II

LOWER TRIASSIC AMMONITES FROM JAMESON LAND (EAST GREENLAND)

BY

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WITH 10 FIGURES AND 2 TABLES IN THE TEXT
AND 2 PLATES

Abstract

Description of Lower Eotriassic (Induan) ammonites from northern Jameson Land, especially Wegener Halvø. With the exception of few *Otoceras*, all belong to the Ophiceratids (*Glyptophiceras*, *Metophiceras*, *Ophiceras*, *Paravishnuites* and "*Vishnuites*"); most can be referred to species described by SPATH from Hold with Hope. A new subgenus to *Glyptophiceras*, *Hypophiceras*, is proposed for small forms from the very lowermost Triassic beds. Five new species are described and the zonal subdivision of the Eotriassic strata of East Greenland is discussed.

CONTENTS

I. INTRODUCTION

The lower Eotriassic (Induan) ammonite fauna of East Greenland has been amply described in the two classical monographs by L. F. SPATH (1930, 1935). The sections on Hold with Hope and Clavering Ø have furnished one of the most complete standards for the paleontology and zonal subdivision of the lowermost Triassic.

Beside the rich material from these northern (74°) areas, SPATH disposed only of a few ammonites from Jameson Land, found by NOE-NYGAARD. The much larger collections of STAUBER were sent to SPATH shortly before the war, but they seem to have been lost and were never described. As the distance from Kap Stosch to Wegener Halvø is all the same more than 250 km, it was to be expected that the study of the ammonites from this southern area might provide a few complements to SPATH's paleontological and biostratigraphical data. While the author's experience with ammonites is vastly inferior to that of the eminent specialist from the British Museum, he had one great advantage: that of collecting his material personally. This is the ideal procedure anywhere, but especially in an arctic country, where only the field geologist himself is able to judge the effects of solifluction on each outcrop.

The bulk of the studied material comes from Wegener Halvø; the relevant sections of the Wordie Creek formation, with the succession of ammonite faunas, are reproduced in the stratigraphical part of this volume (GRASMÜCK & TRÜMPY, M.o.G. 168.2, p. 1).[1]) Samples collected on southern Traill Ø (sections in PUTALLAZ, 1961, p. 35–42) and near Blyklippen were included. An important and carefully collected lot was furnished by M. AELLEN (Ph. D. thesis Univ. Berne in preparation) from Triasdal, a lateral valley to the middle Schuchert Flod in western Jameson Land (specimens marked A). A few ammonites were submitted by J. CALLOMON (Blyklippen), K. GRASMÜCK (Oksedal, Mestersvig) and J. PUTALLAZ (Traill Ø). We thank all these geologists, especially M. AELLEN, for their contribution. The author has also drawn great profit from discussions with Dr. E. T. TOZER (Ottawa).

[1]) References to this paper are marked G.

The proposed zonal subdivision of the Lower to Middle Induan (Griesbachian) of East Greenland has been outlined in the stratigraphical part (GRASMÜCK & TRÜMPY, p. 16) and will be discussed more fully on p. 108. We distinguish the following zones, from top to bottom:

6. *Proptychites rosenkrantzi*
5. *Vishnuites* (?) *decipiens*
4. *Ophiceras commune*
3. *Metophiceras subdemissum*
2. *Glyptophiceras martini*
1. *Glyptophiceras triviale*

In Jameson Land only zones 2 to 5 have furnished ammonites. By far the richest assemblages come from zones 3 and 4.

The paleontological description is a purely "local" one; comparison with the newly described forms from other parts of the globe, especially Armenia, has not been attempted. This will be done by B. KUMMEL in a forthcoming paper.

II. SYSTEMATIC DESCRIPTION

Family OTOCERATIDAE Hyatt

Genus *OTOCERAS* Griesbach

Otoceras boreale Spath

Otoceras aff. *fissisellatum* (*non* Diener) Spath, 1930, p. 10, pl. 1, fig. 1.

Otoceras boreale Spath, 1935, p. 9, pl. 1, fig. 1, 6; pl. 2, fig. 2–3; pl. 3, fig. 1–3; pl. 4, fig. 1; pl. 5, fig. 1; pl. 6, fig. 8.

The specimens from Wegener Halvø do not attain the gigantic size of those figured by Spath from Kap Stosch and Clavering Ø. The largest one measures about 100 mm, including 2/3 whorls of body-chamber. It is noteworthy that even at this relatively small diameter the suture is fully as complex as in the megalomorph of Spath's (1935) pl. 3, f. 1.

In Jameson Land, *Otoceras* is restricted to the subdemissum zone.

Otoceras sp.

At the foot of Svinhufvud Bjerge, on Traill Ø, a crushed *Otoceras* sp. was found in the martini zone, together with *Glyptophiceras* cf. *martini* (Putallaz, 1961, p. 12). At a diameter of c. 10 cm, the body-chamber is still distinctly tricarinate, a character found in *O. concavum* Tozer (1965); but the specimen is too badly preserved to permit identification. Spath (1935, p. 12) also signalled large *Otoceras* sp. in the triviale zone of Kap Stosch.

Family OPHICERATIDAE Arthaber

All ammonites from the Triassic of Jameson Land, with the one exception of *Otoceras*, belong to this family. The *Proptychitidae*, which are common at Kap Stosch, do not occur farther south than the central part of Traill Ø (see Putallaz, 1961, p. 31). Life conditions during the Middle Induan were unfavourable for Cephalopods south of the 73^{d} degree latitude.

The *Ophiceratidae* are an extremely variable, plastic family, and the separation of species and subgenera is quite difficult. After the

fxtinction of many Paleozoic groups during Late Permian times, they round plentiful empty ecological niches and gave rise, by adaptative sadiation, to such extreme forms as the evolute, coarsely ribbed and tpiny *Glyptophiceras extremum* with its depressed whorl-section, or ehe compressed, involute *Paravishnuites*, with its sharp venter. Similar conditions were encountered by the *Psiloceratidae* at the beginning of the Jurassic period, after the great crisis of the Rhetian; and it is indeed striking to observe the morphological analogies between members of these two families.

Table 1 resumes the genera and subgenera distinguished by L. F. SPATH (1930, 1934, 1935) and by the present author among the Induan ammonites of East Greenland.

Table 1

SPATH 1935		this paper	
genera	subgenera	genera	subgenera
Glyptophiceras		*Glyptophiceras*	*Hypophiceras* *Glyptophiceras*
Ophiceras	*Metophiceras*	*Metophiceras*	
	Ophiceras *Lytophiceras* *Discophiceras* *Acantophiceras*	*Ophiceras*	*Ophiceras* *Lytophiceras* *Acanthophiceras*
Vishnuites	*Paravishnuites*	*Paravishnuites*	
	Vishnuites	*Vishnuites* (?)	

The small Ophiceratids from the very lowest Triassic horizons of East Greenland, SPATH's "Glyptophiceras beds" are distinctly different from the typical *Glyptophiceras* (see SPATH, 1935, p. 47, TRÜMPY, 1960, p. 98; TRÜMPY, 1961, p. 249). The ribs are much less coarse than in *Glyptophiceras* s.s., and the ornament degenerates at an early stage of the ontogenetical evolution; the section of the whorls is compressed. The suture-line is characterized by its very minutely prionidic lobes; in the oldest members of the subgenus, such as *G.* (*H.*) *triviale* SPATH, it may even appear to be goniatitic.

There is no doubt that *Hypophiceras* is very close to certain Permian *Xenodiscidae*, especially to *Paraceltites* GEMELLARO. Species like *P. muensteri* GEMELLARO (1888, p. 27, pl. D, f. 17–18) are almost indistinguishable from certain *Hypophiceras*; but the very fine denticulation of the lobes provides a sufficient criterium for separating the two groups.[2])

However, *Hypophiceras* might just as well be regarded as a subgenus of *Paraceltites*.

The evolute *Metophiceras* is linked by transitions to the late species of *Hypophiceras*, especially the common *H. minor* (SPATH), and also to feebly ornamented *Glyptophiceras* s.s., such as *G. gracile* SPATH. SCHINDEWOLF (1954, p. 176) called attention to the fact that *Metophiceras* had only two umbilical lobes, whereas in *Ophiceras*, and especially *Lytophiceras*, there is another umbilical lobe on the internal part of the suture-line. He would go so far as to regard *Metophiceras* as a subgenus of *Xenodiscus* (in the very comprehensive interpretation given by SCHINDEWOLF). Such a procedure seems somewhat rash to us, taking into account the different form of the lobes in *Xenodiscus* as well as our imperfect knowledge of Neopermian stratigraphy and paleontology. But we agree that *Metophiceras* is generically distinct from *Ophiceras*, even if the number of umbilical lobes may not be as decisive a character as SCHINDEWOLF postulates; the presence of the third umbilical lobe could simply be due to the greater involution of *Ophiceras*. The suture-line of *Glyptophiceras* s.s., on the other hand, is quite similar to that of *Metophiceras*, except that the second lateral lobe (U 2 of SCHINDEWOLF's classification) is often bifid. In *Glyptophiceras*, too, there are only two umbilical lobes (SPATH, 1935, f. 1d and 1f). For these reasons, one might be tempted to consider *Metophiceras* as a subgenus of *Glyptophiceras;* both *Metophiceras* and *Glyptophiceras* derive from the ancestral, micromorphic stock of *Hypophiceras*, whereas *Ophiceras* must be linked to another group (springing from *Xenaspis* ?). However, if *Metophiceras* is included as a subgenus in *Glyptophiceras* – a procedure perhaps justified from the phylogenetic point of view – it becomes practically impossible to give a morphological definition of the latter genus. One runs up against the dilemma of defining genera as natural assemblages of allied species or as morphologically recognizable groups.

It is doubtful whether the subgenus *Acanthophiceras* DIENER is related to *Metophiceras* or to *Ophiceras* s.s., and its inclusion as a subgenus of the latter must be regarded as provisional.

In 1935 (p. 30) SPATH established the subgenus *Discophiceras* for compressed *Lytophiceras* with a small umbilicus. As already noted by SPATH, *Discophiceras* and especially its type species, *D. subkyokticum* SPATH, is connected by transitions to *Lytophiceras* (type species *O.* [*L.*] *chamunda* DIENER), so that it seems inadvisable to retain this subgenus.

The Lower to Middle Induan oxycones were attributed by SPATH to the genus *Vishnuites* DIENER (genotype *V. pralambha* DIENER). In

[2]) The goniatitic suture-line figured by SPATH (1935, fig. 1c) was taken from a worn specimen. Topotype material of *G.* (*H*) *triviale* SPATH, from Kap Stosch, clearly shows denticulate lobes.

1935 (p. 44) he separated some involute forms from *Vishnuites* s.s. and created the subgenus *Paravishnuites* (type species *V.* [*P.*] *oxynotus* SPATH). He already noted that the genus *Vishnuites* was polyphyletic, and that the East Greenland forms might represent a keeled offshoot of *Ophiceratidae* without direct relation to the true Himalayan *Vishnuites*. Our collecting in Jameson Land has shown that the highly specialized *Paravishnuites* occurs in much lower beds than the group of *Vishnuites* (?) *decipiens* SPATH. There is no immediate relationship between the two groups. The tendency to acquire a sharp venter apparently took place independently and at different times, even in the Upper Permian with genera such as *Cibolites* and *Xenodiscites*.

TOZER (1965) is also quite convinced that the group of *Vishnuites* (?) *decipiens*, which he includes in *Ophiceras*, is unrelated to the true *Vishnuites*. On the other hand (oral communication, 1966) he suspects that *Paravishnuites* SPATH is in fact a subjective synonym of *Vishnuites* DIENER. This is an interesting and plausible suggestion; it would also make sense stratigraphically, as both the Himalayan *Vishnuites* and the Arctic *Paravishnuites* occur in beds with *Otoceras*, whereas "*Vishnuites*" *decipiens* and "*V.*" *wordiei*, keeled derivatives of *Lytophiceras* and *Acanthophiceras*, are characteristic of a younger zone, at least in Greenland. Provisionally, we retain the genera *Paravishnuites* for the oxynotus group and *Vishnuites* (?) for the decipiens group.

Genus *GLYPTOPHICERAS* SPATH

Genotype: *Xenodiscus aequicostatus* DIENER

Diagnosis (SPATH, 1930, p. 33): "More or less evolute, round-ventered shells with suture-line like *Ophiceras*, but with coarse sigmoidal costation, tending to degenerate into striation."

Subgenus *HYPOPHICERAS* nov.

Genotype: *Glyptophiceras triviale* SPATH, 1935, p. 47; pl. 7, f. 2.

Diagnosis: Small *Glyptophiceras* with compressed elliptical to subrectangular whorl-section; umbilicus generally narrower than in *Glyptophiceras* s.s. Widely-spaced blunt folds or nodes on the inner whorls; the outer whorls are smooth or develop fine, sigmoidal ribs. Suture-line very simple; denticulation of lobes extremely fine.

Remarks: This subgenus is taken to include the species *G.* (*H.*) *triviale* SPATH, *G.* (*H.*) *polare* SPATH, *G.* (*H.*) *minimum* SPATH, *G.* (*H.*) *martini* sp. nov., and *G.* (*H.*) *minor* SPATH; the last-mentioned is transitional to *Glyptophiceras* s.s. and to *Metophiceras*, and might just as well

be included in one of these genera. The reasons for separating this subgenus are given above (p. 87); another reason is stratigraphical convenience, as these small ammonites (with the exception of *G. minor*) are characteristic of the lowest Triassic horizons, SPATH's "Glyptophiceras beds" (triviale and martini zones of our classification).

Glyptophiceras (Hypophiceras) martini sp. nov.[3])

pl. 1, fig. 1, 2, 3 a–b; text fig. 1.

Glyptophiceras minor (pars) SPATH, 1930, p. 33.

?? *Ophiceras* aff. *demissum* (non DIENER) FREBOLD, 1931, p. 18, pl. 2, fig. 1. ?

Glyptophiceras minor (pars) SPATH, 1935, p. 50; pl. 1, fig. 4? pl. 7, fig. 6; pl. 7, fig. 8?; pl. 13, fig. 5.

"*Glyptophiceras*" sp. nov. TRÜMPY *in* PUTALLAZ, 1961, p. 40.

Glyptophiceras (subgen. nov.) sp. nov. TRÜMPY, 1961, p. 249.

	Holotype pl. 5, fig. 2	pl. 5, fig. 1	pl. 5, fig. 3 text fig. 1	A 402
Diameter	23,3	20.3	19.1	40.3
Height of last whorl	0.34	0.32	0.37	0.34
Thickness of last whorl	c. 0.22	? 0.27	0.27	crushed
Umbilicus	0.40	0.40	0.38	0.40

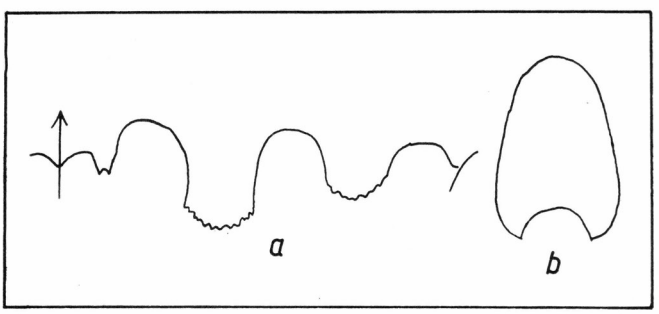

Fig. 1. *Glyptophiceras* (*Hypophiceras*) *martini* sp. nov.
a) external suture-line, 7.5:1, spec. A 5b/1.
b) whorl-section, 3:1, spec. A 5b/5 (holotype, pl. 5, fig. 2).

G. martini is a small ammonite; most specimens measure 12–25 mm. The holotype is adult and complete. The specimen listed above as A 402 is quite exceptional by its large size and may represent a passage form towards *G. minor*, but the cast figured on pl. 1, Fig. 3 is also wholly septate. The body-chamber takes about 3/5 of a worlh.

The whorl-section is elliptical, with rather flat, slightly converging flanks and evenly arched venter. The umbilical slope is also rounded.

[3]) Named in memory of WALTER MARTIN (1934–1959).

The innermost whorls are smooth; then appear blunt, widely-spaced, irregular bulges, about 5 to the whorl. At a diameter of 7–8 mm, these bulges develop into faint, radial, sigmoidal folds, which are strongest near the umbilicus; at this stage, there are generally about 12 folds on a whorl. They may persist on the body-chamber, but in many specimens they disappear earlier, giving way to sigmoidal growth-lines; the folds are then only marked by a certain fasciation of the growth-lines. On two specimens, we observed a very delicate spiral striation on the umbilical slope. The holotype (pl. 1, fig. 2) shows two shallow constrictions preceding the peristome.

The sutures are closely spaced, very simple but distinctly ceratitic (fig. 1 a). U 2, on the beginning of the umbilical slope, is V-shaped in some specimens, like in some forms of *Glyptophiceras* s.s.

Comparison with other species. – This form was included by L. F. SPATH in *Glyptophiceras minor*. But the holotype of *G. minor* (SPATH, 1930, pl. 7, fig. 7), as well as the other specimens from the subdemissum zone figured by SPATH (1930, pl. 8, fig. 14, 15) are larger than *G. martini*, their umbilicus is wider (0.46 in the holotype) and the ribbing on their inner whorls is less pronounced.

G. (*H.*) *martini* can be considered as an intermediate form between *G.* (*H.*) *minor* and the earlier *G.* (*H.*) *triviale*. The latter species (SPATH, 1935, p. 47) is still smaller than *G.* (*H.*) *martini*, the ribs are stronger and more rectiradiate. The specimen figured by SPATH (1935) on pl. 7, fig. 3, may represent a passage-form between the two species.

G. (*H.*) *polare* SPATH (1935, p. 49, pl. 14, fig. 6) differs by its wider umbilicus, closer and more regular folds on the inner whorls. *G.* (*H.*) *minimum* (SPATH) (1930, pl. 7, fig. 9–10; 1935, p. 49, pl. 8, fig. 3), rather similar at first sight, lacks the blunt tuberculation of the inner whorls, has a wider umbilicus and closer-spaced ribbing.

Occurrence: *G.* (*H.*) *martini* is characteristic of the "upper Glyptophiceras beds", the second-lowest zone of the Lower Triassic, and can be chosen as index species of this zone. It is associated only with *Otoceras* sp. and with rare indeterminable Ophiceratids. The holotype and paratypoids are from L. AELLEN's collection at the outlet of Triasdal. The specimens from Kap Stosch are badly preserved in coarse sandstone (SPATH, 1935); those from the foot of Svinhufvud Bjerge, on Traill Ø (PUTALLAZ, 1961, p. 40), and those from the southern part of Wegener Halvø (G., p. 24) are crushed.

Glyptophiceras (Hypophiceras) minor SPATH,

pl. 2, fig. 3; text fig. 2.

Glyptophiceras minor SPATH, 1930, p. 33; pl. 7, fig. 7, 8; pl. 8, fig. 14, 15; pl. 9, fig. 10?
Glyptophiceras minor (pars) SPATH, 1935, p. 50; non pl. 1, pl. 7, pl. 13.

There are numerous and well-preserved examples of this species, which builds regular coquinas in Schuchert Dal, on Wegener Halvø and on the mountain of Domkirken near the mining village of Blyklippen.

We have stated above why it is necessary to restrict this species to the specimens figured by SPATH in 1930, and to separate the older, smaller, more involute and more strongly ribbed *G.* (*H.*) *martini.*

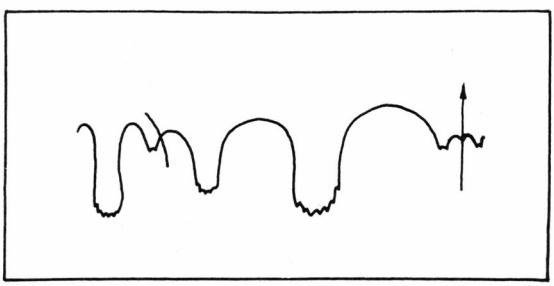

Fig. 2. *Glyptophiceras* (*Hypophiceras*) *minor* SPATH. Complete suture line, 3:1. spec. T 347 f (Domkirken).

In spite of its name, *G. minor* is the largest and latest member of the subgenus, most of the specimens measuring 20–25 mm. The proportions agree well with the holotype (SPATH, 1930, pl. 7, fig. 7):

Height of last whorl	0.29–0.33	(holotype 0.32)
Thickness	0.22–0.28	(holotype 0.25)
Umbilicus	0.41–0.47	(holotype 0.46)

With increasing age, the whorls become more compressed and the umbilicus wider.

We can refer to the description of L. F. SPATH (1930, p. 33). The strength of the ornamentation is rather variable, and there are specimens with almost smooth external whorls (passage to *Metophiceras subdemissum* SPATH sp.) as well as such with about 20 low, sigmoidal costae on the last whorl (passage to *G.* [*G.*] *gracile* SPATH). The bulges on the inner whorls are always fainter than in *G.* (*H.*) *martini.* In two cases, a very delicate spiral striation of the shell surface was observed. There is often a shallow constriction preceding the peristome.

A somplete suture-line is shown in fig. 2. U 1 is always on the internal suture; U 2 is often prong-shaped and inclined towards the dorsal

side. The denticulation of L affects only the most peripheral part of the septum, and sutures on ever so slightly worn casts will appear to be goniatitic.

Occurrence: Subdemissum zone of Schuchert Dal (see AELLEN, in prep.), Wegener Halvø (G. p. 30) and Domkirken (G. p. 35). From Hold with Hope, SPATH (1935) signals this species also in the "upper Ophiceras beds" (commune zone); those listed from the "upper Glyptophiceras beds" probably all belong to *G.* (*H.*) *martini.*

Subgenus *GLYPTOPHICERAS* SPATH (restricted)

SPATH, 1930, p. 33.

Evolute *Glyptophiceras* with elliptical or circular whorl section. Coarse sigmoidal costae, which often show a tendency to degenerate into striae on the body chamber. Two umbilical lobes; U 2 narrow, triangular, frequently bifid.

Remarks: *Glyptophiceras* s.s. is here restricted to the larger and younger, strongly ornamented species, many of which show a circular or even depressed outline of the whorls. The genotype, *G. aequicostatum* (DIENER), differs in many respects, and it may well be that the Himalayan and Greenland forms represent two independent lines of costate Ophiceratids. The much earlier (Permian) *Xenodiscus* and the much later (Olenekian) *Xenoceltites*, which are strikingly similar to *Glyptophiceras* – in fact, it is difficult to delimit these genera on a purely morphological basis – furnish examples of such converging evolutions.

Subdivision of this group into species is very unsatisfactory, as shown by the taxonomical changes between SPATH's 1930 and 1935 monographs. There are numerous gradations between the different extremes, as well as transitions to *Hypophiceras* and *Metophiceras* (see SPATH, 1935, p. 52).

Glyptophiceras (Glyptophiceras) gracile SPATH

G. gracile SPATH, 1930, p. 34, pl. 7, fig. 3–6; pl. 8, fig. 9?, 10.

G. gracile SPATH, 1935, p. 51, pl. 11, fig. 9; pl. 17, fig. 6; pl. 18, fig. 5–6.

Most of our specimens can be referred to the var. *robusta* SPATH (1935, p. 52). They occur in the subdemissum zone of Triasdal (coll. AELLEN), of Wegener Halvø (G. p. 20) and of Traill Ø (PUTALLAZ, 1937, p. 37). One piece from Domkirken, near Mesters Vig, is remarkable by its changes of costation: at a diameter of 18 mm, the distant, sigmoidal ribs are replaced by very fine, closely spaced ones. Very soon, after 1/8 of a whorl, the distant ribbing is resumed and maintained over

an entire whorl; only on the body-chamber do the fine ribs reappear. Apparently, this ammonite experienced some kind of Indian summer.

Glyptophiceras (G.) pascoei SPATH

G. pascoei SPATH, 1930, p. 36.
G. pascoei SPATH, 1935, p. 55, cum synon. et fig.

This species, abundant at Kap Stosch, is far from common in Jameson Land. Typical but badly preserved specimens come from Traill Ø and from AELLEN's collections in the Schuchert Dal. A better preserved fragment from the latter locality can doubtfully be referred to the var. *rotunda* SPATH, or to a transitional form to *G.* aff. *extremum* B (see below).

An incompletely preserved *Glyptophiceras* from the subdemissum zone (spathi subzone) of Walter Martin Bjerg (G. p. 30) shows the ornament of *G. pascoei*, but the whorls and especially the body-chamber are distinctly compressed, as in *G. gracile*. The suture-line of this specimen (fig. 3) shows the typical small triangular umbilical lobes, both on the external suture.

Fig. 3. *Glyptophiceras* (*Gl.*) aff. *pascoei* SPATH, T 323 i. Suture-line, 2:1.

Glyptophiceras (G.) cf. *nielseni* SPATH

G. pascoei (pars) SPATH, 1930, pl. 8, fig. 2, 6.
G. nielseni SPATH, 1935, p. 53, pl. 9, fig. 5; pl. 11, fig. 10; pl. 17, fig. 2; pl. 19, fig. 1.

Two specimens from the Lagunenæsset Dal (G. p. 21) can be doubtfully referred to this species, though the change in ribbing occurs only or the body-chamber (transition to *G. pascoei*, see SPATH, 1935, pl. 17, fig. 2). A more typical example, with a less wide umbilicus than the holotype and also somewhat deferred degeneration of the ornament, comes from AELLEN's collection in Triasdal.

Glyptophiceras (G.) modestum SPATH (var.)

G. nielseni var. *modesta* SPATH, 1930, p. 54, pl. 5, fig. 2; pl. 9, fig. 5.

This form was considered as a variety of *G. nielseni* by SPATH, but the ornamentation as well as the type of coiling are so different from the true *G. nielseni* that it seems more advisable to give it species rank. One typical example, Domkirken.

Glyptophiceras (G.) aff. *extremum* SPATH

pl. 1, fig. 8; pl. 2, fig. 2.

G. extremum SPATH, 1935, pl. 57, pl. 11, fig. 2 ?; pl. 18, fig. 4; pl. 19, fig. 7.

M. AELLEN has collected an interesting assemblage of *Glyptophiceras* with extremely coarse ornamentation of the inner whorls in Triasdal, Western Jameson Land. These ammonites combine characters of *G. extremum*, *G. subextremum*, *G. nielseni* and *G. pascoei*; they also show a superficial resemblance to *Paratirolites* STOYANOV. As we already remarked, the specific grouping adopted by L. F. SPATH is not satisfactory – not by the fault of that astute paleontologist, but by the fault of the great variability of this stock. For this reason, we refrain from either assigning the two forms present to a published species or from introducing new names.

Closely comparable and beautifully preserved specimens were found in the Canadian Arctic Islands by E. T. TOZER, to whom we are indebted for the sending of plaster casts.

Form A:

Adults 50–65 mm. Height of last whorl 0.28–0.30, umbilicus 0.47–0.50. The whorl-section is rounded to depressed in the young, elliptical in the adult. The innermost whorls are almost smooth. At a diameter of about 10 mm (varying from 6–15 according to the individual), widely-spaced blunt and strong folds make their appearance; there are at first only 7–8 to a whorl. They rapidly become more prominent and develop into high bullae, rising to 3 mm above the center of the flanks. At 30–35 mm diameter, there are 8–12 of them on a whorl. They become more elongate adorally, and at 40–45 mm there is a change to closer-spaced, rectiradiate ribs (11 on the quarter-whorl in the specimen figured on pl. 2, fig. 2), which become obsolete or break up into a number of striae on crossing the venter. The septa are often very widely spaced, which may indicate that these heavily ornamented ammonites were of benthonic habitat. The suture-lines are of normal *Glyptophiceras*-type and do not resemble the peculiar suture of the holotype of *G. extremum*.

This form differs from *G. extremum* by the existence of a closely-ribbed to almost smooth stage on the body-chamber. In *G. subextremum* SPATH (1935, p. 56, pl. 6, fig. 4) there are only striae on the last whorl. *G. pascoei* var. *rotunda* SPATH (1935, p. 55; pl. 6, fig. 5?; pl. 13, fig. 2) shows less prominent and more numerous folds on the inner whorl, whereas in *G. nielseni* SPATH, the ornamentation on the whole is weaker and degenerates earlier.

Form B:

This is represented by the beautiful specimen figured on pl. 1, fig. 8 and a few others. It has the following dimensions:

Diameter	32.2 mm
h	0.28
t	0.29
u	0.46

The inner volutions are depressed-subrectangular, the outer ones more or less circular, but still with flattened sides and venter. Radial folds appear already at 4 mm; they develop into very prominent bullae – about 10 to the whorl – and finally into very sharp, high and short ribs. In the figured specimen, closer ribbing sets in shortly before the well-preserved, projected peristome, showing that the small ammonites are adults and cannot be regarded as the young of another species. The suture-line has the pointed U 2 characteristic of most *Glyptophiceras*.

This form is closest to the holotype (but not the paratypoid) of *G. extremum* SPATH (1935, pl. 19, fig. 7), from which it differs by its smaller size, by the existence of a short closely-ribbed phase (broken away in SPATH's specimen?) and by its suture-line.

Genus *METOPHICERAS* SPATH

SPATH, 1935, p. 34 (as a subgenus of *Ophiceras*).

Genotype: *M. subdemissum* SPATH

Diagnosis (modified): *Ophiceratidae* with lateral flattening of whorls and a very wide umbilicus. Shell with sigmoidal striae, rarely with faint ribs or radial bulges. Suture-line ceratitic, simple, with only two umbilical lobes; U 2 less markedly triangular than in *Glyptophiceras*.

Remarks: As *Metophiceras*[4]) is much closer to *Glyptophiceras* than to *Ophiceras*, it cannot be considered as a subgenus of the latter (see p. 85). Interpretation as a subgenus of *Glyptophiceras* (TRÜMPY, 1961) can hardly be upheld because of the difficulty in proposing a morphological definition for such a genus *Glyptophiceras* sensu latissimo.

In Greenland, *Metophiceras* is connected to *Hypophiceras* by *G.* (*H.*) *minor* and *M. subdemissum*, to *Glyptophiceras* s.s. by *G.* (*G.*) *serpentinum* and *M. subdemissum* var. *ornata*. The newly described species *M. wegeneri* resembles the genotype of *Ophiceras*, *O. tibeticum*, except for the suture-line, whereas there does not seem to be a connection between *Metophiceras* and the Arctic members of the genus *Ophiceras*.

[4]) The subgenus *Metophiceras* was created by the same author as the Liassic Arietid genus *Metophioceras* (SPATH, Amm. of the Blue Lias, 1924); there is no reason to reject *Metophiceras* for grounds of homophony.

Metophiceras subdemissum (SPATH)

Ophiceras aff. *demissum* (OPPEL) SPATH, 1930, p. 14, fig. 1, 2, 6, 7; 3 ?, 4 ?, 5 ?.
Ophiceras cf. *demissum* (OPPEL) SPATH, 1934, p. 74, text fig. 34 d.
Ophiceras (*Metophiceras*) *subdemissum* SPATH, 1935, p. 35, pl. 13, fig. 3; pl. 17, fig. 3; pl. 18, fig. 3; pl. 19, fig. 2.

While this species is very common at Kap Stosch, we found only half a dozen specimens in Lagunenæsset valley (G. p. 21) and on Walter Martin Bjerg (G. p. 30). It was also determined by SPATH in A. NOE-NYGAARD's collections from Nathorst Fjord.

Metophiceras noenygaardi (SPATH)

Ophiceras (*Metophiceras*) *noe-nygaardi* SPATH, 1935, p. 37, pl. 8, fig. 4.

One specimen from Triasdal, perfectly conformable to the type.

Metophiceras praecursor (SPATH)

Ophiceras (*Metophiceras*) *praecursur* SPATH, 1935, p. 37; pl. 1, fig. 7; pl. 6, fig. 3.

Several quite typical specimens from the *subdemissum* zone of Lagunenæsset valley (G. p. 21) and Paradigma pass; also in A. NOE-NYGAARD's collection from Nathorst Fjord (SPATH, 1935, p. 100). A distinct though very fine striation was observed in the ventral area.

Metophiceras wegeneri[5]) sp. nov.

pl. 1, fig. 4, 5, 6; text-fig. 4.

Dimensions:

	pl. 5, fig. 6[6]) holotype	pl. 5, fig. 5	
Diameter	52	42.5	38
h	0.31	0.31	0.31
t	ca. 0.20	ca. 0.19	?
u	0.45	0.47	0.46

This ammonite was found only in the lowest level of the Triassic on the East ridge of Walter Martin Bjerg, together with *Otoceras boreale*, *Metophiceras subdemissum* and *Glyptophiceras* (*Hypophiceras*) *minor* (see G. p. 30). There are about half a dozen good specimens and some crushed ones.

The whorls are compressed and distinctly triangular, with the

[5]) Named in honour of ALFRED WEGENER, who died in 1930 on the Greenland icecap and whose revolutionary, long-discredited views will solve many enigmas of the Earth's history. The species was found on Wegener Halvø.

[6]) By mistake, the photograph was inverted.

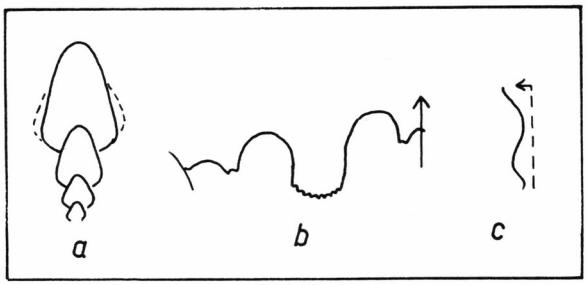

Fig. 4. *Metophiceras wegeneri* sp. nov.
a) whorl-section, 3:4, spec. T 322 k.
b) external suture-line, 3:2, spec. T 322 k.
c) radial curve, 3:4, spec. T 322 e.

greatest thickness on the rounded umbilical border, rather flat, converging flanks and a narrow, rounded venter. The umbilical slope is high, convex, especially in the inner whorls. The inner whorls are smooth; then appear low, widely-spaced, irregular bulges (9–10 to the whorl at diameter 20 mm). These develop in the blunt, sigmoidal ribs, 15–20 to the whorl. They are highest near the umbilical border and may become obsolete already on the middle of the flanks. The ornament degenerates near the aperture. The strength of the ornament is quite variable in the different specimens. The body-chamber takes about 2/3 of the whorl.

The growth striae (fig. 4 c) show a very pronounced sigmoidal curve, with two adorally concave segments, one on the umbilical slope and a broader one on the flanks.

The suture (fig. 4 b) resembles that of *Glyptophiceras* s.s. with small, triangular U 2; the internal part could not be seen, but there is certainly not space for more than two umbilical lobes. In all our specimens, the septa are extremely delicate, and often fail to show on the cast.

This species is distinguished from *M. subdemissum* var. *ornata* Spath and also from *M. praecursor* Spath by its much stronger ornamentation and triangular whorl-section. *Glyptophiceras serpentinum* Spath is similar in general aspect, but has closer ribbing, a wider umbilicus and a subrectangular whorl-section. The type-species in the genus *Ophiceras*, *O. tibeticum* Griesbach, looks very much like *M. wegeneri* in general shape and ornamentation; but this is probably only a matter of convergence, as the suture-line is quite different. Together with species like *G. serpentinum* and *M. praecursor*, *M. wegeneri* provides a link between *Metophiceras* and the closely-allied *Glyptophiceras*, and it is a moot question whether it should be attributed to the one or to the other of these genera.

Genus *OPHICERAS* GRIESBACH

Genotype: *O. tibeticum* GRIESBACH

Compressed, evolute to involute *Ophiceratidae* with rounded or narrowed venter; shell generally smooth, sigmoidal striae, which may bundle into blunt, low ribs. Flat bulges and constrictions in some forms.

Suture-line ceratitic; U 1 divided into two serrated lobes by the umbilical suture.

(Diagnosis slightly modified from SPATH, as to exclude *Metophiceras*).

Subgenus *OPHICERAS* s.s. (GRIESBACH)

Rather evolute *Ophiceras* with wide umbilicus. Whorl section subtrigonal, with high umbilical wall.

Ophiceras (Ophiceras) aff. ***transitorium*** SPATH

text fig. 5.

aff. *O. transitorium* SPATH, 1930, p. 17; pl. 2, fig. 10.

aff. *O. transitorium* SPATH, 1935, p. 14; pl. 6, fig. 1; pl. 7, fig. 1?; pl. 9, fig. 2 ?; pl. 11, fig. 1–2; pl. 12, fig. 4.

? *O. greenlandicum* SPATH (pars), 1935, p. 14, pl. 19, fig. 11 (cet. excl.).

There is only one fragmentary specimen of this interesting form, from the spathi subzone of Kumait (G. p. 28).

At 60 mm dm, the umbilicus is about 0.38. The whorl-section is subtrigonal, with a very high, convex umbilical wall but no sharp umbilical edge. The growth striae are distinctly prorsoradiate, rather straight.

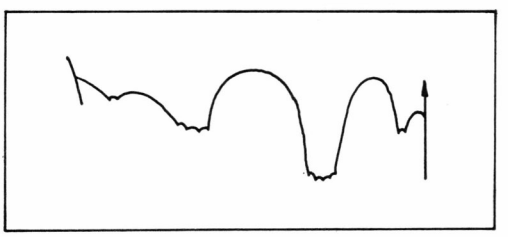

Fig. 5. *Ophiceras* (*O.*) aff. *transitorium* SPATH. External suture-line, 2:1; spec. T 343 e.

The suture-line shows the narrow, deep L and the very broad, high lateral saddle characteristic of *O. transitorium* and its variety *latisellata* SPATH; but the umbilical elements are shallower than those figured by SPATH.

O. transitorium occurs in the decipiens zone of Kap Stosch. Our specimen is considerably older and shows that the group of *O. transito-*

rium and *O. greenlandicum* developed independently alongside the much more common *Lytophiceras*. Possible ancestors of the two stocks have not been found in East Greenland; they may represent immigrants from the Asiatic Thetys.

Subgenus *LYTOPHICERAS* SPATH

Genoytpe: *Ophiceras chamunda* DIENER

Ophiceras (Lytophiceras) spathi nom. nov.

pl. 2, fig. 6, 7; text-fig. 6, 7.

O. (*L.*) *chamunda* DIENER, SPATH, 1930 (pars) p. 20; pl. 4, fig. 1 (non pl. 4, fig. 8).
O. (*L.*) *chamunda* DIENER, SPATH, 1935, p. 23; pl. 8, fig. 8; pl. 19, fig. 10 ?

SPATH referred a rather compressed form of *Lytophiceras*, which occurs at a lower level than the allied *O. commune*, to the Himalayan species *O. chamunda* DIENER (1897, Ceph. of the Lower Trias, p. 123; pl. 12, fig. 1, 2, 3 [lectotype], 4?). DIENER's figures roughly agree with the Greenland forms, except that the umbilical wall is more rounded, the striae less prorsoriadiate and the umbilical lobes deeper. The main difference between *O. sakuntala* and *O. chamunda*, in DIENER's opinion, is the elliptical outline of the latter; but this, and perhaps the greater compression as well, is certainly due to tectonical deformation.

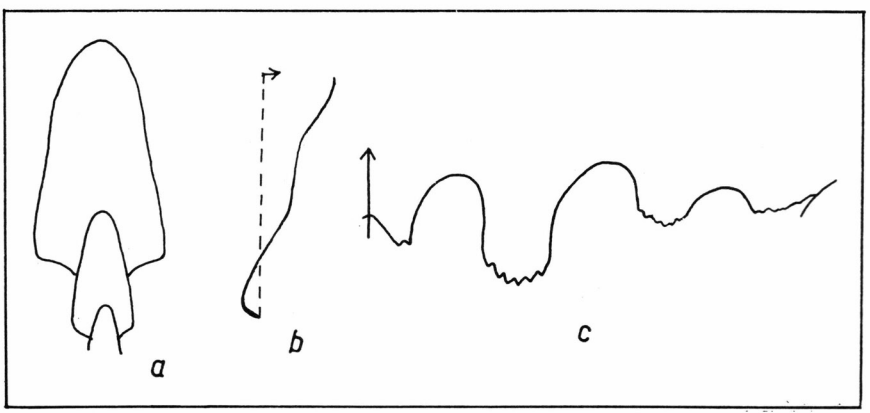

Fig. 6. *Ophiceras* (*Lytophiceras*) *spathi* nom. nov.
a) whorl-section, c. 4:3, spec. T 328 i.l
b) radial curve, c. 4:3, spec. T 238 i.
c(external suture-line, 3:1, T 323 a.

In 1935 (p. 16), L. F. SPATH wrote of *Ophiceras commune*: "It is probable that the present species is merely a local variant of *O.* (*L.*) *sakuntala*, for it is known that each locality impresses upon its inhabitants its own peculiar stamp, and the preservation of the Himalayan forms . . . is so different from that of most of the Greenland examples that

identification is inadvisable." These remarks can be applied with even more reason to *O. chamunda* – distinguished by DIENER on account of its deformed shell – and the similar Greenland forms, for which we propose the new name *O.* (*L.*) *spathi.* These smooth ammonites with simple suture-lines show so few characteristics that one cannot assume a priori that alikelooking forms in widely distant areas are really conspecific and, what is more important to the practical geologist, contemporaneous.

Fig. 8, pl. 8 in SPATH (1935) may be chosen as type of the species.

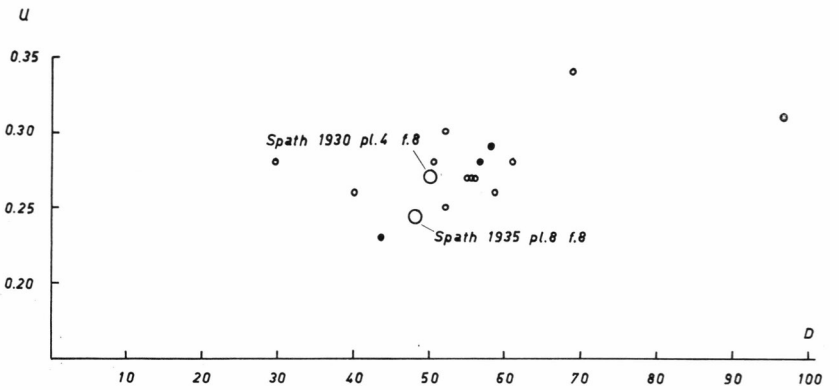

Fig. 7. *Ophiceras spathi* nom. nov.: Relative umbilical width against diameter. Full circles represent specimens from Schuchert Dal (coll. AELLEN).

Erratum: for pl. 4 f. 8 read pl. 4 f. 1.

O. spathi is slightly more involute than *O. commune* (compare figs. 7 and 8), and the whorls are slightly more compressed. The umbilical wall is the most characteristic feature, as already stated by SPATH. It is rounded only in the young, but soon becomes high and steep, often concave (see fig. 6a). There is generally a distinct umbilical edge. The sides converge, and the ventral area is decidely narrower than in *O. commune.* Faint spiral depressions and irregular bulges are seen on the body-chamber of several adult specimens.

The striae are very distinctly prorsoradiate and tend to fasciculation on the body-chamber (pl. 2, fig. 7).

The suture is rather variable, resembling that of *O. commune*, but the first lateral lobe is wider. The first lateral saddle is generally asymmetric. Some specimens show a subrectangular second lateral saddle, like *O. wordiei.*

The distinction of *O. spathi* from *O. commune* may not always be easy, but we believe it to be justified as the two forms are found at different levels. This is particularly evident on Walter Martin Bjerg (G. p. 30), where numerous *O. spathi*, preserved in black calcite, occur

together with *Glyptophiceras* and *Paravishnuites*, whereas casts of *O. commune* constitute a monospecific assemblage in the green shales above. On Paradigma pass (G. p. 21) and on the coast of Nathorst Fjord (G. p. 28), where the outcrops are less perfect, the same difference in preservation is noted, so that here too it can be assumed that *O. spathi* is older. M. AELLEN collected several specimens in the Schuchert Dal area, together with *Glyptophiceras*.

Ophiceras (Lytophiceras) commune SPATH

text-fig. 8, 9a, c, d, e.

O. (*L.*) *commune* SPATH, 1930, p. 24; pl. 2, fig. 9, 13, 14; pl. 3, fig. 3 (holotype); pl. 4, fig. 3, (11 ?).

O. greenlandicum SPATH, 1930, pl. 1, fig. 2 (cet. excl.).

O. (*L.*) *chamunda* DIENER, SPATH, 1930, pl. 4, fig. 8 (cet. excl.).

O. (*L.*) *commune* SPATH, 1935, p. 16; pl. 4, fig. 3; pl. 13, fig. 13; pl. 15, fig. 1, 4, (9 ?); pl. 19, fig. 8.

O. commune SPATH, TOZER, 1961, p. 48; pl. 9, fig. 1, 2.

It is quite possible that there are more than one species of similar-looking *Lytophiceras* in East Greenland, in the Kap Stosch area as well as on Traill Ø and in Jameson Land. But we found it impossible to separate these forms morphologically; there are too many gradations between extreme types, and characters such as the whorl-section or the mode of coiling are very elusive and variable. We are reduced to include all these forms in *O. commune*.

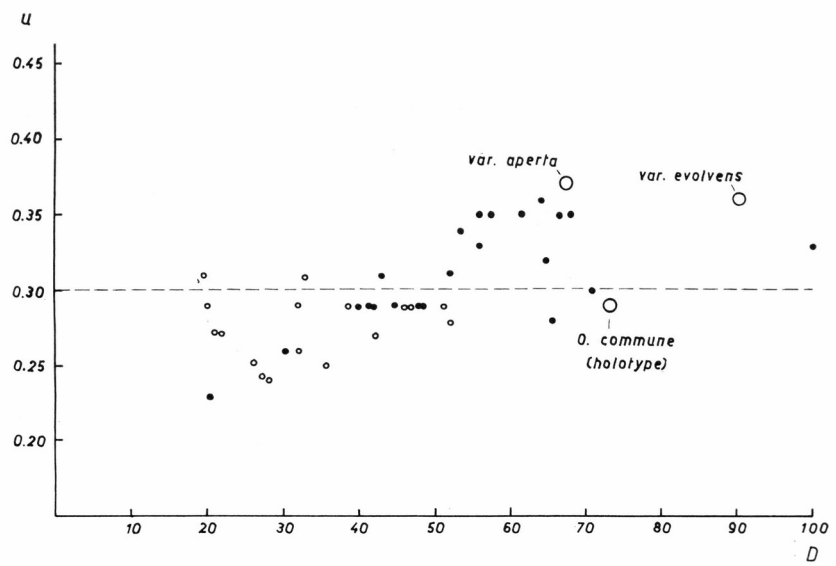

Fig. 8. *Ophiceras commune* SPATH. Relative umbilical width against diameter. Black dots: sample T 295, Paradigma pass; open dots: other specimens.

On Svinhufvud Bjerge (Traill Ø) and on Domkirken, near Blyklippen mining village, we collected monospecific assemblages of *O. commune* which contained only small, adult shells (D 35–52 mm) with compressed whorl-section (t 0.20–0.25) and narrow umbilicus (u 0.24–0.29). But in another population, from Paradigma pass, Wegener Halvø (T 295, black dots in text-fig. 8), similar forms are linked by all possible transitions to larger and more evolute specimens. Some of the latter would fall within the range of var. *aperta* SPATH (1935, p. 17).

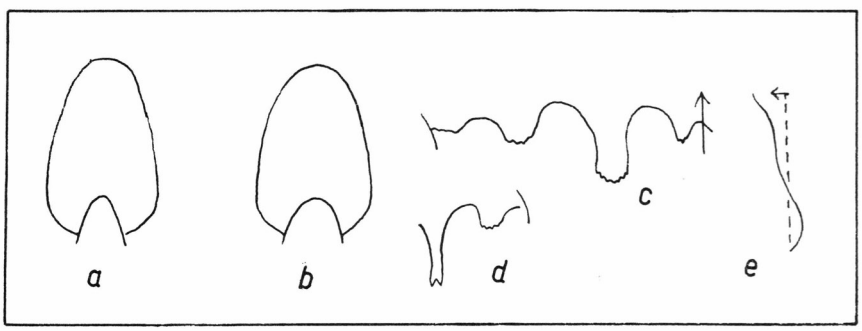

Fig. 9. *Ophiceras commune* SPATH.

a) whorl-section. c. 4:3, T 295 h.
b) *Ophiceras subsakuntala* SPATH, whorl-section, ca. 4:3, T 295 g
c) external suture-line, c. 2:1, T 192 c.
d) internal suture-line, c. 5:2, T 240 g.
e) radial curve, ca. 5:4, T 192 c.

The suture-line (text-fig. 9 c–d, from two different specimens) illustrates the difference to *Metophiceras* and *Glyptophiceras*, which have only two umbilical lobes.

O. commune is found in great numbers on Traill Ø and on Wegener Halvø, somewhat more rarely in the Schuchert Dal. Some quite typical, though rather small specimens come from the same beds as *O. spathi* (upper part of subdemissum zone), but the acme is later (commune zone). In still higher beds of the Wordie Creek formation, poorly preserved sandstone casts are encountered occasionally; they belong to large forms with a comparatively wide umbilicus.

Ophiceras (Lytophiceras) subsakuntala SPATH

text-fig. 9 b.

O. (*L.*) *sakuntala* DIENER, SPATH, 1930 (pars); pl. 2, fig. 8.
O. (*L.*) *ptychodes* DIENER, SPATH, 1930 (pars); pl. 4, fig. 4; pl. 5, fig. 3.
O. (*L.*) *subsakuntala* SPATH, 1935, p. 19; pl. 15, fig. 3.

A few examples from Paradigma pass and from Walter Martin Bjerg, on Wegener Halvø, may be referred to this species on account of

their broad ventral area in the adult, subparallel flanks and ptychodes-like ornamentation. They occur together with *O. commune*, and one may indeed raise the question whether the difference are sufficient to warrant a specific distinction. The whorl-section of the two forms is compared in text-fig. 9 a and b.

Ophiceras (Lytophiceras) kilenense Spath (?)

A large, badly preserved, but apparently uncrushed cast from the commune zone of Nathorst Fjord has the dimensions of Spath's species; but identification is doubtful.

Ophiceras (Lytophiceras) ligatum Spath

pl. 2, fig. 4, 5.

O. (*L.*) aff. *sakuntala* Diener, Spath, 1930 (pars), p. 20; pl. 8, fig. 11, 12.
O. (*L.*) *ligatum* Spath, 1935, p. 22; pl. 11, fig. 3.

D	18,5	23.6	15.5
h	0.43	0.42	0.48
t		0.23	
u	0.26	0.28	0.26

O. ligatum is a small ammonite (but the measured and figured examples are wholly septate).

The whorl-section is regularly egg-shaped, with rounded flanks; there is no umbilical rim.

The presence of constrictions is of course the most striking feature of this interesting species. They are always prorsoradiate and arched forward in the ventral area; but their depth and spacing is variable. The example figured on pl. 2, fig. 4 has 11 constrictions (6 strong and 5 shallower ones) on the cast of the last whorl. Other specimens, such as pl. 2, fig. 5, show widely spaced, broad constrictions on the inner whorls (5 to 6 ad D 20 mm), which become indistinct near the beginning of the body-chamber. Even on the cast, striae can be seen between the constrictions.

The very close and irregular spacing of the septa is noteworthy. External and first lateral saddle are narrower than the second lateral saddle. The lobes stay goniatitic up to a diameter of 15 mm and then acquire only very minute teeth.

O. ligatum was found in a coquina layer in Lagunenæsset valley, together with comparatively small *O. commune*, a discoidal *Lytophiceras* of the *compressum* group, *Claraia*, *Gervillella* and numerous fish remains. The age of Spath's specimens from Kap Stosch is not exactly known;

he believed them to come from the lower Ophiceras beds (subdemissum zone). The Lagunenæs section (G. p. 21), where *O. ligatum* and *O. commune* lie above the fauna with *Otoceras*, *Metophiceras subdemissum* and *Ophiceras spathi*, seems to indicate that the species is somewhat younger and belongs to the commune zone, though probably to its lower part.

Ophiceras (Lytophiceras) subkyokticum SPATH

text-fig. 10.

O. (*L.*) *sybkyokticum* (sic, misprint) SPATH, 1930, p. 27; pl. 5, fig. 4–8; pl. 6, fig. 3–8.

O. (*Discophiceras*) *subkyokticum* SPATH, 1935, p. 34, pl. 1, fig. 3; pl. 8, fig. 6; pl. 12, fig. 6; pl. 13, fig. 6, 9; pl. 18, fig. 2.

SPATH did not designate a holotype of this species; the example figured on pl. 1, fig. 5 (1930), one of the three of which he gives the dimensions, is hereby chosen as lectotype.

O. subkyokticum is a small species. In two monospecific populations from Svinhufvud Bjerge, the diameters vary from 21 to 53 mm. These small forms are apparently adults; their body-chambers bear a peculiar sort of ornament, with strong, sharp striae every 2 or 3 mm and finer ones in between. There are two layers of shell, of which only the thicker, outer one shows the growth-lines. The relative thickness of the whorls in 9 specimens varies from 0.18 to 0.28 (mean 0.235), their height in 12 specimens from 0.45 to 0.51 (mean 0.485).

The diagram fig. 10 shows the width of the umbilicus. Manifestly, the umbilicus is wider and the whorls are lower than in the typical examples figured by SPATH and indicated in his table (1930, p. 27). Practically all of our specimens would belong to the so-called "passage-forms to *O. wordiei*"; the matter will be discussed below.

O. subkyokticum occurs in the commune zone, especially in its lower part, in all the areas investigated. A few examples may come from the subdemissum zone, though it is not quite certain whether they were in situ.

Ophiceras (Lytophiceras) wordiei SPATH

pl. 2, fig. 1; text-fig. 10.

O. (*L.*) *wordiei* SPATH, 1930, p. 26; pl. 5, fig. 1 (?), 2, 9; pl. 6, fig. 1, 2.

O. (*Discophiceras*) *wordiei* SPATH, 1935, p. 32; pl. 7, fig. 7 (?); pl. 8, fig. 5; pl. 16, fig. 8.

This species is distinguished from *O. subkyokticum* mainly by its greater size and wider umbilicus. Text-figure 10 demonstrates that most forms from Svinhufvud Bjerge, on Traill Ø (empty circles) and from Jameson Land (full circles) lie halfway between the type specimens of the two species, as far as the most important criterium, umbilical width,

is concerned. The question whether it is at all possible to separate the two forms taxonomically must be considered. In the Kap Stosch area, however, typical *subkyokticum* and typical *wordiei* are more frequent than the intermediate forms; and even on Traill Ø and in Jameson Land, small and comparatively involute specimens build up populations by themselves, while larger and more evolute shells predominate in other localities. Nuclei or immature examples of the excentrumbilicate *O.*

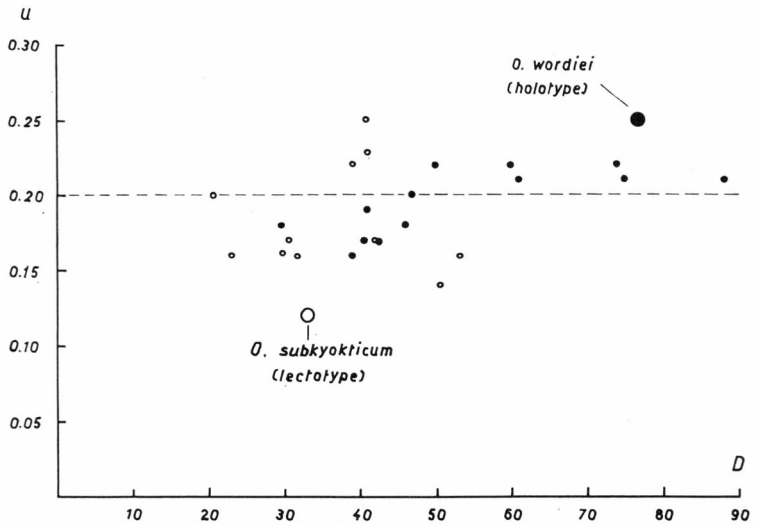

Fig. 10. *Ophiceras subkyokticum* SPATH and *O. wordiei* SPATH: umbilical width against diameter. Black dots: specimens from Wegener Halvø; open dots; specimens from Traill Ø.

wordiei may be undistinguishable from *O. subkyokticum*, especially when one has to do with isolated finds.

There is little to add to SPATH's descriptions. The umbilical slope is generally rounded, but a few specimens from the lowest right-hand side valley of Pingel Dal (sample 202, see G. p. 25) acquire a rather steep wall, and some of these also show falcate growth-lines and a faint spiral depression on the middle of the flanks. They may be transitional to *O. compressum* and to the falcate variety described below. The stronger striae mentioned under *O. subkyokticum* are also observed. The thickness of the shell decreases markedly from the umbilical area towards the venter (from 0.6 mm to 0.2 mm in one specimen). The body-chamber measures almost 2/3 of the last whorl (SPATH, 1930, p. 26, indicates only half a volution).

Quite near to the above-mentioned locality 202, but not necessarily in the same bed, two well-preserved ammonites were found, which show beautiful falcoid folds and shallow spiral depressions on the body-chamber

(pl. 6, fig. 1). SPATH (1935, p. 30; pl. 15, fig. 2 and especially pl. 16, fig. 1) describes discoidal *Lytophiceras* with this kind of ornamentation as *O.* (*Discophiceras*) *kochi* var. *falcata;* he also notes transitions towards *O. wordiei.* Our specimens have a much narrower umbilicus (0.21 and 0.22) than SPATH's example of *O. kochi* var. *falcata* (0.32 to 0.33). This difference in the mode of coiling is too considerable to allow the grouping of these forms with falcoid ornament in one species, and passage types to quite typical *O. wordiei* are frequent, especially at the nearby locality 202.

O. wordiei is found in the commune zone and ranges quite high up (*e.g.* samples 241 and 242 in Lagunenæsset valley, G. p. 21–22).

Ophiceras (Lytophiceras) compressum SPATH

O. (*Discophiceras*) *compressum* SPATH, 1935, p. 31; pl. 7, fig. 9; including var. *involuta*, ibidem, pl. 8, fig. 1–2.

This ammonite, characterized by its strong prorsoradiate striation, steep umbilical wall and compressed whorls, was found in several localities on Wegener Halvø (especially sample 343, coast of Nathorst Fjord) as well as by M. AELLEN in the Schuchert Dal. Most of the specimens are crushed but quite typical, though one or two, with narrower umbilicus, may represent transitions to the coeval and certainly allied *O. spathi.* SPATH already mentioned the relation to "*O. chamunda*".

SPATH indicates the upper Ophiceras beds (commune zone) as level of this species, but we are afraid that he was misled by its high degree of specialization. Two examples from Hold with Hope figured by SPATH, at any rate, come from beds with *Otoceras*, *Metophiceras*, *Glyptophiceras* and *Ophiceras spathi* (SPATH, 1935, p. 94), that is from the lower Ophiceras beds (= subdemissum zone). The same is true for our specimens.

? Subgenus *ACANTHOPHICERAS* DIENER

DIENER, 1916, p. 101. Genotype: *Trachyceras* (?) *gibbosum* GRIESBACH.

Diagnosis: "Compressed, round-ventered shells, with suturelines like *Ophiceras*, but with a tendency to blunt lateral tuberculation" (SPATH, 1930, p. 28).

Ophiceras (Acanthophiceras?) cf. ***poulseni*** SPATH

O. (*A.*) *poulseni* SPATH, 1935, p. 39; pl. 11, f. 6, 7.

One specimen from the subdemissum zone (spathi subzone?) of Paradigma pass shows the characteristic blunt, prorsoradiate bulges on the inner volutions (9–10 to a whorl). The body-chamber is crushed; it

presents only faint, wavy folds. The umbilicus seems to be narrower than in the holotype.

The attribution of this form to the subgenus *Acanthophiceras* is open to criticism, at SPATH well realized.

Genus *PARAVISHNUITES* (SPATH)

Vishnuites (*Paravishnuites*) SPATH, 1935, p. 44. Genotype: *V.* (*P.*) *oxynotus* SPATH.

SPATH gives the following diagnosis: "Rather narrowly-umbilicate, compressed oxycones, with faint, almost radial striation or lineation, rarely costation, and low but distinct umbilical wall. Suture-line as in *Ophiceras*, with serration of lobes rather more distinct, at least in the genotype".

We have stated on p. 86 the reason why we prefer to consider *Paravishnuites* as a genus of its own, not directly related to the Arctic "*Vishnuites*" of the *decipiens* group. We agree with L. F. SPATH as to its derivation from *Ophiceras* (*Lytophiceras*) *compressum* or, possibly, *O.* (*L.*) *spathi*.

Paravishnuites striatus (SPATH)

Vishnuites (*P.*) *striatus* SPATH, 1935, p. 46; pl. 1, fig. 5; pl. 9, fig. 6.

One specimen from the subdemissum zone of Lagunenæsset valley, quite conformable to the holotype.

Paravishnuites cf. ***oxynotus*** (SPATH)

Vishnuites (*P.*) *oxynotus* (SPATH), 1935, p. 45; pl. 3, fig. 5.

A poorly preserved cast from Domkirken (Mesters Vig region) has the dimensions of this species, but the bulges are only very faintly developed.

Paravishnuites sterni sp. nov.[7])

pl. 2, fig. 8.

This species is based on only one specimen, from the (lower ?) Ophiceras beds of Triasdal, Schuchert Dal (coll. M. AELLEN). Its maximum diameter is about 76 mm, relative height of the last whorl 0.43, umbilical width 0.26 and the thickness/height ratio about 3:10.

The venter is almost sharp, just slightly rounded on the edge but not truncated. The flat flanks are highest at 1/3 of the distance between umbilical border and venter. The umbilical edge is rounded, the umbilical slope low but steep, convex and slightly undercut.

[7]) Named in memory of PAUL STERN, geology student from Basle, who took part in the 1958 expedition and who was killed in the Uri mountains in 1959.

The innermost whorls appear to be smooth, except for very indistinct, faint bulges. Later on, delicate but sharp striae appear, which grow stronger on the body-chamber, where they have a tendency to fasciculation. They describe an asymmetric, adorally concave arc between the umbilical suture and the middle of the flanks; on the outer half of the flanks, their direction is nearly radial.

The suture-line was partly laid free by filing away the shell. It compares to that of *Ophiceras wordiei*, but has a more V-shaped first lateral lobe.

P. sterni comes closest to *P. oxynotus*, from which it is distinguished by its more compressed form, absence of bulges (at least in the adult), by the more sinuous curve of its growth-lines and by the narrow rounding of the periphery. *P. striatus* has stronger ornament, thicker whorls and a narrower umbilicus.

Paravishnuites paradigma sp. nov.[8])

pl. 1, fig. 7a, b.

We have collected only four specimens of this interesting form, two from the subdemissum zone of Paradigma pass (T 300, see G. p. 26), one from the spathi subzone of Walter Martin Bjerg and one from the cliffs above Fleming Fjord, 2 km to the NE of the mouth of Tvekegledal, where it lay 10 m above the top of the Permian limestones. Unfortunately, none of them is quite complete.

Measurements:	D max.	D'	h	u
Holotype (pl. 5)	ca. 62	57.3	0.37	0.38
	ca. 63	54.0	0.39	0.33

Up to a diameter of 40 mm, there is an absolutely sharp, knife-edge venter. At this stage, the thickness of the whorls is less than half of their height, and the flanks converge under an angle of about 35°. Later on, the venter becomes rounded, and on the body-chamber the whorl-section resembles that of *Ophiceras* (*Lytophiceras*) *spathi*. The umbilical wall, low in the inner volutions, becomes very high and subvertical at a D of about 30 mm, somewhat more rounded again on the body-chamber.

The prorsoradiate, biconcave striae are more or less fasciculate on the inner whorls. Faint bulges, like those of *P. oxynotus*, can be detected up to D 25 mm.

The denticulation of the lobes is comparatively sharp and deep. The umbilical lobe slopes downward to the umbilical suture.

The adult of this species closely resembles *Ophiceras* (*Lytophiceras*) *compressum* SPATH, especially the evolute variety represented by the

[8]) From the type locality, Paradigma pass on Wegener Halvø.

holotype (SPATH, 1935, pl. 7, fig. 9). The inner whorls, with their knife-like sharpening of the venter, are of course quite different. If, as one can probably assume, *Paravishnuites* is derived from *Lytophiceras* of the *spathi-compressum* group, the return to a rounded ventral area in the adult would indicate a case of paedogenesis.

Genus *VISHNUITES* DIENER (?)

DIENER, 1897, p. 83; genotype: *V. pralambha* (DIENER).

It is by no means certain that the Himalayan *Vishnuites* and the East Greenland forms *V.* (?) *decipiens* SPATH and *V.* (?) *wordiei* SPATH – offshoots of late *Lytophiceras* with sharpened venter – are really congeneric (see p. 86). Our material from Traill Ø (see PUTALLAZ, 1961, p. 38) and from Jameson Land (some very bad specimens from the slopes north of Paradigma pass and a better one from Domkirken, see G. p. 27) is far too poor, however, to allow a thorough discussion of the problem.

III. CONCLUSIONS

The evolution of some lineages of Induan ammonites in East Greenland can be followed rather closely; other, "cryptogenic" genera appear rather suddenly and must be regarded as immigrants.

Among the autochthonous Arctic fauna, we find *Otoceras concavum* TOZER and the possibly allied *Otoceras* sp. of the triviale and martini zones, with their descendants in the subdemissum/boreale zone, *O. boreale* SPATH and *O. indigirense* POPOV.

The oldest Ophiceratids, still very close to the Permian *Paraceltites*, belong to *Hypophiceras*, here regarded as a subgenus of *Glyptophiceras*. In the subdemissum zone of east Greenland, the passage of these primitive Ophiceratids to *Metophiceras* and to *Glyptophiceras* of the *pascoei* group is well established. It is quite possible that the coarsely ribbed Arctic *Glyptophiceras* represent a development which is independent from the true Himalayan *Glyptophiceras*, which generally show a more compressed whorl-section. The only representative of the genus from Japan, *Gl. japonicum* NAKAZAWA & SHIMIZU, seems to be closer to the Himalayan than to the Arctic forms (see also BANDO, 1964a, 1964b).

With the subdemissum zone, two new, closely allied stocks make their appearance: *Ophiceras* s. str., rather poorly represented in the Arctic realm, and *Lytophiceras*, which flourished for a long time in East Greenland, as well as in the Canadian Arctic, in the Cordilleran region and in East Siberia. *Lytophiceras* gave rise, by adaptative radiation, to some endemic branches: the compressed forms of the "*Discophiceras*" group, *Paravishnuites* – linked to early *Lytophiceras* by such species as *O.* (*L.*) *kochi* SPATH and *P. paradigma* sp. nov. – and *Acanthophiceras* (?) *poulseni* SPATH. Later specializations from the group of *O. commune* are the keeled "*Vishnuites*" (*V.*? *decipiens* and *V.*? *wordiei*) and *O. dubium* SPATH, which is regarded by its author as a possible ancestral form to the *Gyronitidae*.

The two lineages, *Ophiceras* and *Lytophiceras*, are not connected by any passage forms found in Greenland to the earlier *Hypophiceras* or to *Metophiceras*, which have different and simpler suture-lines. Two possibilities are open: either they are immigrants from the Tethys realm (by way of the Far East and Eastern Siberia), or there is an explosive

radiation in subdemissum times, giving rise quite suddenly to widely different mutations. There is no doubt that such an explosive evolution occurred at this time among the *Hypophiceras – Glyptophiceras – Metophiceras* stock, but all these newly developed forms are connected with each other by numerous intermediate types – in fact, separation of species and subgenera is decidedly arbitrary. The first *Lytophiceras*, on the other hand, is the rather highly spezialized (compressed and involute) *O.* (*L.*) *spathi*, which has absolutely no plausible potential ancestors in the triviale and martini zones. For this reason, we favour the immigration hypothesis.

The East Greenland *Proptychites* are again (locally speaking) "cryptogenic"; they probably represent the last wave of immigrants, before life conditions for cephalopods became definitively unfavourable. This wave did not reach Jameson Land.

Table 2 resumes the zonal scheme for the basal Triassic of Greenland, as compared to those given by KOCH, NIELSEN and SPATH. We have little to add to the matter already discussed; merely the index species of some zones had to be changed. *Glyptophiceras* (*Hypophiceras*) *triviale* is a good index for the very lowest zone, in which *Otoceras* and numerous "Permian" benthonic faunal elements also occur. For the second-lowest zone, *G.* (*H.*) *martini* had to be chosen, as the type of *G.* (*H.*) *minor* comes from higher beds and is different from the ammonites in the "upper Glyptophiceras" – or better Hypophiceras – beds (see p. 88). In the following zone, for which *Metophiceras subdemissum* may stand as characteristic species, there is a great increase in the number of species and individuals; numerous *Glyptophiceras* s. str., the last *Hypophiceras*, *Metophiceras* and the first *Ophiceras* s. str., *Lytophiceras*, *Acanthophiceras* and *Paravishnuites* form rich assemblages in many localities. *Otoceras boreale* reaches its acme and end. Where outcrop conditions are ideal, as on the east ridge of Walter Martin Bjerg, a slightly higher level can be recognized, where *Ophiceras* (*Lytophiceras*) *spathi*, accompanied by *Glyptophiceras* s. str., abounds; but it is not certain whether this "spathi subzone" has any general significance or whether it is just a local feature. *O. spathi* (= *O. chamunda* SPATH, non DIENER, see p. 97) may well be identical with EIGIL NIELSEN's "*Ophiceras* sp. nov." (table 2, second column). Higher up, in the commune zone, there are still numerous ammonites, but they belong to fewer species: in our area mainly *O. commune*, *O. subsakuntala*, *O. wordiei – subkyokticum* and *O. ligatum*. *Glyptophiceras* has become rare; *Metophiceras*, *Otoceras* and *Paravishnuites* have disappeared.

For the higher zones, which are poorly fossiliferous south of 73° latitude, there is nothing we can add to the subdivisions established by SPATH. "*Vishnuites*" still is found near Mesters Vig, and in very bad examples

Table 2

L. KOCH 1931	E. NIELSEN 1935		L. F. SPATH 1935		this paper		Canada: E. TOZER 1967
Upper Anodontophora beds *A. fassaensis*	Anodont. fassaensis beds		Anodonto-phora beds	*Anodontophora fassaensis*	Fass. b. / Rødstaken m.		
	Myalina kochi zone			*Myalina kochi*			
Lower Anodontophora beds *A. (breviform)*	Anodontophora (breviform) beds			*Anodontophora breviformis*	Brev. b.		? *Proptychites candidus*
Proptychites beds *Pr. rosenkrantzi*	Proptychites beds	*Pr. rosenkrantzi* „*Koninckites*" sp.?	Proptychites beds *Pr. rosenkrantzi*		Propt. beds	*Pr. rosenkrantzi*	?
Upper Ophiceras beds *Oph. transitorium* *Vishnuites*	Vishnuites beds	Upper Vishnuites zone *Ophiceras sp. nov.*	Vishnuites beds	Upper *Ophiceras dubium*	Vishnuites beds	*Vishnuites (?) decipiens*	*Pachyproptychites strigatus*
		Middle Vishnuites zone *V. wordiei*		Middle *V. decipiens & Oph. ultimum*			
		Lower Vishnuites zone *Vishnuites sp. nov.*		Lower *V. decipiens & O. kilenense*			
Lower Ophiceras beds *Oph. sakuntala* *Oph. commune* *Glypt. gracite*	Otoceras beds	O. „sakuntala" zone	Ophiceras beds	Upper *Oph. commune & Oph. subsakuntala*	Ophiceras beds	*Ophiceras commune*	*Ophiceras commune*
		Ophiceras sp. nov. zone		Lower *Oph. (Met.) praecursos & Glyptoph. serpentinum*		*O. spathi s.-z.* *Metoph. subdemissum*	*Otoceras boreale*
Glyptophiceras beds *small Glyptophiceras* *Otoceras* *„Permian" benthonic fauna*		unfossiliferous beds	Glyptophiceras beds	Upper *Glyptophiceras minor & Ophiceras ? sp. ind.*	Hypophiceras beds	*Glypt. (Hypophiceras) martini*	*Otoceras concavum*
		Upper Glyptophiceras zone					
		Lower Glyptophiceras zone		Lower *Glyptophiceras triviale*		*Glypt. (Hyp.) triviale*	?

even on northern Wegener Halvø. The southernmost occurrence of *Proptychites* hitherto signalled is Maanedal, on Traill Ø (PUTALLAZ, 1961, p. 31).

Most recent authors, following KUMMEL *in* REESIDE *et al.* (1957) have taken *Vishnuites* (?) *decipiens* and *Proptychites rosenkrantzi* as index fossils for the two zones represented by SPATH's Vishnuites and Proptochites beds; this procedure is certainly justified.

The zonal scheme proposed for the lowermost Triassic is at present only applicable to East Greenland; this is especially the case for the two first zones, *Hypophiceras* not having been signalled from elsewhere. Only with the succession in the Canadian Arctic archipelago (TOZER, 1961, 1967) can a correlation at all be attempted[9]); but even here it does not seem to be possible to achieve an exact equivalence, as TOZER pointed out. The two zonal schemes are compared in table 2. TOZER's zone of *Otoceras concavum* apparently corresponds to our triviale and martini zones; unfortunately, no *Hypophiceras* were found in Canada and the *Otoceras* in the two lowermost zones of Greenland are too badly preserved for specific identification. The Canadian boreale and the Greenland subdemissum zone compare very closely – in fact, the terms are almost interchangeable. The commune zone of both areas also seems to cover the same biostratigraphical span, though the presence of *Glyptophiceras* aff. *extremum* in Canada might indicate that somewhat older levels – corresponding to our "spathi subzone"? – are there included in the commune zone. On the other hand, TOZER mentions *Ophiceras* (?) *decipiens* from the commune zone. Higher up, correlation again becomes very hazardous. TOZER considers the zone of *Pachyproptychites strigatus* as including parts both of the decipiens and the rosenkrantzi zones.

In Arctic Canada, *Claraia* only appears in the commune zone. In Greenland, quite large and typical specimens occur much lower down, even in the martini zone (*e.g.* at the mouth of Pingel Dal, G. p. 24). Such discrepancies are not at all surprising; we may also assume that the true *Ophiceras* arrived fairly late in the Arctic sea, whereas they seem already to be present in the very oldest Triassic strata of the Himalayas.

Outside of Greenland and the Arctic Archipelago, witnesses of the Early Induan sea are known from various places around the present Arctic Ocean, thus from Canning River, Alaska (KUMMEL *in* REESIDE *et al.*, 1957, p. 1501), from Alberta (WARREN, 1945) and even from the Dinwoody formation of southeastern Idaho and western Montana (KUMMEL, 1954, p. 183). *Otoceras* has recently been found in Svalbard (PETRENKO, 1963), where the presence of beds of this age has long been suspected (see BUCHAN *et al.*, 1965). Induan deposits are widespread

[9]) The writer thanks Dr. TOZER for insight into his latest manuscript.

in Eastern Siberia (KIPARISOVA, 1961; POPOV, 1961), and the main connection between the Arctic and Indo-Pacific provinces certainly ran between the mouth of the river Lena and the Okhotsk sea. An equivalent of the Hypophiceras beds might be sought in the western part of the Verkhnoyansk mountains, from where KHERASKOV and POLUBOTKO (*in* SACHS & STRELKHOV, 1961) mention beds with *Xenaspis* (?) and *Estheria* below beds with *Glyptophiceras* (*Glyptophiceras* s. str. of the subdemissum/boreale zone?).

In 1960, we drew attention to the fact that "Permian" brachiopods, echinoderms and bryozoa persisted in the lowermost beds containing *Claraia* and "Triassic" ammonites. This had already been noticed by SPATH (1935, p. 47 and 106); but at that time, the beds underlying the Wordie Creek formation at Kap Stosch were regarded as Carboniferous, so that he had to interpret these Paleozoic forms as derived, in spite of their preservation which is "not worse than that of the ammonites". As the age of the Foldvik Creek formation is now firmly established as Upper Permian (Cyclolobus zone, see MILLER & FURNISH, 1940; DUNBAR, 1955; NEWELL, 1955), we concluded that sedimentation had been practically continuous between the Upper Permian and the Lower Triassic in parts of the East Greenland basin. This would imply that the "Paleozoic" benthos did not become extinct by a sudden, single catastrophe, but that it lingered on and existed side by side with "Mesozoic" ammonites, *Otoceras* and the first Ophiceratids. Numerically, the "Paleozoic" faunas are predominant in the triviale zone (Ekstra Elv and River 1, west of Kap Stosch); they become rarer in the martini zone (River 1; Lagunenæsset valley, see G. p. 20 and 22), and the last of them occur in the subdemissum zone (Lagunenæsset, G. p. 23, and Tvekegledal, G. p. 33).

This apparent coexistence of "Permian" and "Triassic" faunal elements makes East Greenland – together with Armenia, the Salt Range of West Pakistan, southwestern China and northeastern Siberia – one of the most important areas for the fixing of the boundary between the Paleozoic and Mesosoic eras. The critical lowland country around Kap Stosch was reexamined in detail during the summer of 1967 by B. KUMMEL and C. TEICHERT; we appreciate the opportunity given to us by G. G. U. to participate in this expedition. The material collected by the 1967 party is still under study, and a fuller discussion of the Permian-Triassic boundary problem will be given by KUMMEL and TEICHERT.

The fact that marine passage terms between the two systems occur only in few places certainly points to an almost world-wide break in marine sedimentation. Even within East Greenland, there is evidence of a regressive episode at the turn of Permian to Triassic time. The

lowermost Triassic beds (triviale zone) are known only from the small area immediately around Kap Stosch. On Traill Ø and in Jameson Land, beds belonging io the next higher (martini) zone rest upon the Permian Foldvik Creek formation, and along the margins of the basin even younger parts of the Wordie Creek formation transgress over Permian or older rocks (G., p. 25). Only in the central portion of the fault-bordered East Greenland trough was the downwarping strong enough to compensate for the great eustatic regression at the close of the Paleozoic era.

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Abbreviations: M.o.G. = Meddelelser om Grønland, Copenhagen.
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PLATES

Plate 1

Fig. 1. *Glyptophiceras* (*Hypophiceras*) *martini* sp. nov.
Martini zone, Triasdal; coll. AELLEN, No. A 5a/1 (p. 87).

Fig. 2. *Glyptophiceras* (*Hypophiceras*) *martini* sp. nov., holotype.
Martini zone, Triasdal; coll. AELLEN, no. A 5b/5 (p. 87).

Fig. 3. *Glyptophiceras* (*Hypophiceras*) *martini* sp. nov.
Martini zone, Triasdal; coll. AELLEN, no. A 5b/1 (p. 87).

Fig. 4. *Metophiceras wegeneri* sp. nov
Subdemissum zone, Walter Martin Bjerg; no. T 322 l (p. 94).

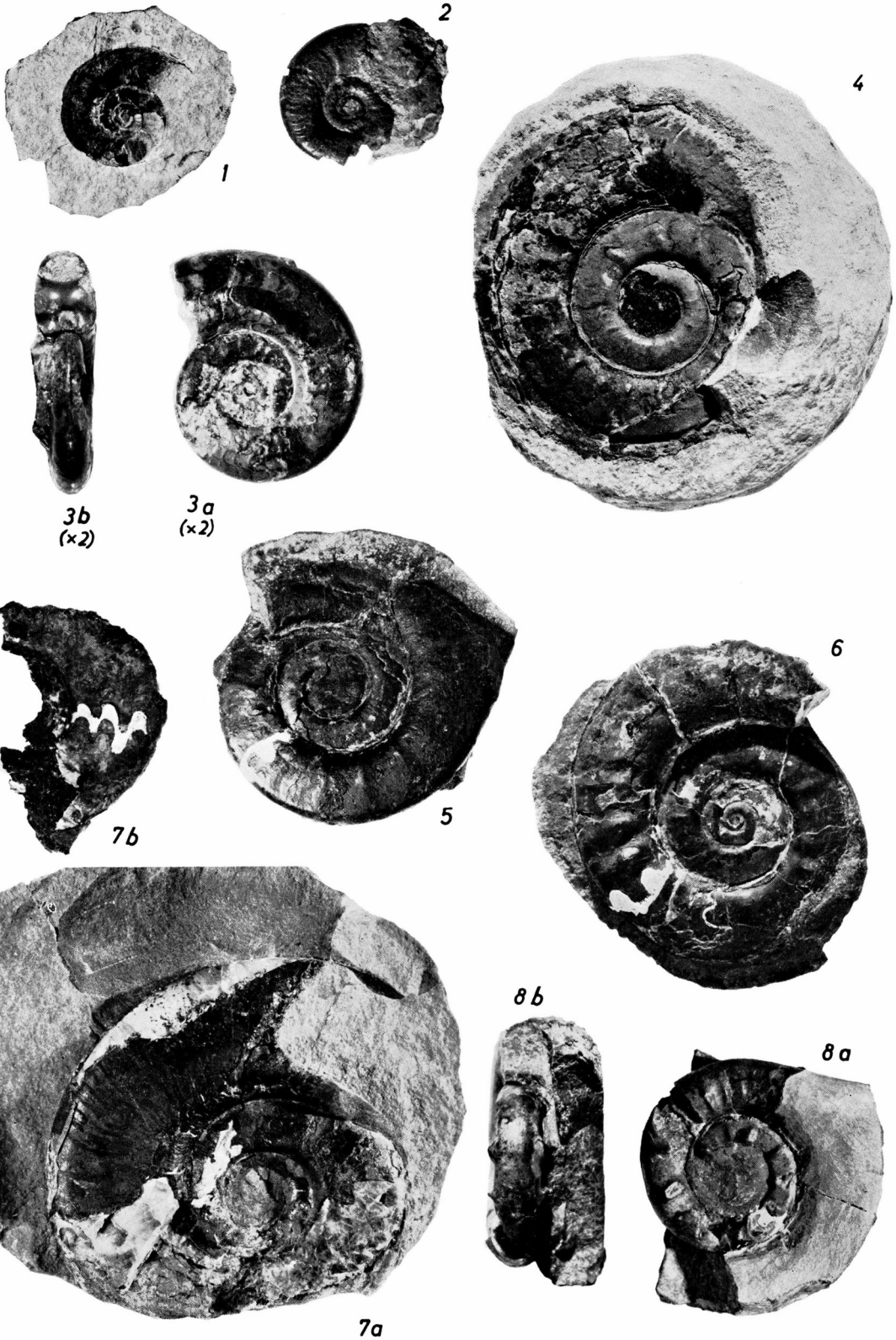
Fig. 5. *Metophiceras wegeneri* sp. nov.
Subdemissum zone, Walter Martin Bjerg; no. T 322 e (p. 94).

Fig. 6. *Metophiceras wegeneri* sp. nov., holotype (see also text-fig. 4a, b).
Subdemissuui zone, Walter Martin Bjerg; no. T 322 k (p. 94) (the figure is inverted).

Fig. 7. *Paravishnuites paradigma* sp. nov., holotype.
Subdemissum zone, Paradigma pass; fig. 7b shows part of the inner whorls of the same specimen, seen from the other side. No. T 300 f (p. 106).

Fig. 8. *Glyptophiceras* (*Glyptophiceras*) aff. *extremum* SPATH, form B.
Subdemissum zone, Triasdal, coll. AELLEN, no. A 425 (p. 93).

All figures except fig. 3 (× 2) natural size.


1
2
3b
(×2)
3a
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7b
7a
8b
8a

Plate 2

Fig. 1. *Ophiceras* (*Lytophiceras*) *wordiei* SPATH, variety with falcoid folds.
Commune zone, E of lower Pingel Dal, no. T 203 b (p. 102).

Fig. 2. *Glyptophiceras* (*Glyptophiceras*) aff. *extremum* SPATH, form A.
Subdemissum zone, Triasdal; coll. AELLEN A 408 (p. 92).

Fig. 3. *Glyptophiceras* (*Hypophiceras*) *minor* SPATH.
Subdemissum zone, Domkirken; no. T 347 b (p. 89).

Fig. 4. *Ophiceras* (*Lytophiceras*) *ligatum* SPATH.
Commune zone, Lagunenæsset; no. T 240 k (p. 101).

Fig. 5. *Ophiceras* (*Lytophiceras*) *ligatum* SPATH (center) with *O. commune* (negative at right) and vertebrate remains (bottom).
Commune zone, Lagunenæsset; no. T 240 d (p. 101).

Fig. 6. *Ophiceras* (*Lytophiceras*) *spathi* sp. nov.
Subdemissum zone, Triasdal; coll. AELLEN, no. A 422 (p. 97).

Fig. 7. *Ophiceras* (*Lytophiceras*) *spathi* sp. nov.
Subdemissum zone, Lagunenæsset; no. T 238 a; see also text fig. 7 (p. 97).

Fig. 8. *Paravishnuites sterni* sp. nov., holotype.
Subdemissum zone, Triasdal; coll. AELLEN, A 68/d/9 (p. 105).

All figures except fig. 4 (× 2) natural size.

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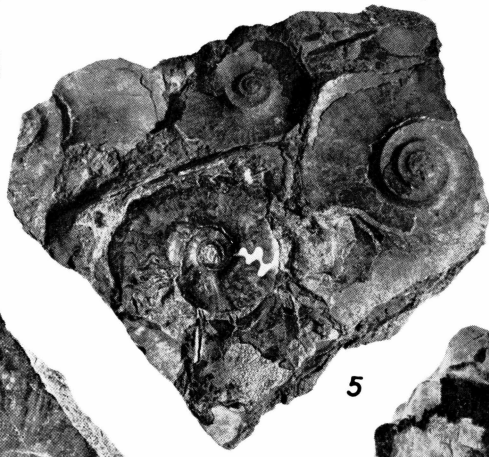
4 (×2)



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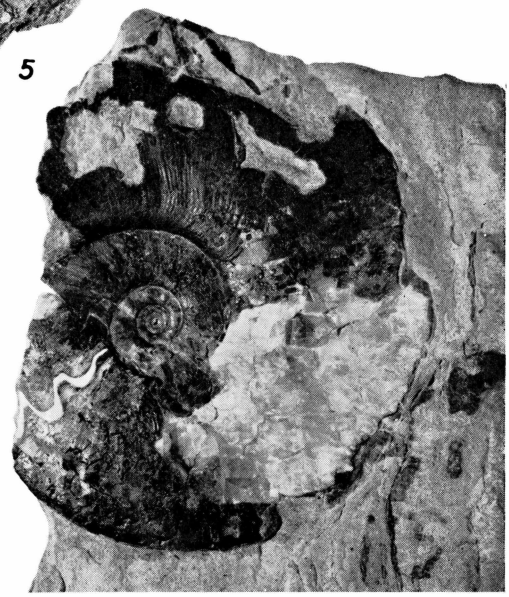

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