzone being the lower subzone of the *Cranocephaloide* Zone in East Greenland (Callomon 1975). Also the presence of the genus *Costacadoceras* is not contradictory to such biostratigraphical interpretation. The studied fauna may also be correlated with the upper part of *Kochi* Zone distinguished by Russian geologists in West Siberia (Meledina 1972, 1973, 1977, 1987) and Spitsbergen (Ershova, Kortchinskaja 1980, Ershova 1983) as cor-

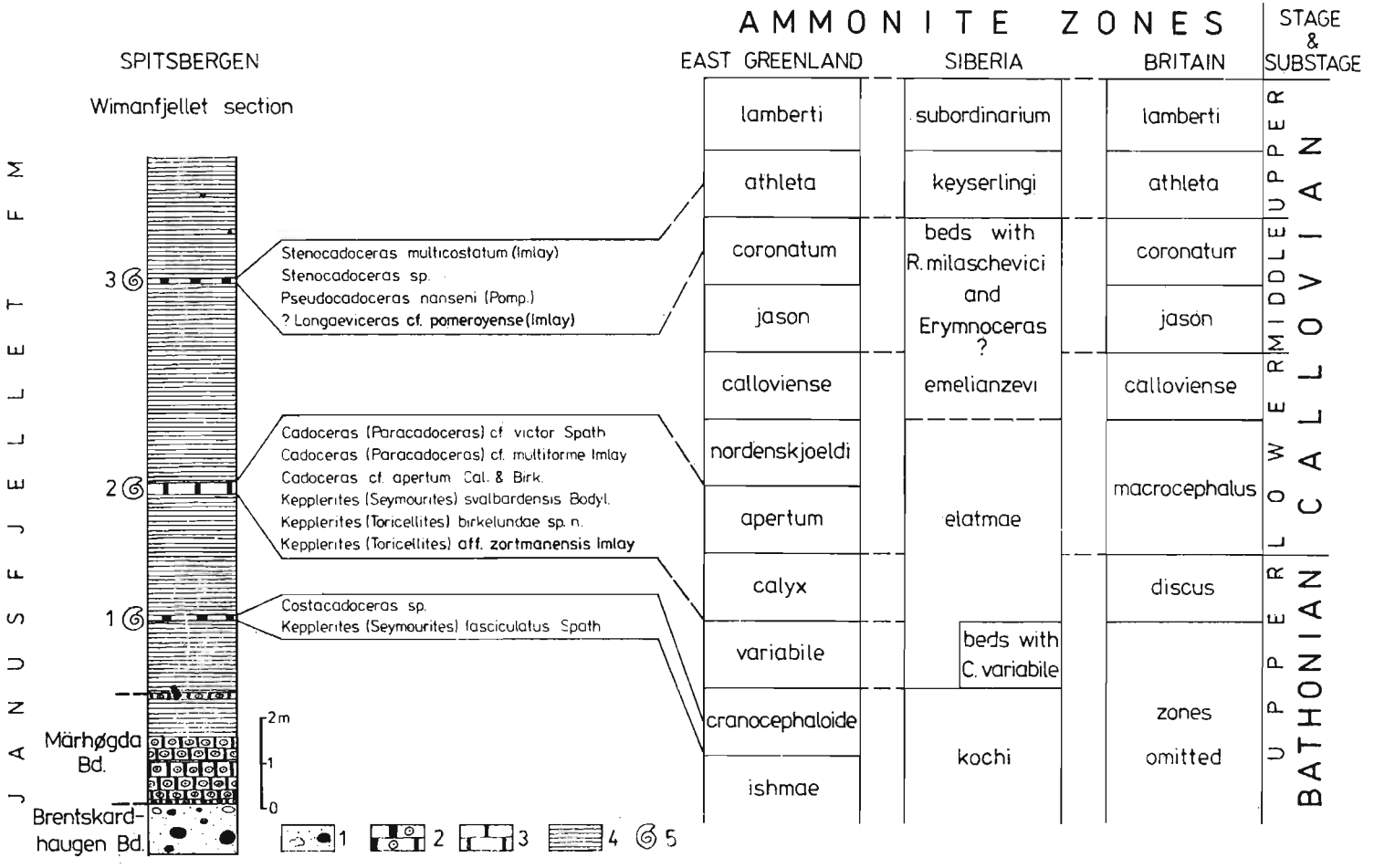


Fig. 2. The levels of studied ammonite faunas from the Sassenfjorden area in the framework of the ammonite zonations of East Greenland, Siberia and Britain

1 conglomeratic sandstones; *2* ironestones; *3* siderites; *4* shales; *5* ammonite faunas (1—3)

responding at least at places, to the *Cranocephaloide* Zone (Meledina *et al.* 1987: 87—88, 94).

The discussed ammonite fauna from the lower part of the *Cranocephaloide* Zone is the oldest ammonite fauna of the Bathonian stage stated so far in the Sassenfjorden area. The older Bathonian ammonite fauna composed of the representatives of the genus *Arcticoceras*, among others *A.* cf. *ishmae* (Keyserling) and *A. kochi* Spath, is known only from the eastern and southern Spitsbergen as well as from the Kong Karls Land in eastern Svalbard (cf. Ershova 1983 and the earlier papers cited therein, Rawson 1982; see also table 1). It is indicative of the *Ishmae* Zone from East Greenland and the lower part of the *Kochi* Zone from Siberia being also the oldest Bathonian ammonite fauna known so far from the Svalbard area.

The second ammonite fauna described here (fig. 2) is profuse and composed of some species of Gowericeratinae — *Kepplerites* (*Seymourites*) *svalbardensis* Bodylevsky, *K.* (*Toricellites*) *birkelundae* Kopik sp. n. and *K.* (*Toricellites*) aff. *zortmanensis* Imlay, as well as of Cadoceratinae — *Cadoceras* (*Paracadoceras*) cf. *victor* Spath, *C.* (*Paracadoceras*) cf. *multiforme* Imlay, *C.* cf. *apertum* Callomon et Birkelund. The most common is *K.* (*Seymourites*) *svalbardensis* whose stratigraphical position has been clarified but nowadays (Callomon, pers. inf.) and which is treated as indicative of the lower part of the *Calyx* Zone of the uppermost Bathonian (cf. the paleontological description of the species, fig. 2). Also the forms from the subgenus *Toricellites* showing the tabular ventral side clearly resemble the species known from East Greenland *Calyx* Zone, as well as those in some North American faunas and correlated with the same zone (cf. paleontological part of the paper, see also Callomon 1984*a*).

However, the presence of some representatives of the subgenus *Paracadoceras* in the studied ammonite fauna suggests also its younger age. Both in Europe and in East Greenland the representatives of the subgenus occur in the lowest part of the lower Callovian (Callomon 1984*a*, 1985). An additional factor confirming such age of the ammonite fauna is the presence of the microconch very close to those of *Cadoceras apertum* Callomon et Birkelund from the *Apertum* Zone of the lowermost Callovian in East Greenland (Callomon and Birkelund 1985).

All these indicate that the second ammonite fauna represents either the *Calyx* Zone or a longer time-span corresponding to the *Calyx* Zone of the uppermost Bathonian and the *Apertum* Zone of the lowermost Callovian (fig. 2). This fauna may be also correlated with the upper part of *Elatmae* Zone of Siberia well above the beds with *Cadoceras variabile* as distinguished recently by Meledina *et al.* (1987).

The fauna in question partly corresponds also to that of the *Tychonis* Zone as distinguished by Ershova (1983) in Spitsbergen, who recognized *K.* (*Seymourites*) *svalbardensis* Bodyl., as the characteristic species for the

Table 1

The most important Bathonian-Callovian ammonite sites in Svalbard and their stratigraphical interpretation

E. GREENLAND		SPITSBERGEN		KONG KARLS LAND
		SASSENFJORDEN	HORNSUND AND SØRKAPPLAND	
AMMONITE ZONES J.H. CALLOMON 1975-85		J. KOPIK, A. WIERZBOWSKI this paper	T. M. PCHELINA 1967 J. KOPIK 1979 (UNPUBL.) E.S. ERSHOVA 1983	M. LØFALDLI, J. NAGY 1980 P.F. RAWSON 1982 E.S. ERSHOVA 1983
CALLOVIAN	PELTOCERAS ATHLETA	Longaeviceras cf. pomeroyense Stenocadoceras multicostatum Pseudocadoceras nanseni	Longaeviceras sp L. cf. keyserlingi	Longaeviceras stenolobum Pseudocadoceras chinitnense Stenocadoceras multicostatum Rondiceras ex gr. tchefkini
	ERYMNOCERAS CORONATUM			
	KOSMOCERAS JASON			
	SIGALOCERAS CALLOVIENSE			
	CADOCERAS NORDENSKJOELDI			
	CADOCERAS APERTUM	Cadoceras (Paracadoceras) sp. Cadoceras (Paracadoceras) cf. victor C. (P.) cf. multiforme C. cf. apertum		Pseudocadoceras chinitnense P. grewingki
BATHONIAN	CADOCERAS CALYX	Kepplerites (Toricellites) birkelundae K. (T.) aff zortmanensis K. (Seymourites) svalbardensis		
	CADOCERAS VARIABILE			
	ARCTICOCERAS CRANOCEPHALOIDE	Kepplerites (Seymourites) sp K. (S.) fasciculatus K. (? Toricellites) sp Costacadoceras sp	Kepplerites (Seymourites) cf. tychonis Cadoceras sp cf. crassum Costacadoceras sp Arcticoceras cf. ishmae A. sp cf. pseudolamberti A. kochi	Cadoceras sp Costacadoceras bluethgeni Arcticoceras harlandi A. cf. kochi
	ARCTICOCERAS ISHMAE			

Arrows indicate the direction of the possible change of the stratigraphic position.

Zone. On the other hand, Ershova mentions from this zone *K.* (*Seymourites*) *tychonis* Ravn, and this suggests that the *Tychonis* Zone from Spitsbergen is equivalent to the upper part of the *Cranocephaloide* Zone as well as the *Variabilis* and the *Calyx* Zone from East Greenland (cf. Callomon and Birkelund 1980).

The third ammonite fauna (fig. 2) consists of: *Stenocadoceras multicostatum* (Imlay), *Stenocadoceras* sp., *Pseudocadoceras nanseni* (Pompeckj) and (?)*Longaeviceras* cf. *pomeroyense* (Imlay). The most remarkable, when compared with the two faunas discussed previously, are: the appearance of the new genus *Stenocadoceras* as well as the overall occurrence of Cardioceratidae to the virtual exclusion of Kosmoceratidae. These features make the correlation of the fauna studied especially close to those from Siberia and northern North America and somewhat more distant to that from East Greenland. The genus *Stenocadoceras* and the species *S. multicostatum* (Imlay) occur very commonly in southern Alaska in the *Stenocadoceras stenoloboide* fauna which is correlated with the uppermost Lower Callovian (the upper part of the *Calloviense* Zone from NW Europe and East Greenland), and especially with the Middle Callovian (*Jason* and *Coronatum* Zones from NW Europe and East Greenland), but possibly also with the lower part of the Upper Callovian (Imlay 1975, see also Callomon 1984*a*, who, however, treats the fauna in narrower sense placing it in the lower part of the Middle Callovian). Also in Siberia occurs the genus *Stenocadoceras* in the Middle Callovian and Upper Callovian (Meledina 1977). *Pseudocadoceras nanseni* (Pompeckj) stated in the studied fauna from Spitsbergen, seems to occur in the Middle Callovian in the Franz Josef Land (Meledina 1972) and in the lower part of the Upper Callovian in the northern North America (Callomon 1984*a*, fauna D6). It should be added that the presence of a form close to *Longaeviceras pomeroyense* (Imlay) from Alaska in the fauna studied may indicate the early Late Callovian age, lower *Athleta* Zone (Callomon 1984*a*, fauna B 10). It seems, therefore, that the youngest ammonite fauna from Spitsbergen may correspond to the upper part of the Middle Callovian (upper *Coronatum* Zone and its equivalents) and/or lower part of the Upper Callovian (lower *Athleta* Zone or lower *Keyserlingi* Zone) in the East Greenland and Siberian zonations (fig. 2). The ammonite fauna in question probably has its partial counterparts in other findings from Spitsbergen, e.g. representatives of the genus *Longaeviceras* from southern and western Spitsbergen, as well as representatives of *Rondiceras* and assemblage *Longaeviceras* — *Stenocadoceras* — *Pseudocadoceras* in the Kong Karls Land (Ershova 1983 and earlier papers cited therein, Løfaldli and Nagy 1980; see also table 1).

The presented distribution of the ammonites in the succession studied provides some information on the biogeographical position of Spitsbergen in the Late Bathonian and Early to Middle/Late Callovian times. Within the Boreal Realm the boundaries of the Boreal and the Subboreal pro-

vinces shifted through the Spitsbergen area during the Early/Middle Callovian time. The faunas of the Late Bathonian in Spitsbergen (fauna 1 and 2, see fig. 2) include the representatives of the family Cardioceratidae — subfamily Cadoceratinae, as well as those of the family Kosmoceratidae — subfamily Gowericeratinae. Apart from Spitsbergen the ammonites of the two families have been found in some areas including East Greenland, where they are considered as characteristic of the Subboreal province (Callomon 1984*a*, 1985; Taylor *et al.* 1984). In the Middle/Late Callovian Kosmoceratidae has totally retreated from Spitsbergen, and the only ammonites occurring here (fauna 3) are of the family Cardioceratidae. This indicates that this area has become a part of the Boreal province *sensu stricto* and makes the comparisons with Siberia and northern North America much closer than previously.

DESCRIPTIONS

Superfamily **Stephanocerataceae** Neumayr, 1875
Family **Kosmoceratidae** Haug, 1887
Subfamily **Gowericeratinae** Buckman, 1926
Genus *Kepplerites* Neumayr et Uhlig, 1892
Subgenus *Kepplerites* (*Seymourites*) Kilian et Reboul, 1909
Kepplerites (*Seymourites*) *svalbardensis* Bodylevsky, 1931
(pl. 20: 2, pl. 21: 1—2, pl. 22: 8—9)

1929. *Macrocephalites* sp. cf. *evolutus* Quenstedt; Frebold: 10, pl. 2: 1—3, *non* 4.
1931. *Kepplerites svalbardensis* Bodylevsky *in*: Sokolov and Bodylevsky 79, pl. 5: 1, 2.
1932. *Kepplerites* (*Seymourites*) *svalbardensis* Sokolov and Bodylevsky; Spath: 87.
1983. *Kepplerites* (*Seymourites*) *svalbardensis* Bodylevsky; Ershova: pl. 2: 1—4.

Material. — 15 specimens (Nos. IGPUW/A21/1, 7, 8, 13, 15, 41, 44, 48—50) from the middle siderite layer in locality 1, moreover IGPUW/A21/2, 10, 14 in the rubble, most probably from the same layer; IGPUW/A21/16—17 from locality 2; the specimens often flattened but some of them rather well preserved.

Description. — In phragmocone at D = 60 mm (specimen IGPUW/A21/16) whorl section high-oval, the umbilicus fairly narrow (Ud = 23%). Ribs numerous (about 16 at half of whorl): primaries somewhat swollen and prorsiradiate, secondaries thin, initially rectiradiate, then more or less rursiradiate close to the venter: the point of furcation situated slightly below the mid-height of whorl and marked with tubercle-like swelling. Secondary ribs usually grouped into sets of three, but intercalatory ribs also occur.

Body-chamber somewhat more than half a whorl long (specimen IGPUW/A21/1). A marked uncoiling from the beginning of body chamber results in gradual increase in umbilical diameter. Some specimens (IGPUW/A21/17) have oblique umbilical wall ornamented with numerous rursiradiate umbilical ribs. The primary ribs become denser and thinner, increasing in number up to 15—16, in the last quarter of the outermost whorl; secondary ribs crowd and weaken, swellings disappear at the point of furcation; the periapertural part of whorl with a feeble ornamentation.

Remarks. — The variability of the species as found in the specimens studied is

rather low. The differences are marked mostly in accentuation of the ribbing and in degree of rib flexuosity. The species seems similar to *Kepplerites* (*Seymourites*) *loganianus* (Whiteaves) from Alaska; the specimens described here differ however from the holotype of the latter (Whiteaves 1876: pl. 8: 2) in denser primaries and more flexuosus ribbing. *K. svalbardensis* is also similar to *Kepplerites* (*Seymourites*) *traillensis* Donovan from East Greenland (Donovan 1953). The specimen described as *Kepplerites tychonis* Ravn from East Greenland (Callomon and Birkelund 1980: pl. 1: 3) has also several features in common with *K. svalbardensis*.

Specimen	D	W_h	W_t	U_d
IGP UW/A 21/7	120	40	—	34
IGP UW/A 21/1	~120	33	25	~30
IGP UW/A 21/13	105	38	—	29

Stratigraphic and geographic range. — The stratigraphical position of *K. svalbardensis* has never been precisely stated in the geological literature. According to Bodylevsky (Sokolov and Bodylevsky 1931) the species was found together with *Cadoceras* cf. *crassum* Madsen in the Deltaneset profile which indicated its relatively low position in the biostratigraphical column (cf. Callomon 1959). The only specimen of *K. svalbardensis* reported but not illustrated from East Greenland was found after Spath (1932) in the *Tychonis* Zone. The species was stated in the Sassenfjorden area in the *Tychonis* Zone (but probably treated in wider sense) by Ershova (1983). Callomon (1959) and Rawson (1982) believed the species to occur in Spitsbergen in the *Variabile* and the *Calyx* Zones, but recently (Callomon, personal information) the species is recognized as indicative of the lower part of the *Calyx* Zone.

Kepplerites (*Seymourites*) *fasciculatus* Spath, 1932

(pl. 20: 1)

1932. *Kepplerites* (*Seymourites*) *tychonis* Ravn var. *fasciculata* Spath: 86, pl. 26: 6.
1975. *Keplerites stephanoides* Callomon: 381, figs. 4A and 4B.

Material. — One fragmentary specimen (IGPUW/A21/9) from the lower siderite layer in locality 1.

Description. — The specimen is about 115 mm in diameter. It represents the end part of the phragmocone and a part of the body chamber about a half whorl long. The cast of the inner whorl shows dense and moderately thin secondary ribs (about 45 ribs at about half of whorl). The whorl section in the body chamber is high-oval with rounded ventral side; the umbilicus tends to become wide with increasing shell diameter (at D = 115 mm, Ud = 29% and Wh = 37%). The primary ribs strong, moderately dense (about 10 per a quarter of whorl), with a marked twist at umbilical wall, prorsiradiate, splitting somewhat below the middle of whorl into sets of about 5 secondary ribs; some intercalatory ribs in the outer part of whorl also appear; the point of furcation marked with tubercle-like swelling. The ribbing becomes denser and weaker in the end-part of the body chamber preserved.

Remarks. — The specimen, although so fragmentary, may be compared with specimens from Greenland — *K.* (*Seymourites*) *tychonis* var. *fasciculata* Spath, 1932, and North Sea — *K.* (*Seymourites*) *stephanoides* Callomon, 1975 (see synonymy). The two specimens are conspecific as stated by Callomon (1975) who has dismissed the

name *fasciculata* replacing it with a new one *stephanoides*; the former name is however still valid according to the ICZN and retained in the present paper.

K. (S.) fasciculatus Spath is very close to *K. (Seymourites) costidensus* Imlay, 1953 known from the Rierdon Fm. of Western Interior of United States. The relation between the species in question and *K. (Seymourites) tychonis* Ravn (Ravn 1911: pl. 38: 1a, b) is not as close, however, as Spath (1932) maintains. The two forms have to be distinguished taxonomically on the specific level.

Stratigraphical range and occurrence. — *Kepplerites (Seymourites) fasciculatus* Spath has been reported from the Vardekløft Formation and from the *Tychonis* Zone of East Greenland (Jameson Land) by Spath (1932). Callomon (1975) distinguished *K. stephanoides* as diagnostic species and the index-form of the lower Subzone of the *Cranocephaloide* Zone in East Greenland.

Subgenus *Kepplerites (Toricellites)* Buckman, 1922
Kepplerites (Toricellites) birkelundae sp. n.
(pl. 22: 3ab, 4, 5)

Holotype: IGPUW/A21/29; pl. 22: 3ab.

Type horizon: Middle siderite layer in the studied sections (fig. 2), Janusfjellet Formation, the *Calyx* and/or *Apertum* Zones (uppermost Bathonian and/or lowermost Callovian).

Type locality: Locality 1 at Wimanfjellet in Sassenfjorden area (fig. 1).

Derivation of the name: In memory of late Professor Tøve Birkelund the outstanding student of the Jurassic and Cretaceous of the Arctic.

Diagnosis. — Microconchs of middle size, aperture with lappets, coiling seminvolute, whorl section high-trapezoidal, ornamentation rather strong with secondary ribs moderately dense in the body chamber, lateral tubercles disappearing close to the aperture.

Material. — Six specimens: IGPUW/A21, 29, 32 from the middle siderite layer in locality 1, IGPUW/A21/34 from the rubble, most probably from the same layer; IGPUW/A21/22, 47 in the rubble in locality 2.

Description. — The holotype (pl. 22: 3ab) is of a medium size with well preserved but incomplete body chamber about 1/3 of whorl long. The body chamber high-trapezoidal in cross-section and rather strongly ornamented. The primary ribs strong with a distinct lateral tubercles located somewhat below half way up the whorl side,

Specimen	D	W_h	W_t	U_d
IGP UW/A 21/29 (holotype)	41,5	40	(ca25)	0,32
IGP UW/A 21/22	44	35	—	33

from which 1—2 moderately flexuous secondary ribs develope; intercalatory ribs in the outer part of whorl not connected with lateral tubercles. The ventral side flat and narrow, bordered by two rows of feeble tubercles joined by ribs passing over the venter. The umbilicus moderately wide and shallow.

The other specimens add some data on the species. The specimen IGPUW/A21/22 (pl. 22: 4) has the end-part of body chamber with the last stage of ornamentation: lateral tubercles disappearing, primary ribs becoming somewhat longer and more

prorsiradiate, and secondary ribs being more flexuous; the shell ends with elongate lappets (see also specimen IGPUW/A21/21 presented in pl. 22: 5). The specimen IGPUW/A21/47 shows the negatives of the sharp tubercles (?with spines) developed at the edge of the ventral side.

Remarks. — The specimens studied differ from the specimen described below as *Kepplerites* (*Toricellites*) aff. *zortmanensis* coming from the same siderite layer in less dense and stronger ribbing as well as in the presence of distinct lateral tubercles on the body chamber. Similar differences exist between *K.* (*Toricellites*) *birkelundae* sp. n. and *K.* (*T.*) *pauper* Spath, 1932 (see Spath 1932: pl. 24: 3a—b) from East Greenland as well as *K.* (*T.*) *vigorosus* Imlay, 1953 from the Western Interior of United States.

The new species is close to *K.* (*Toricellites*) *spinosus* Frebold, 1963 (Frebold 1963: pl. 11: 2) from western Canada, which shows similar "perisphinctoidal" coiling as well as similar ribbing. The described species differs in stronger development of lateral tubercles and less numerous primary ribs.

Occurrence. — As the type specimen.

Kepplerites (*Toricellites*) aff. *zortmanensis* Imlay, 1953

(pl. 22: 7)

Material. — One specimen (IGPUW/A21/24) from the middle siderite layer in the locality 1.

Description. — Microconch about 40 mm in diameter with phragmocone partly preserved and the body chamber badly corroded. The initial whorls moderately involute with fragmentary preserved, but rather strong and prorsiradiate primary ribs, as well as with poorly preserved lateral tubercles, the latter occur in phragmocone up to the diameter of 20 mm, then they become weaker and disappear rather suddenly in the body chamber.

The ribbing modifies on the body chamber: there appear dense, flexuous, slightly prorsiradiate ribs which remind those of some kosmoceratids (*Gulielmiceras*). The ribs are biplicate, less frequently triplicate, with point of furcation situated low at about one third of whorl height; some intercalatory ribs also occur. In the ventrolateral part of the whorl the secondary ribs show rather poorly marked tubercles.

The whorl sides at the body chamber are flattened; the ventral side is not visible. The umbilicus is moderately wide and shallow.

Remarks. — There exist some morphological similarities between the form in question and the group of *Gulielmiceras*-like species of the subgenus *Toricellites* including *Toricellites zortmanensis* Imlay, *T. knechteli* Imlay and *T. vigorosus* Imlay known from the western Interior of the United States and western Canada (cf. Imlay 1953, Frebold 1963). The form described seems especially similar to those species which show a strong weakening or a lack of the lateral tuberculation on the body chamber, such as *K.* (*T.*) *zortmanensis* Imlay (see Imlay 1953: pl. 14: 2, 5); however, the ribbing of the inner whorls of the latter species seems to be denser and fainter when compared with the form under consideration.

Also some *Toricellites* from East Greenland, as *K.* (*Toricellites*) *pauper* Spath and *Kepplerites tychonis* Ravn (m) *in*: Callomon and Birkelund 1980: pl. 1: 4, show a similar *Gulielmiceras*-like ornamentation the details of which differ however from those encountered in the form in question.

Stratigraphic and geographic range. — The North-American and Greenland species of *Toricellites* mentioned above occur in the deposits corresponding most probably to the *Calyx* Zone of the Boreal Bathonian (Callomon 1984*a*).

Family **Cardioceratidae** Siemiradzki, 1891
Subfamily **Arctocephalitinae** Meledina, 1968
Genus *Costacadoceras* Rawson, 1982
Costacadoceras sp.
(pl. 22: 1—2)

1972. *Pseudocadoceras* sp. (cf. *mundum* Sazonov); Meledina: 109, pl. 8: 5.
1983. *Arcticoceras* sp. juv.; Ershova: 9, pl. 1: 3.
1987. ?*Costacadoceras* sp. ex gr. *bluethgeni* Rawson; Meledina *et al.*: 87.

Material. — Two specimens (IGPUW/A21/18, 33) from the lower siderite layer in locality 1.

Description. — Small-sized phragmocones belonging probably to microconchs. In an early stage, at D = 15 mm (specimen IGPUW/A21/33) the form is involute: Wh = = 36%, Ud = 22%. The whorl section probably oval with slightly convex whorl sides. The ribbing rather strong, moderately dense (12 secondaries and 7 primaries at one fourth of the whorl), prorsiradiate, mostly biplicate, but with occasional single ribs. The furcation of ribs takes place somewhat below the middle of the whorl-height and it is especially well visible in the second specimen studied (IGPUW/A21/18: pl. 22: 1). The ribs initially densely spaced, become sparser with increasing diameter; at the same time the primary ribs become shorter, and the secondary ribs much longer. The ventral side is probably narrow and rounded.

Remarks. — The specimens in question seem to be close to *Pseudocadoceras* sp. (cf. *mundum* Sazonov) of Meledina (1972; and especially to the specimen presented there in pl. 8: 5), more recently (Meledina *et al.* 1987) allocated into *Costacadoceras*, and coming from the *Kochi* Zone in the lower Lena river area of Central Siberia. Also the specimen described as *Arcticoceras* sp. juv. (Ershova 1983: pl. 1: fig. 3) from the *Kochi* Zone of the Hornsund area in SW Spitsbergen is very close to the specimens studied. The specimens in question are also similar to the densely ribbed *Costacadoceras bluethgeni* Rawson (see Rawson 1982: pl. 1: 5—6) from the lower *Ishmae* Zone of the Kong Karls Land in the eastern Svalbard. Poor preservation of the specimens prevents however closer comparisons.

Stratigraphic and geographic range. — The specimens have been found in the lower siderite layer (fig. 1) along with *Kepplerites* (*Seymourites*) *fasciculatus* Spath (= *K. stephanoides* Callomon) which is the diagnostic form of the lower subzone of the *Cranocephaloide* Zone of the Boreal Bathonian. The specimens from Central Siberia (cf. synonymy) are known from the *Kochi* Zone which covers the indicated stratigraphical interval (see Meledina *et al.* 1987).

Subfamily **Cadoceratinae** Hyatt, 1900
Genus *Pseudocadoceras* Buckman, 1918
Pseudocadoceras nanseni (Pompeckj, 1899)
(pl. 24: 1ab)

?1897. *Ammonites* (*Macrocephalites*) *macrocephalus* Schlotheim; Newton and Teall: 497, pl. 39: 1—2.
1899. *Cadoceras Nanseni* Pompeckj: 86, fig. 16ab, pl. 2: 6ab (*non* figs. 1, 2, 3ab, 5).
1932. *Pseudocadoceras nanseni* (Pompeckj); Spath: 62, pl. 9: 2ab, pl. 11: 4.
non 1972. *Pseudocadoceras nanseni* (Pomp.); Meledina: 111, fig. 2, pl. 8: 1ab.
1982. *Costacadoceras nanseni* (Pompeckj); Rawson: 96.

Material. — One specimen (IGPUW/A21/23) from the upper siderite layer in locality 1.

Description. — Incomplete somewhat flattened microconch of middle size (D = = 38 mm); whorls high and narrow (Wh = 47%). The ribbing on the last whorl preserved (?still phragmocone) is dense, moderately strong and prorsiradiate. Primary ribs strongly twisted at the umbilicus; they split indistinctly above the mid-height of whorl into two secondaries, but simple ribs also occur; in the outer part of whorl there appear the intercalatory ribs which are sinuously curved. Umbilicus shallow, initially rather narrow, then, at the end of the preserved part of phragmocone, wider (Ud = 26%).

Remarks. — The studied specimen does not differ from the specimens regarded as typical of *P. nanseni* from the Franz Josef Land, the lectotype included. The still existing discrepancies in interpretation of the species, may be ascribed to an equivocality of its original diagnosis (Pompeckj 1899) and to poor recognition of its age. It should be remembered that the species has been first emended by Spath (1932) who distinguished the specimen presented by Pompeckj (1899: fig. 16) as the lectotype. He rejected the possibility of attaining larger sizes by the representatives of the species; consequently, the species has been allocated into the microconch genus *Pseudocadoceras*. Spath (1932: pl. 9: 2, pl. 11: 4) presented also new specimens found similarly as the lectotype, in Franz Josef Land. Only a few *Pseudocadoceras* species may be partly compared with the discussed one, e.g. *P. concinnum* (Buckman) found close to the boundary of the Middle and Upper Callovian of England, as well as some species of the *P. grewingki* group of Alaska, and British Columbia such as *P. grewingki* (Pompeckj), *P. schmidti* (Pompeckj), and *P. petelini* (Pompeckj) (see Pompeckj 1900; Imlay 1953; Frebold and Tipper 1967). The specimens from Eastern Siberian *Kochi* Zone, attributed to *P. nanseni* by Meledina (1972, 1973, 1987), most probably represent and older, not strictly related species.

The opinion of Rawson (1982) that *P. nanseni* due to an oval cross-section of the juvenile whorls of its lectotype, belongs to the genus *Costacadoceras* does not seem convincing.

Stratigraphic and geographic range. — The exact stratigraphical position of the specimens of Pompeckj (1899) and Spath (1932) is unknown; according to some opinions (Meledina 1972) they come from the Middle Callovian. The specimens attributed to *P. nanseni* by Sazonov (1965) from the Russian Platform (area of Elatma) also come from the Middle Callovian.

Genus *Cadoceras* Fischer, 1882

Cadoceras cf. *apertum* Callomon et Birkelund, 1985

(pl. 23: 1)

cf. 1985. *Cadoceras apertum* Callomon et Birkelund: 80, pl. 3: 1, 4, 5, fig. 8e.

Material. — One specimen (IGPUW/A21/3) from the middle siderite layer in locality 1.

Description. — An incomplete phragmocone, about 25 mm in diameter. The specimen is moderately evolute; cross-section of the last whorl of phragmocone oval (Wh = 36%), thickest at about one fourth of whorl height. Primary ribs somewhat swollen, prorsiradiate, rather short; about 15 primaries per half of the whorl. They split below the midheight of whorl into 2, more rectiradiate to somewhat rursiradiate, secondary ribs. The umbilical wall poorly developed, somewhat curved; the ventral side of whorl slightly deformed, but generally rounded. The umbilicus shallow and moderately wide (Ud = 37%).

Remarks. — The discussed specimen is similar to the microconchs from East Greenland distinguished together with corresponding macroconchs by Callomon and Birkelund (1985) as new biospecies — *Cadoceras apertum* Callomon et Birkelund However, the specimen is incomplete and it is impossible to discuss it in detail as well as determine its relationship to the microconch taxa known so far.

Stratigraphic and geographic range. — *Cadoceras apertum* is known from East Greenland where it is indicative of the *Apertum* Zone of the Lower Callovian (Callomon and Birkelund 1985).

Subgenus *Cadoceras* (*Paracadoceras*) Crickmay, 1930 (= *Streptocadoceras* Meledina, 1977)

Cadoceras (*Paracadoceras*) cf. *victor* Spath, 1932

(pl. 23: 2)

cf. 1932. *Cadoceras victor* Spath: 67, pl. 16: 6a—c.

Material. — One specimen (IGPUW/A21/27) in locality 1 found in the rubble, but most probably coming from the middle siderite layer.

Description. — Macroconch represented by incomplete, partly deformed phragmocone, about D = 110 mm in diameter. The ribbing is well visible on the last whorl preserved, and partly on the penultimate whorl. The inner whorl flattened and moderately densely ribbed; the primary ribs somewhat swollen mostly close to the point of furcation and strongly prorsiradiate, they split rather low on the whorl side into two, prorsiradiate secondaries. The umbilicus wide and shallow. This type of ornamentation begins to modify on the last half of whorl preserved: the primary ribs still prorsiradiate become sparser and tend to be wider and more flattened. At the same time the whorl thickness probably increases and the tubercle-like swellings of the primary ribs appear on the rounded umbilical wall. The umbilical wall, slightly curled, shows the presence of ribbing; the umbilicus is still wide (Ud = 36%).

Remarks. — The discussed specimen seems close to *Cadoceras* (*Paracadoceras*) *elatmae* group, especially to *C.* (*P.*) *victor* Spath described from East Greenland (Spath 1932: pl. 16: 6a—c). The specimen in question differs from *C.* (*P.*) *elatmae* Nikitin (see Nikitin 1881: pl. 4: 20) in larger size and much later disappearance of the secondary ribbing. It differs also from *C.* (*P.*) *anabarense* Bodylevsky (see holotype in: Bodylevsky 1960: pl. 4: 3, and also Meledina 1977: pl. 21: 1, pl. 22: 1, pl. 23: 1) in narrower umbilical wall without sharp umbilical edge. The specimen in question differs from *C.* (*P.*) cf. *multiforme* Imlay, coming most probably from the same layer, in different type of the umbilicus on the last whorls as well as in the denser ribbing. The discussed specimen differs mostly from *Cadoceras calyx* Spath (see Spath 1932: pl. 20: 1*ab*) in the presence of narrower, not so well separated umbilical wall and in somewhat different ribbing.

Stratigraphic and geographic range. — The holotype of *C.* (*P.*) *victor* Spath has been found in the Vardekløft Fm., in the *Tychonis* Zone, in East Greenland. Meledina (1972) reported *Cadoceras* ex gr. *victor* Spath from the deposits well above the *Kochi* Zone in the Lena river area in Siberia.

Cadoceras (*Paracadoceras*) cf. *multiforme* Imlay, 1953

(pl. 23: 3ab)

cf. 1953. *Cadoceras* (*Paracadoceras*) *multiforme* Imlay: 88, pl. 42: 1—2, 5—8, 10.

Material. — One specimen (IGPUW/A21/40) in locality 1, found in the rubble, but most probably coming from the middle siderite layer.

Description. — An incomplete macroconch, 115 mm in diameter, represented by the phragmocone (preserved as imprint) and a part of the body chamber. The ribbing on phragmocone at D = 80 mm is fairly well preserved, except the periumbilical part of whorl which is completely missing: the furcation points of ribs, marked with swellings; the sparse secondary ribs flattened and prorsiradiate. The preserved part of the body chamber about half a whorl long. The initial part of the whorl section triangularly-oval with well separated, oblique and rather wide umbilical wall; the wall joins the whorl side at an angle of about 100° giving a well developed umbilical edge; it is the zone of the maximum whorl thickness. The ribbing disappears completely at the end of the phragmocone, and the body chamber becomes smooth. Umbilicus wide (Ud = 36%).

Remarks. — The studied specimen seems to correspond to *Cadoceras (Paracadoceras) multiforme* Imlay (Imlay 1953: pl. 42: 1—2, 5—8, 10). They are similar in the relatively lower degree of coiling, the character of the whorl section and rather early disappearance of ornamentation.

Stratigraphic and geographic range. — *Cadoceras (Paracadoceras) multiforme* has a rather wide geographical distribution being known from the southern Alaska, through Spitsbergen up to the northern Siberia. In Alaska it occurs in the *Catostoma* Zone (*Comma* Zone), in the upper part of the Chinitna Formation (Imlay 1953, 1975; Callomon 1984a). In northern Siberia, in the area of the Anabar river, it has been reported (Bodylevsky 1960; Meledina 1977) from the upper part of the *Elatmae* Zone.

Genus *Stenocadoceras* Imlay, 1953

Stenocadoceras multicostatum (Imlay, 1953)

(pl. 24: 2ab)

1953. *Cadoceras (Stenocadoceras) multicostatum* Imlay: 90, pl. 44: 1—16.
1977. *Stenocadoceras multicostatum* Imlay; Meledina: 133, pl. 28: 2, pl. 29: 1, pl. 31: 1ab.

Material. — Two specimens (IGPUW/A21/4, 26) from the upper siderite layer in locality 1.

Description. — Incomplete macroconchs, partly deformed and represented by phragmocones, up to 90 mm in diameter (specimen IGPUW/A21/26). At D = 55 mm the whorls are high (Wh = 38%) and the specimens moderately involute (Ud = 23%). The primary ribs moderately thick, sparse and rectiradiate, whereas the secondaries rather densely spaced and prorsiradiate; the secondaries/primaries ratio about 2.5 at D = 55 mm. The ribbing biplicate and single, but the intercalatory ribs occur in the outer part of whorl as well. The division point of ribs situated somewhat below the mid-height of whorl and often poorly marked. At D = 55—70 mm the ribbing becomes less dense and coarser; the well separated oblique umbilical wall, and the umbilical edge appear. From about 70 mm the whorl becomes smooth, and its lateral sides seem to incline stronger towards the venter. The whorl attains its maximum thickness in the lower periumbilical part, close to the umbilical edge.

Remarks. — The specimens studied are closely comparable with those from the southern Alaska (including the type specimens) and northern Siberia (cf. synonymy).

Stenocadoceras multicostatum differs from *S. bowserense* (Imlay) (see Imlay 1953: pl. 43, figs 2—3, 7—8) and *S. striatum* (Imlay) (op. cit. pl. 45: 4—7) in more evolute coiling and some features of ornamentation. The species studied differs from *S. stenoloboide* (Pompeckj) (see Pompeckj 1900: pl. 7: 2—3) in wider umbilicus, better developed umbilical wall and earlier disappearance of ribbing; Callomon, (1984a), however has regarded the names *Stenocadoceras bowserense* (Imlay), *S. multicostatum*

(Imlay) and probably *S. striatum* (Imlay) as younger synonyms of *Stenocadoceras stenoloboide* (Pompeckj).

Stratigraphic and geographic range. — *S. multicostatum* is widely distributed being known from southern Alaska (Imlay 1953), northern Siberia (Meledina 1977) and the Svalbard archipelago; in Svalbard the species has been reported earlier from the Kongsøya island in Kong Karls Land (Løfaldli and Nagy 1980) where it occurs together with *Pseudocadoceras chinitnense* (Imlay).

The species occurs in southern Alaska in the upper part of the Chinitna Formation (mostly in Paveloff Siltstone Member) and in the middle part of the Shelikof Formation. It is characteristic of *Stenocadoceras stenoloboide* ammonite assemblage and regarded as indicative of the Middle Callovian (Imlay 1953, 1975, 1980, 1981) or only its lower part (Callomon 1984a). The Siberian specimens from eastern Taymyr are, on the other hand, referred to the *Subordinarium* Zone of the Uppermost Callovian (Meledina 1977).

Genus *Longaeviceras* Buckman, 1918

?*Longaeviceras* cf. *pomeroyense* (Imlay, 1953)

(pl. 24: 3ab)

Material. — One specimen (IGPUW/A21/5) from the upper siderite layer in locality 1.

Description. — An incomplete wholly septate macroconch, strongly deformed. Primary ribs moderately strong, appearing on the umbilical wall and splitting into 2 or 3 secondary ribs. Intercalatory ribs also occur. The ventral side is strongly flattened, but as the character of ribbing suggests it was not very wide and gently rounded. The umbilicus most probably rather wide.

Remarks. — Strong deformation prevents closer determination of the specimen studied. The morphological features indicated above, as well as its stratigraphical position, suggest that the specimen is close to *Longaeviceras pomeroyense* (Imlay), the species known from southern Alaska (Imlay 1953: pl. 45: 1—3, pl. 46: 2). The systematic position of the species is however unclear: Imlay (1953) originally placed it in the subgenus *Stenocadoceras*, transfering it afterwards into *Longaeviceras*; this opinion has been accepted recently by Callomon (1984a). According to Meledina (1977) the species should be placed within the genus *Eboraciceras*, which has also some stratigraphical implications.

Stratigraphic and geographic range. — *L. pomeroyense* (Imlay) has been described from the upper part of the Chinitna Formation, and from the lower and middle members of the Shelikof Formation in south Alaska, and placed into the *Stenocadoceras stenoloboide* ammonite assemblage (Imlay 1953, 1975, 1980); the species is regarded as indicative of the Middle Callovian (Imlay 1975) or of the *Athleta* Zone of the Upper Callovian (Callomon 1984a).

REFERENCES

BÄCKSTRÖM, S. A. and NAGY, J. 1985. Depositional history and fauna of a Jurassic phosphorite conglomerate (the Brentskardhaugen Bed) in Spitsbergen. — *Norsk Polarinst. Skrift.*, **183**, 1—61.

BIRKENMAJER, K. 1972. Megaripples and phosphorite pebbles in the Rhaeto-Liassic beds south of Van Keulenfjorden, Spitsbergen. — *Norsk Polarinst. Arbok*, **1970**, 117—128.

— 1975. Jurassic and Lower Cretaceous sedimentary formations of SW Torell Land, Spitsbergen. — *Studia Geol. Polonica*, **44**, 7—43.

— 1980. Jurassic-Lower Cretaceous succession at Agardhbukta, East Spitsbergen. — *Ibidem*, **66**, 35—52.

[BODYLEVSKY, W. I.] БОДЫЛЕВСКИЙ, В. И. 1960. Келловейские аммониты Северной Сибири. — *Зап. Ленингр. Горн. Институт.*, **37**, 2, 49—81.

CALLOMON, J. H. 1959. The ammonite zones of the Middle Jurassic beds of East Greenland. — *Geol. Mag.*, **96**, 6, 505—513.

— 1975. Jurassic ammonites from the northern North Sea. — *Norsk Geol. Tidsskr.*, **55**, 373—386.

— 1984*a*. A review of the biostratigraphy of the post-Lower Bajocian Jurassic ammonites of western and northern North America. — *Geol. Assoc. Canada, Special Paper* **27**, 143—174.

— 1984*b*. Report of the Callovian working group. Int. Symp. on Jurassic Stratigraphy, Erlangen 1984, I, 77—86. Copenhagen.

— 1985. The evolution of the Jurassic ammonite family Cardioceratidae. — *Spec. Papers in Palaeont.*, **33**, 49—90.

— and BIRKELUND, T. 1980. The Jurassic transgression and the Mid-Late Jurassic succession in Milne Land, central East Greenland. — *Geol. Mag.* **117**, 3, 211—310.

— and — 1985. Appendix. Description of three new species. In: Callomon J. H. The evolution of the Jurassic ammonite family Cardioceratidae. — *Spec. Papers in Palaeont.*, **33**, 78—86.

DONOVAN, D. T. 1953. The Jurassic and Cretaceous stratigraphy and palaeontology of Traill, East Greenland. — *Medd. Grønland*, 111, 4, 1—150.

[ERSHOVA, E. S.] ЕРШОВА, Е. С. 1983. Объяснительная записка к биостратиграфической схеме юрских и нижнемеловых отложений архипелага Шпицберген. Мин. Геол. СССР, ПГО „Севморгеология", 1—88. Ленинград.

[—, KORTCHINSKAJA, M. W.] ЕРШОВА, Е. С., КОРЧИНСКАЯ, М. В. 1980. Зональная схема мезозоя Свальбарда (Шпицберген). Межд. Геол. Конгресс XXVI Сес. Доклады советских геологов. Палеонтология, Стратиграфия, 180—187. Москва.

FREBOLD, H. 1929. Oberer Lias und unteres Callovian in Spitzbergen. — *Skrift. Svalbard Ish.*, **20**, 1—24.

— 1963. Ammonite faunas of the Upper Middle Jurassic beds of the Fernie Group in western Canada. — *Bull. Geol. Surv. Canada*, **93**, 1—33.

— and TIPPER, H. W. 1967. Middle Callovian sedimentary rocks and guide ammonites from southwestern British Columbia. — *Geol. Surv. Canada, Paper* **67**—21, 1—29.

IMLAY, R. W. 1953. Callovian (Jurassic) ammonites from the United States and Alaska. Part 1, 2. — *U.S. Geol. Surv. Prof. Paper*, **249***A*, *B*, 1—108.

— 1975. Stratigraphic distribution and zonation of Jurassic (Callovian) ammonites in southern Alaska. — *Ibidem*, **836**, 1—28.

— 1980. Middle Jurassic (Bathonian) ammonites from southern Alaska. — *Ibidem*, **1091**, 1—42.

— 1981. Jurassic (Bathonian and Callovian) ammonites in eastern Oregon and western Idaho. — *Ibidem*, **1142**, 1—24.

KRAJEWSKI, K. P. (in press). Phosphorization in a starved shallow shelf environmen: the Brentskardhaugen Bed (Toarcian-Bajocian) in central Spitsbergen.

— (in press). Organic geochemistry of a phosphorite to black shale transgressive

succession: the Wilhelmøya and Janusfjellet Formations (Rhaetian-Jurassic) in central Spitsbergen. *In*: Chemical geology. Elsevier. Amsterdam.

LØFALDLI, M. and NAGY, J. 1980. Foraminiferal stratigraphy of Jurassic deposits of Kongsøya, Svalbard. — *Norsk Polarinst. Skrift.*, **172**, 63—95.

MAJOR, H. and NAGY, J. 1972. Geology of the Adventdalen map area. — *Ibidem*, **138**, 1—58.

[MELEDINA, S. W.] МЕЛЕДИНА, С. В. 1972. О возрасте и географическом распространении зоны *Arcticoceras kochi* в Бореальной области. Проблемы палеозоогеографии мезозоя Сибири. — *Тр. Инст. Геол. Геоф. Акад. Наук СССР, Сибирск. Отдел.*, **111**, 102—113.

— 1973. Аммониты и зональная стратиграфия байоса-бата Сибири. — *Ibidem*, **153**, 1—152.

— 1977. Аммониты и зональная стратыграфия келловея Сибири. *Ibidem*, **356**, 1—290.

— 1987. Аммониты и зональная стратыграфия келловея суббореальных районов СССР. — *Ibidem*, **691**, 1—184.

[—, NALNJAEVA, T. I., SCHURIGIN, B. N.] —, НАЛЬНЯЕВА, Т. И., ШУРЫГИН, Б. Н. 1987. Юра Енисей-Хатангского Прогиба. Инст. Геол. и Геоф. Акад. Наук СССР, Сибирск. Отд., 1—127. Новосибирск.

MØRK, A., KNARUD, R. and WORSLEY, D. 1982. Depositional and diagenetic environments of the Triassic and Lower Jurassic succession of Svalbard. *In*: A. F. Embry and H. R. Balkwill (eds.), Arctic Geology and Geophysics. — *Canadian Soc. Petrol. Geol., Mem.*, **8**, 371—398.

NEWTON, E. T. and TEALL, J. J. H. 1897. Notes on a collection of rocks and fossils from Franz Josef Land, made by the Jackson-Harmsworth Expedition during 1894—1896. — *Quart. Journ. Geol. Soc. London*, **53**, 477—519.

NIKITIN, S. 1881. Der Jura der Umgegend von Elatma. — *Mém. Soc. Imp. Nat. Moscou, nouv. mém*, **14**, 1, 87—133.

[PCHELINA, T. M.] ПЧЕЛИНА, Т. М. 1967. Стратиграфия и некоторые особенности вещественного состава мезозойских отложений южных и восточных районов Западного Шпицбергена. Мат. по геологии Шпицбергена, Науч.-Иссл. Инст. Геологии Арктики, 127—158, Ленинград.

POMPECKJ, J. F. 1899. The Jurassic fauna of Cape Flora, Franz Josef Land, *In*: Nansen, F. (ed.), The Norwegian North Polar Expedition, 1893—96. Scientific results. 1, 2, 33—148. Christiana.

— 1900. Jura-Fossilien aus Alaska. — *Verh. Russ. kais. Mineral. Ges. S. Petersburg*, ser. 2, **38**, 239—282.

RAVN, J. P. J. 1911. On Jurassic and Cretaceous fossils from north-East Greenland. — *Medd. Grønland*, **45**, 437—500.

RAWSON, P. F. 1982. New Arctocephalitinae (Ammonoidea) from the Middle Jurassic of Kong Karls Land, Svalbard. — *Geol. Mag.* **119**, 1, 95—100.

[SAZONOV, N. T.] САЗОНОВ, Н. Т. 1965. Новые данные о келловейских, оксфордских и киммериджских аммонитах. Фауна мезозоя европ. части СССР и Сред. Азии, 1—99. Москва.

SOKOLOV, D. and BODYLEVSKY, W. 1931. Jura und Kreidefaunen von Spitzbergen. — *Skrift. Svalbard Ish.*, **35**, 1—151.

SPATH, L. F. 1932. The invertebrate faunas of the Bathonian-Callovian deposits of Jameson Land (East Greenland). — *Medd. Grønland*, **87**, 7, 1—158.

TAYLOR, D. G., CALLOMON, J. H., HALL, R., SMITH, P. L., TIPPER, H. W. and WESTERMANN, G. E. G. 1984. Jurassic ammonite biogeography of western North America: the tectonic implications. — *Geol. Assoc. Canada, Spec. Paper*, **27**, 121—142.

WHITEAVES, J. F. 1876. On some invertebrates from the coal-bearing rocks of the Queen Charlotte Islands. Mesozoic Fossils, 1, 1, Geolog. Survey Canada, 1—92. Montreal.

WIERZBOWSKI, A., KULICKI, C. and PUGACZEWSKA, H. 1981. Fauna and stratigraphy of the Uppermost Triassic and the Toarcian and Aalenian deposits in the Sassenfjorden, Spitsbergen. — *Acta Palaeont. Polonica*, **26**, 3—4, 195—241.

JANUSZ KOPIK i ANDRZEJ WIERZBOWSKI

AMONITY I STRATYGRAFIA BATONU I KELOWEJU OKOLIC JANUSFJELLET I WIMANFJELLET W SASSENFJORDEN, SPITSBERGEN

Streszczenie

Opisano trzy zespoły amonitów zebrane z przeławiceń syderytowych wśród łupków reprezentujących niższą część formacji Janusfjellet, odsłoniętych w okolicach Wimanfjellet i Janusfjellet, w Sassenfjorden na Spitsbergenie (fig. 1—2). Zespoły te zostały porównane z zespołami amonitów z innych obszarów domeny borealnej, a zwłaszcza Wschodniej Grenlandii, Syberii oraz północnej części Ameryki Północnej, co umożliwiło zaliczenie ich do odpowiednich poziomów amonitowych w stosowanych podziałach stratygraficznych (fig. 2).

Najstarszy zespół amonitów stanowią: *Kepplerites* (*Seymourites*) *fasciculatus* Spath (= *K. stephanoides* Callomon), *K.* (*Seymourites*) sp. oraz *Costacadoceras* sp. Zespół ten jest charakterystyczny dla podpoziomu *stephanoides* poziomu *cranocephaloide* z górnego batonu Wschodniej Grenlandii oraz odpowiadającej mu górnej części szeroko rozumianego poziomu *kochi* z Syberii.

Drugi zespół jest dość bogaty i reprezentowany przez następujące formy: *Kepplerites* (*Seymourites*) *svalbardensis* Bodyl., *K.* (*Toricellites*) *birkelundae* sp. n. Kopik, *K.* (*Toricellites*) aff. *zortmanensis* Imlay, *Cadoceras* cf. *apertum* Cal. et Birk., *C.* (*Paracadoceras*) cf. *victor* Spath oraz *C.* (*Paracadoceras*) cf. *multiforme* Imlay. Zespół ten reprezentuje poziom *calyx* najwyższego batonu oraz ewentualnie poziom *apertum* najniższego keloweju ze wschodniej Grenlandii, odpowiadające razem części szerokiego poziomu *elatmae* z Syberii.

Najmłodszy badany zespół amonitów złożony jest ze *Stenocadoceras multicostatum* (Imlay), *Stenocadoceras* sp., *Pseudocadoceras nanseni* (Pompeckj) oraz ?*Longaeviceras* cf. *pomeroyense* (Imlay). Amonity te mogą być uznane jako diagnostyczne dla wyższej części poziomu *coronatum* (oraz jego odpowiedników, por. fig. 2), a więc najwyższego środkowego keloweju, oraz, bądź też, niższej części poziomu *athleta* (= niższej części poziomu *Keyserlingi*), która odpowiada najniższej części keloweju górnego w podziałach ze wschodniej Grenlandii i Syberii.

W pracy przedstawiono także stosunek zbadanych zespołów do innych zespołów amonitów batonu i keloweju opisanych dotąd ze Spitsbergenu, a także z Ziemi Króla Karola w Swalbardzie (tab. 1).

Analiza zespołów amonitowych pozwoliła na określenie pozycji biogeograficznej Spitsbergenu w batonie i keloweju. Współwystępowanie przedstawicieli rodzin Cardioceratidae i Kosmoceratidae w późnym batonie wskazuje, że obszar Spitsbergenu należał w tym czasie do prowincji subborealnej podobnie jak wschodnia Grenlandia. Z kolei, w środkowym i w późnym keloweju, amonity występujące na obszarze Spitsbergenu należą wyłącznie do rodziny *Cardioceratidae*, co wskazuje, że obszar ten wszedł w obręb prowincji borealnej *s.s.*, i wykazywał tym samym szczególne pokrewieństwa faunistyczne z Syberią oraz północnymi obszarami Ameryki Północnej.

W części paleontologicznej pracy opisano 11 form należących do następujących rodzajów i podrodzajów: *Kepplerites* (*Seymourites*, *Toricellites*), *Costacadoceras*, *Cadoceras* (*Paracadoceras*), *Stenocadoceras*, *Pseudocadoceras* oraz *?Longaeviceras*. Ustanowiony został także nowy gatunek, *Kepplerites* (*Toricellites*) *birkelundae* sp. n.

Praca została wykonana w ramach programu CPBP 03.03.

EXPLANATION OF PLATES 20—24

Figures in natural size unless specified otherwise. All specimens are from Janusfjellet Formation

Plate 20

1. *Kepplerites* (*Seymourites*) *fasciculatus* Spath: body chamber with end-part of phragmocone in lateral view; locality 1 at Wimanfjellet, lower siderite layer, IGPUW/A21/9.
2. *Kepplerites* (*Seymourites*) *svalbardensis* Bodylevsky: nearly complete specimen but somewhat deformed, lateral view; locality 1 at Wimanfjellet, middle siderite layer, IGPUW/A21/1.

Plate 21

Kepplerites (*Seymourites*) *svalbardensis* Bodylevsky

1. Phragmocone and partly preserved body chamber in lateral view; locality 1 at Wimanfjellet, rubble (probably from middle siderite layer), IGPUW/A21/2.
2. Phragmocone and partly preserved body chamber in lateral view; locality 1 at Wimanfjellet, middle siderite layer, IGPUW/A21/13.

Plate 22

Costacadoceras sp.

1. Incomplete phragmocone in lateral view; locality 1 at Wimanfjellet, lower siderite layer, latex cast, IGPUW/A21/18.
2. Incomplete phragmocone in lateral view, locality 1 at Wimanfjellet, lower siderite layer, ×2, IGPUW/A21/33.

Kepplerites (*Toricellites*) *birkelundae* sp. n.

3. Phragmocone and incomplete body chamber in lateral (*a*) and ventral (*b*) views; locality 1 at Wimanfjellet, middle siderite layer, IGPUW/A21/29, holotype.
4. Adult body chamber with lappet in lateral view, locality 2 at Wimanfjellet, rubble (probably from middle siderite layer), latex cast, IGPUW/A21/22, paratype.
5. End-part of body chamber with lappet in lateral view; locality 1 at Wimanfjellet, middle siderite layer, IGPUW/A21/21.

Kepplerites (?*Toricellites*) sp.

6. Ventral view; locality 3 in Konusdalen, siderite layer (?lower siderite layer), IGPUW/A21/35.

Kepplerites (*Toricellites*) aff. *zortmanensis* Imlay

7. Phragmocone and partly preserved, strongly flattened body chamber, lateral view; locality 1 at Wimanfjellet, middle siderite layer, IGPUW/A21/24.

Kepplerites (*Seymourites*) *svalbardensis* Bodylevsky

8. Phragmocone in lateral view; locality 2 at Wimanfjellet, rubble (probably from middle siderite layer), latex cast, IGPUW/A21/16.
9. Specimen with periapertural part preserved, lateral view; locality 2 at Wimanfjellet, rubble (probably from middle siderite layer), latex cast, IGPUW/A21/17.

Plate 23

Cadoceras cf. *apertum* Callomon et Birkelund

1. Wholly septate (?) microconch, lateral view; locality 1 at Wimanfjellet, middle siderite layer, IGPUW/A21/3.

Cadoceras (*Paracadoceras*) cf. *victor* Spath

2. Phragmocone in lateral view; locality 1 at Wimanfjellet, rubble (probably from middle siderite layer), IGPUW/A21/27.

Cadoceras (*Paracadoceras*) cf. *multiforme* Imlay

3. *a* Fragmentarily preserved phragmocone and smooth body chamber, lateral view; locality 1 at Wimanfjellet, rubble (probably from middle siderite layer), IGPUW/A21/40; *b* the same specimen, latex cast of inner, wholly septate whorl.

Plate 24

Pseudocadoceras nanseni (Pompeckj)

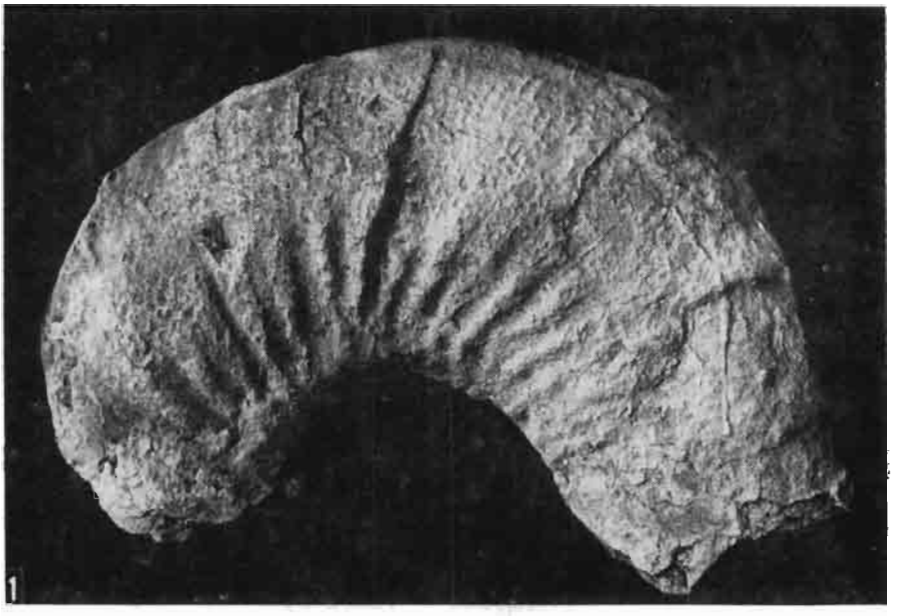
1. *a* Wholly septate (?) specimen in lateral view; locality 1 at Wimanfjellet, upper siderite layer, latex cast, IGPUW/A21/23; *b* the same specimen, fragmentarily preserved natural cast.

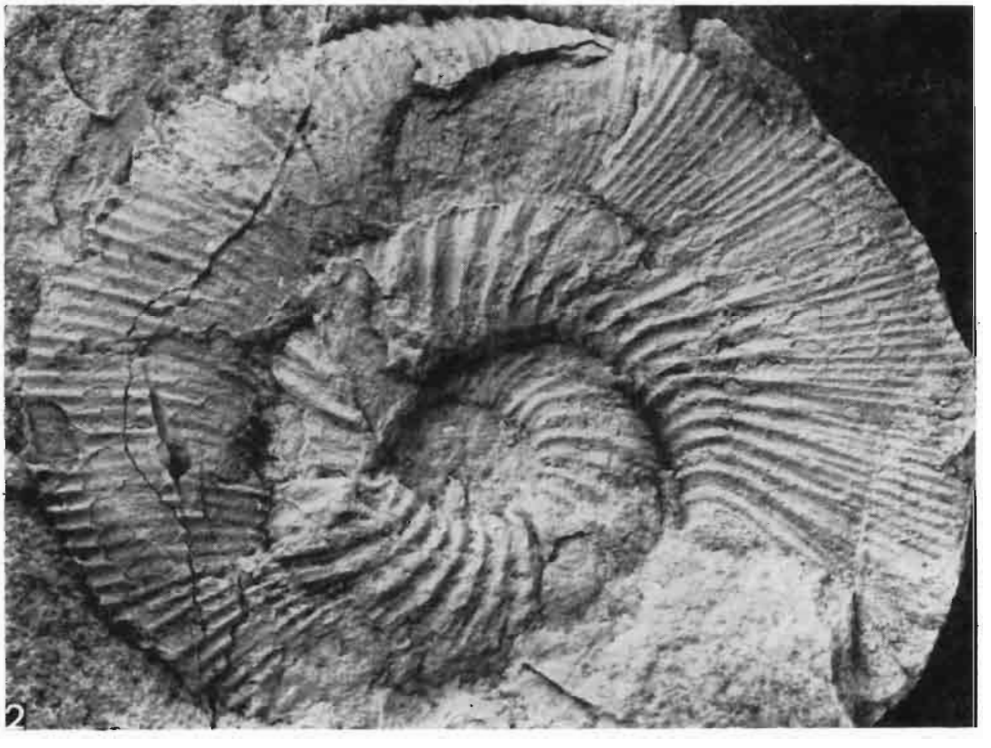
Stenocadoceras multicostatum (Imlay)

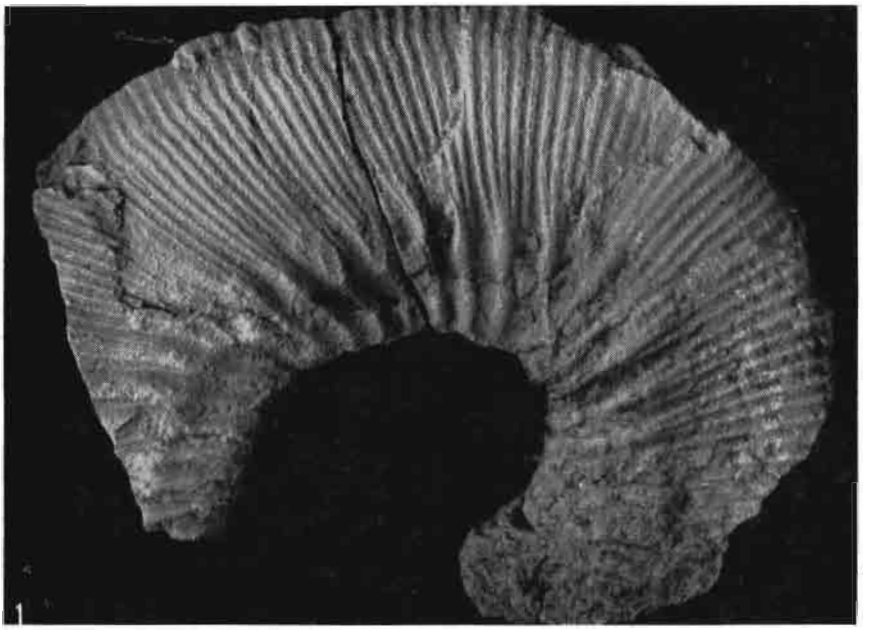
2. *a* Somewhat compressed phragmocone in lateral view; locality 1 at Wimanfjellet, upper siderite layer, IGPUW/A21/26; *b* the same specimen, smooth end-part of phragmocone in lateral view.

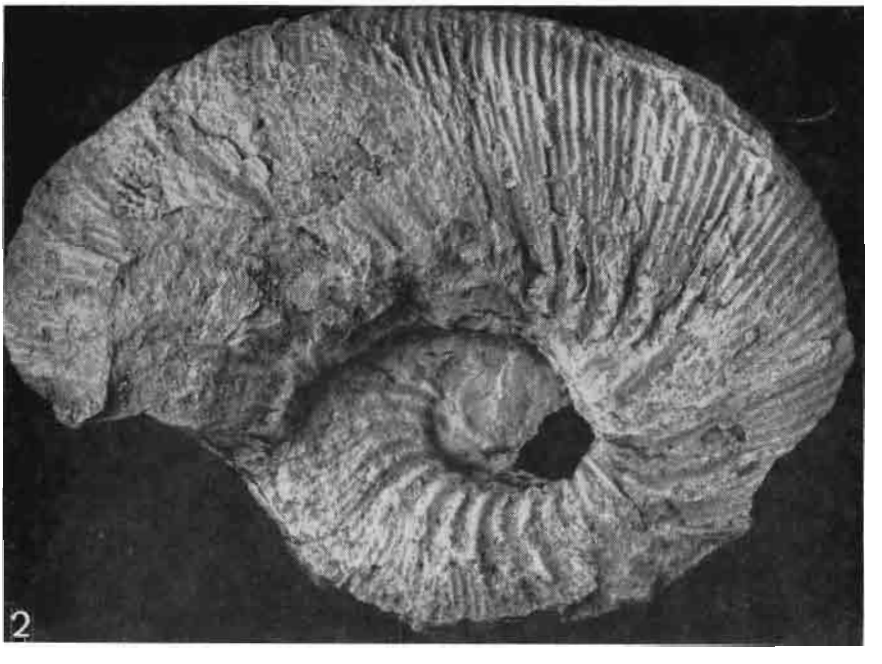
?*Longaeviceras* cf. *pomeroyense* (Imlay)

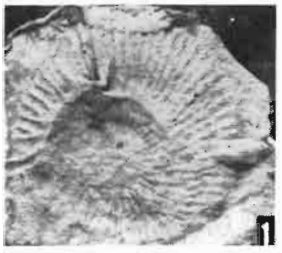
3. *a* Wholly septate, strongly deformed specimen in ventrolateral view; locality 1 at Wimanfjellet, upper siderite layer, IGPUW/A21/5; *b* the same specimen, venter flattened, ventral view.

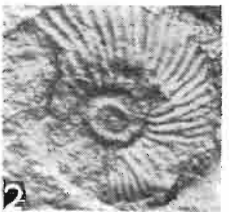

1


2


1


2

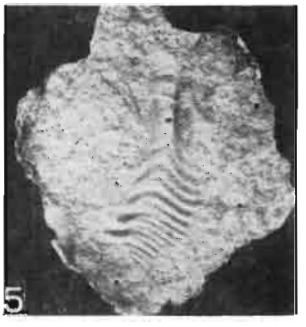

1


2

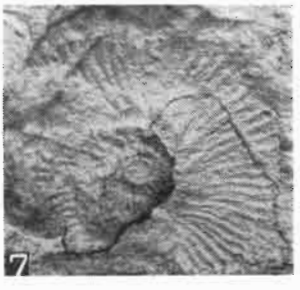

4


3a


3b


5


6

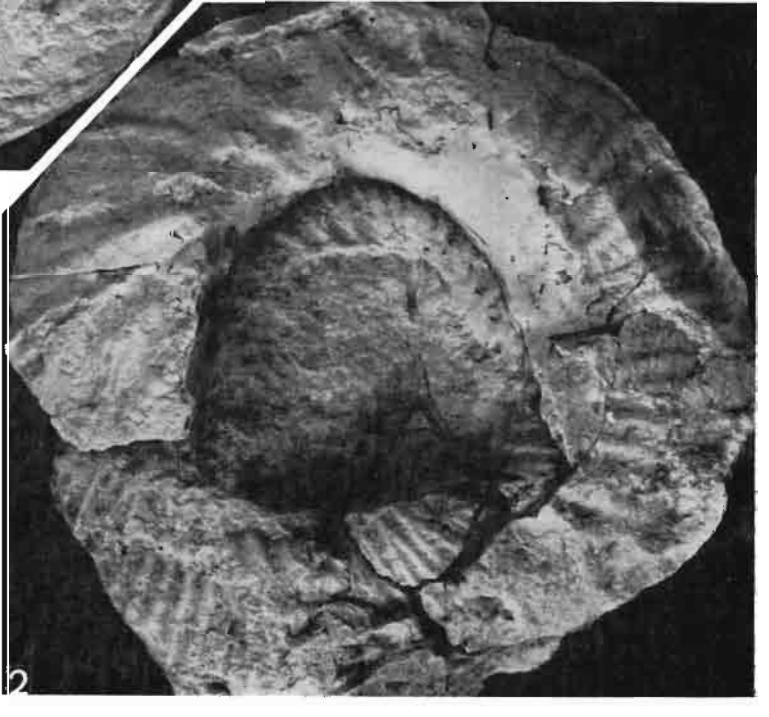

7


8


9


3b


3a

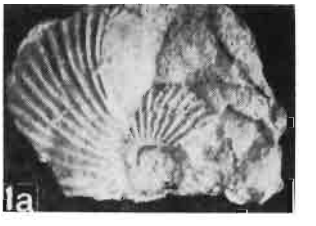

2


1


3a


2b


1b


1a


2a


3b