MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND
Bd. 195 • Nr. 9

DANSK NORDØSTGRØNLANDS EKSPEDITION 1938–39
UDSENDT AF:
ALF TROLLE, EBBE MUNCK OG EIGIL KNUTH TIL MINDE OM
DANMARK EKSPEDITIONEN
LEADERS: EBBE MUNCK AND EIGIL KNUTH

# FOSSIL FISHES FROM THE MARINE LATE PALAEOZOIC OF HOLM LAND - AMDRUP LAND, NORTH-EAST GREENLAND

BY

SVEND ERIK BENDIX-ALMGREEN

WITH 11 FIGURES AND 1 TABLE IN THE TEXT
AND 2 PLATES

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
1975

## Abstract

This paper presents morphological descriptions and comparisons of some late Palaeozoic fish remains, more precisely teeth, scales and a single fin-spine representing selachians (*Ctenacanthus* sp. and '*Cladodus*' sp.), durophagous elasmobranchs (*Lagarodus* sp., *Petalodus* sp., '*Helodus*' sp. and a cochliodontid or menaspid representative), and a single actinopterygian (*Acrolepis*? sp.). The material originates from Upper Carboniferous (Moscovian) and Lower Permian marine deposits constituting the so-called 'Lower Marine group' and 'Upper Marine group' of Holm Land and Amdrup Land (80°–81°) in North-East Greenland.

The collection comprises two faunal assemblages which, being the northernmost of their kind and age yet found, are biostratigraphically evaluated on the basis of comparisons with broadly contemporaneous fish faunal material from Europe (particularly the U.S.S.R.) and from North America. The palaeontological evidence presented, including certain aspects of the author's recent investigations of new *Heliocoprion* material from Arctic Canada, indicates rather conclusively a late Lower Permian (perhaps Roadian) age for the uppermost part of the 'Upper Marine group'. It is concluded that this part of the Holm Land — Amdrup Land marine sequence can be broadly correlated with: 1) The Assistance Formation of Arctic Canada, 2) the Meade Peak Member of the middle Phosphoria Formation of western U.S.A., and 3) the Brachiopod Cherts of western Spitsbergen.

On basis of chronostratigraphical evidence a broad correlation of the Holm Land — Amdrup Land marine sequence and the late Palaeozoic continental Mesters Vig Formation of central East Greenland is attempted.

A final short comment concerns changes in composition between the elasmobranch assemblage from the late Lower Permian of Amdrup Land, as now known, and the richly varied fauna found in the Upper Permian (Araksian) Foldvik Creek Formation of central East Greenland.

Svend Erik Bendix-Almgreen
Mineralogisk Museum
Øster Voldgade 7
DK-1350 København K

ISBN 87 421 0113 1

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## Introduction

The late Palaeozoic marine fish remains which are the subject of this paper were collected on the 'Dansk Nordøstgrønlands Ekspedition 1938–39', but have remained undescribed until now. The collection is small and, consisting as it does of detached, partly fragmentary teeth and dental-plates, some few scales and a single fin-spine fragment, it is of little importance in terms of morphology of the various elasmobranchs and the single actinopterygian present. With respect to palaeontology, on the other hand, this material is significant enough to put on record since one is here dealing with 'bradyodont and pleurodont shark teeth of types not previously known from Greenland' (Nielsen, 1941, p. 34). The fish remains are of importance also in terms of biostratigraphy and correlation because the material constitutes two distinctive marine fish faunal assemblages, one being of Upper Carboniferous age while the other apparently belonging to the late Lower Permian. Both in respect to their kind and age these faunal assemblages are the most northerly yet encountered and, in a geographical sense, so to speak, they bridge the gap between contemporaneous European and North American fish faunas.

Various reasons have prompted the author to undertake this investigation and documentation. One reason was a survey recently carried out with the aim of presenting a broad, but up-to-date review of our state of knowledge concerning fossil vertebrates from Greenland (Bendix-Almgreen, 1976). The present paper also serves as the first in a series centered upon fossil elasmobranchs from the widespread occurrences of marine late Palaeozoic deposits in East Greenland.

## History and stratigraphical provenance of the material

The marine deposits from which the material under consideration is derived are located in Holm Land and Amdrup Land (80°–81°) on the east coast of Greenland (figs 1 & 7). These late Palaeozoic deposits were discovered during the 'Danmark Ekspeditionen 1906–08' when they were explored particularly by J. P. Koch and A. Wegener. Their collections of fossils and rocks were later studied by Grönwall (1916; see also Nathorst, 1911). The locality, remote and isolated as it is, was not

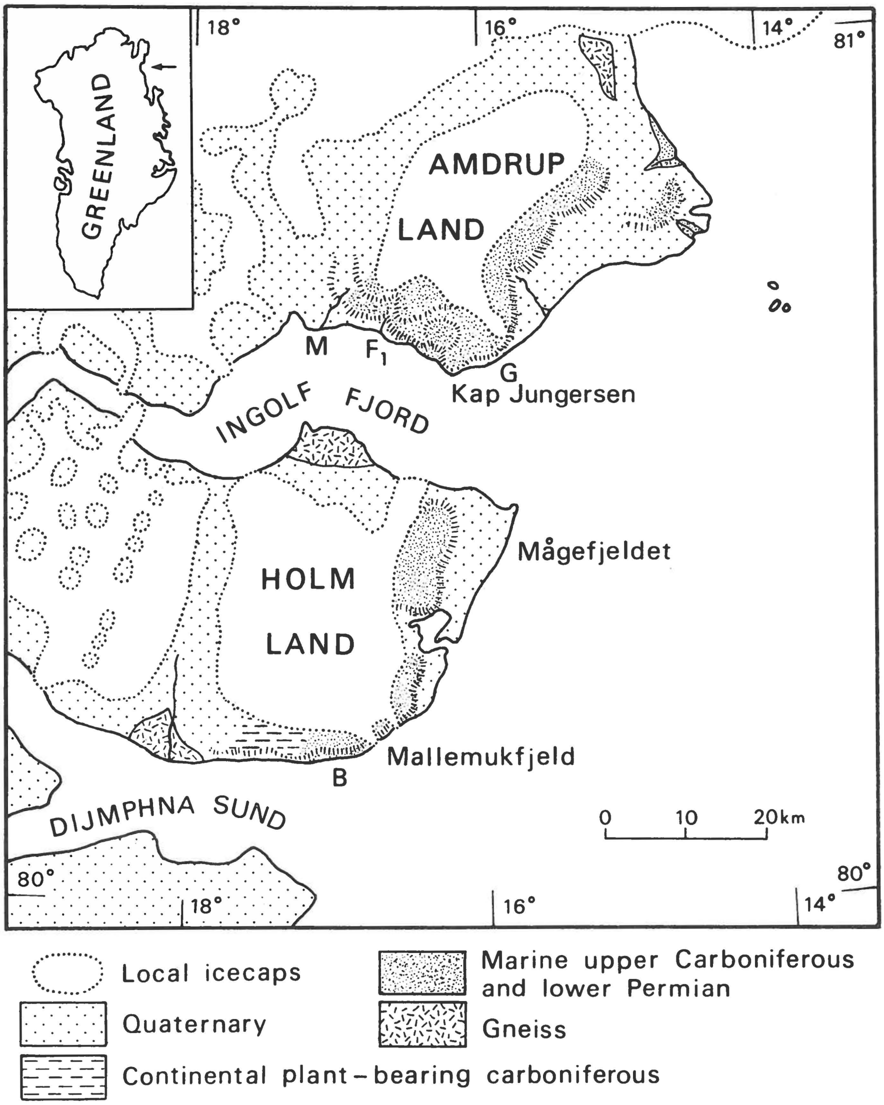

Fig. 1. Map of Holm Land and Amdrup Land showing the distribution of Carboniferous and lower Permian sedimentary deposits and the location of vertebrate yilding sections (profiles B, $F_1$, G, and M).

revisited until the spring of 1939 when E. NIELSEN investigated the Holm Land — Amdrup Land deposits while a participant in the 'Dansk Nordøstgrønlands Ekspedition 1938–39' (NIELSEN, 1941; NIELSEN *in* KNUTH, 1942). In the course of few days, while subjected to difficult climatic conditions, he accomplished a most impressive field study during which he measured several detailed sections through the deposits. NIELSEN also gathered many small fossil collections some of which, in

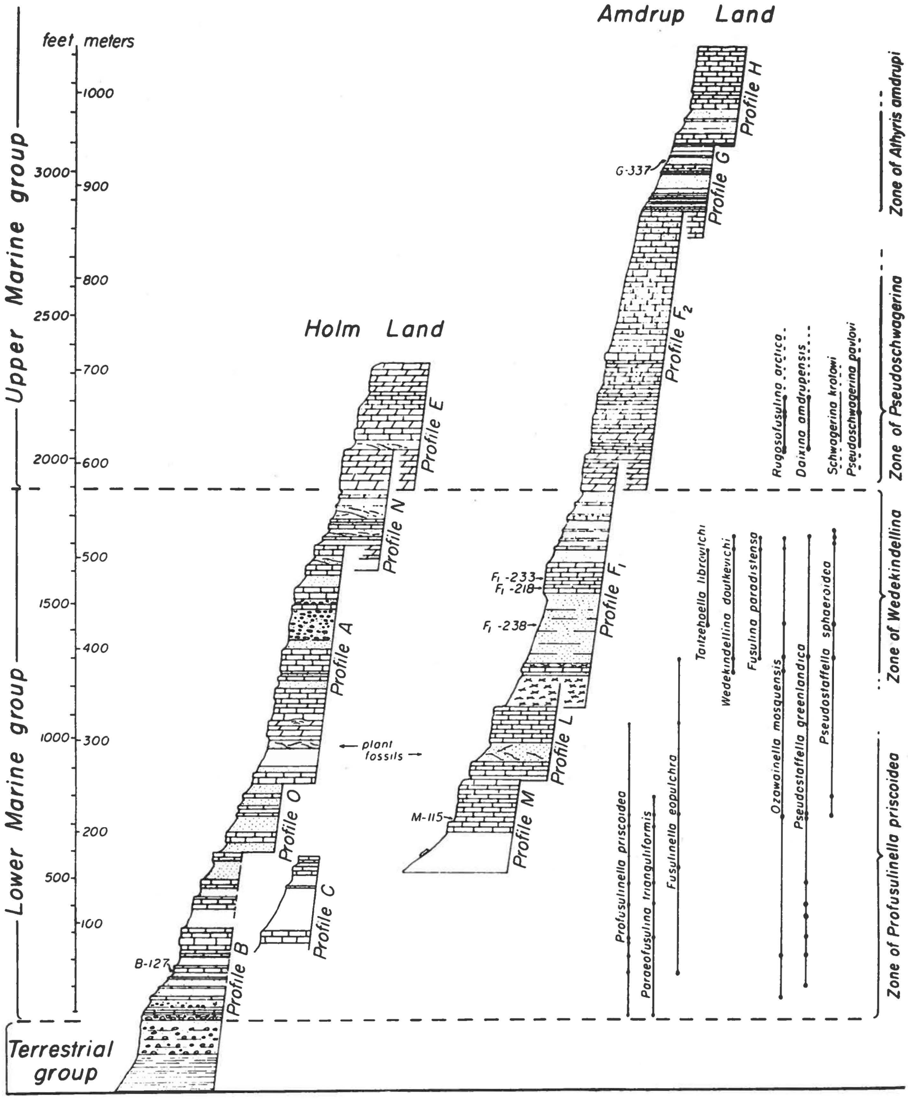

Fig. 2. Composite stratigraphical scheme of the Holm Land — Amdrup Land late Palaeozoic sedimentary sequence, reproduced from Dunbar *et al.* (1962), to show the relative location of vertebrate yielding horizons (e.g. B 127).

addition to invertebrates, also contained the fish remains described in the present paper. Nearly all the small collections were accurately located in the measured sections.

The invertebrate material (foraminiferans, bryozoans, corals, brachiopods, poorly preserved molluscs and crinoids) has been dealt with by Frebold (1950) and, more recently, in a series of papers by Dunbar (1961, 1962), Dunbar *et al.* (1962), Ross & Dunbar (1962), and Ross &

Fig. 3. Exposures of the 'Lower Marine group' in the coastal cliffs of south-eastern Holm Land. Photo: E. NIELSEN, 1939.

ROSS (1962), to whose papers the reader is referred for detailed information concerning the geological development and nature of the deposits. In the present context it may suffice to say that the Holm Land — Amdrup Land marine sequence is divisable into two, on the basis of its invertebrate fossils and sedimentary development, as ascertained already by GRÖNWALL (1916) when he proposed the names 'Lower Marine group' and 'Upper Marine group' for these divisions, respectively. It has been shown that the invertebrate faunas of the 'Lower Marine group' are closely allied to those of the Moscow Basin Upper Carboniferous (upper Middle Carboniferous according to Russian terminology, cf. NALIVKIN, 1973) and this division of the Holm Land — Amdrup Land sequence has been tentatively correlated with the Kashira and Podolsk stages (DUNBAR *et al.*, 1962). Correlative indications offered by the invertebrates are only clear for the lower part of the 'Upper Marine group' which may, according to the foraminiferans, duly be placed somewhere in the Sakmarian series (using here and in the sequel the terminology introduced by FURNISH, 1973). The correlation and age determination of the middle and upper part of this division rests still on insufficient evidence. DUNBAR *et al.* (1962) suggested that these parts of the 'Upper Marine group' (profiles G & H, see figs 2 & 4) might reach into the upper Lower Permian (Artinskian). This suggestion finds definitive support from evidence offered by some of the fish remains considered in the present paper.

The topographical location of the various stratigraphical sections in the Holm Land — Amdrup Land sequence from which fish remains were collected is shown on fig. 1 (see also fig. 4), while fig. 2 shows the stratigraphical position of the vertebrate-yielding horizons (e.g. B 127).

The specimens described and discussed in the sequel are kept in the Mineralogical Museum, The University of Copenhagen, Denmark. The MMHVP numbers in the text and plates refer to the Catalogue of fossil vertebrate specimens in this collection.

## Description and comparison of the material

### Fin-spine of ***Ctenacanthus*** type

(Pl. 1, figs A–D)

#### Material and locality

A fin-spine fragment (MMHVP 1006) from collection M 115 of profile M in Amdrup Land (figs 1 & 2). The specimen was developed by mechanical preparation from a hard, fine grained, light grey limestone (weathering yellowish grey with a slight green tinge) which contains numerous foraminiferans and some crinoid remains and belongs to the *Profusulinella priscoidea* zone.

#### Description

The fin-spine fragment is 17 mm long and represents a part of the exserted portion only. In transverse section the fin-spine is shaped almost as an arrowhead (pl. 1, fig. C), showing crenulation along the originally exposed, ornamented surfaces and a broad, not very deeply incruving of the posterior surface, where the fin-spine bears the insertion groove for the fin and its endoskeleton.

The surface ornamentation consists of closely spaced longitudinal ridges covered by an enameloid substance ( ? consisting throughout of; thin sections could not be made). These diminish in height from front to back. Some of these ridges converge and unite distally (pl. 1, fig. A) and all exhibit a characteristic ornamentation of small nodules which appear either in a paired series, one at each side of a ridge, or in a single series surmounting a ridge (pl. 1, figs A–B, D).

The fin-spine fragment is, in all these features as well as in its denticulated postero-lateral margins (pl. 1, fig. A), clearly similar to other selachian fin-spines known from late Palaeozoic deposits elsewhere and referred to the genus *Ctenacanthus* (see i.a. DAVIS, 1883; WORTHEN, ST. JOHN & MILLER, 1883; TRAQUAIR, 1884; WOODWARD, 1889). The features shown by the present specimen do not, however, permit any reliable estimate concerning the original length of the fin-spine, the length ratio between inserted and exserted portions, or the anterior and posterior curvature ratios.

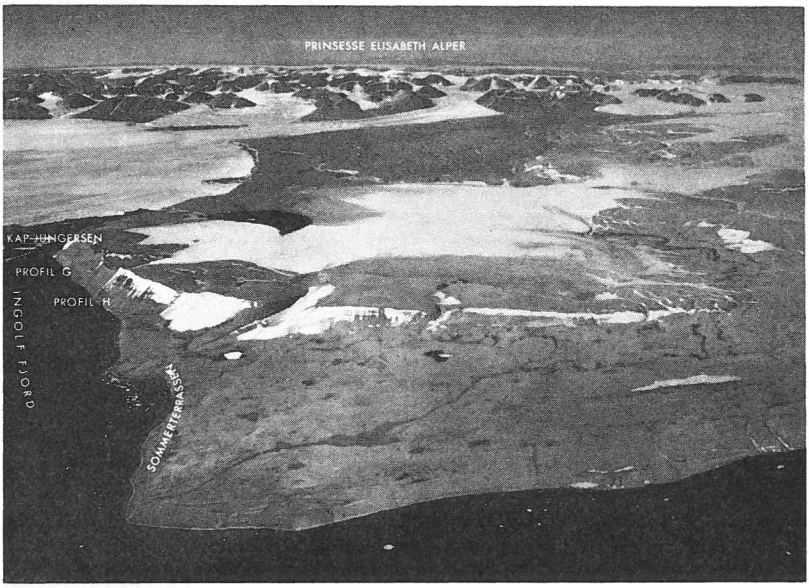

Fig. 4. Amdrup Land seen from an altitude of 4000 m to show the location of the youngest Palaeozoic deposits (the *Athyris amdrupi* zone) yet encountered in the area east of Kap Jungersen (profiles G & H). According to their fossil fish fauna these deposits belong to the late Lower Permian. Copyright: Geodetic Institute, Denmark.

### Remarks

The above described *Ctenacanthus* type fin-spine differs in various features from described and figured fin-spines of this genus occurring in Upper Carboniferous deposits elsewhere. However, it is, of course, unwarranted to assign a specific name to this new fragmentary one, which duly may be labelled *Ctenacanthus* sp.

## ***'Cladodus'*** sp.

(Fig. 5a–d; pl. 2, figs A–E)

### Material and locality

One almost complete tooth and a fragment of another (MMHVP 1011 & 1012; fig. 5a–d), both from collection G 337 of profile G in Amdrup Land (figs 1–2 & 4). The specimens were developed by mechanical preparation from a light grey, calciferous sandstone (weathering yellowish grey, in some cases with rust-brown blotches) which contains a rich fauna including brachiopods, gastropods, bryozoans (Frebold, 1950; Dunbar *et al.*, 1962; Dunbar, 1962; Ross & Ross, 1962) and elasmobranchs with durophagous dentition (*'Helodus'* sp.; see below p. 15). This rock layer belongs to the *Athyris amdrupi* zone (fig. 2) of the uppermost part of the marine sequence in the area.

### Description

Both of the specimens under description show the typical features of teeth usually referred to the morphogenus *Cladodus*. One of them (the fragmentary; fig. 5c–d) represents a larger tooth than the other, but comparisons of their features show them to be so alike that they may even have belonged to one and the same dentition. The following description is mainly based on the almost complete specimen (MMHVP 1012; fig. 5a–b; pl. 2, figs A–E):

The large central crown cusp is slightly lenticular in cross section and exhibits well developed cutting edges. It is flanked on each side by a pair of 'accessory' crown cusps which are almost circular in cross section. The outer ones of these 'accessory' cusps attain nearly half the height of the central cusp, while the height of the inner ones, judging from the best preserved of them, measures less than one fifth of the central cusp (fig. 5a; pl. 2, figs A–C). All five crown cusps are situated labially on the tooth-base (pl. 2, figs A, C, D), at the labial border of which two gently rounded bosses, covered with enameloid substance protrudes downwards, relative to the tooth-base (pl. 2, figs A–E). All crown cusps show a well marked ornamentation on both their labial and lingual surfaces (pl. 2, figs A–D) consisting of comparatively coarse ridges. The ridges present on the lingual face of the central cusp diverge in an apical direction (fig. 5a; pl. 2, fig. B).

The tooth-base is moderately thick and, when seen in occlusal (or basal) view, is slightly reniform with its anterior and posterior marginal parts directed lingually (fig. 5b; pl. 2, figs D–E). Its occlusal surface shows a paired depression situated adjacent to the centre part of the lingual tooth-base border (pl. 2, figs B–D). From the shape, size and location of this paired depression it seems obvious to correlate it, as a pressure scar, with the two labially situated, downwards protruding bosses (cf. above description) of the succeeding tooth in the file. This suggested the development, in this particular cladodont form, of a kind of overlapping 'articulation' between members of the individual tooth-file which could therefore act as one dental unity, highly efficient for the grasping and rasping of prey.

### Affinity of the material

Comparisons with other known teeth of the *Cladodus* type show that the Greenlandic specimens are very similar in their morphology to teeth that Branson (1916) described and referred to *Cladodus occidentalis* Leidy. Branson's material is derived from the Meade Peak Member of the Phosphoria Formation in western Wyoming, U.S.A. Even allowing for the uncertainties involved when evaluating tooth material of the

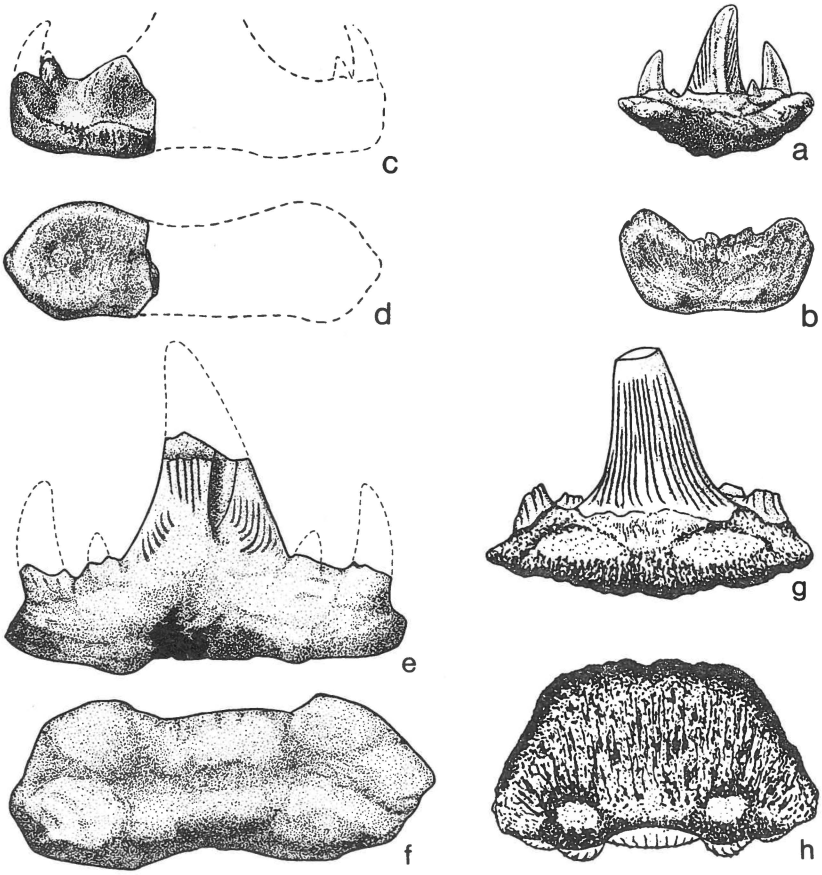

Fig. 5: Figures illustrating the close similarity between the '*Cladodus*' sp. teeth (a–b: MMHVP 1012; c–d: MMHVP 1011) from Amdrup Land and one of BRANSON's (1916) specimens (e–f) from the Phosphoria Formation Meade Peak Member of western Wyoming. The peculiarities shared by these teeth (reniform tooth-base and its various details, crown cusp ornamentation and pattern) clearly distinguish them from the majority of those of the *Cladodus*-type represented here by the Pennsylvanian species *Cladodus occidentalis* LEIDY (g–h). Specimens shown in lingual (a, c, e, g) and basal (b, d, f, h; lingual side margin directed upwards) aspects. Approx. ×3 (a–d) and ×3/2 (e–h); e–f drawn from specimen figured by BRANSON, 1916; g–h redrawn from ZIDEK, 1973a.

present kind, the author finds that the '*Cladodus*' sp. teeth from Greenland and those from Wyoming share peculiarities that may be indicative of a very close relationship between the selachian forms represented by the teeth under discussion (comp. fig. 5a–f). Indeed, one may be dealing with teeth of one and the same species, which is what the author tends to believe.

It should be added, finally, that neither BRANSON's material nor the present teeth from Greenland show any close similarity to the Pennsylvanian species *Cladodus occidentalis* LEIDY (fig. 5g–h), recently dealt with by ZIDEK (1973a). BRANSON's referral of his material to this species consequently has to be abandoned.

## ***Petalodus*** sp.

(Pl. 1, fig. E)

### Material and locality

An incomplete tooth (MMHVP 1005) from collection B 127 of profile B in Holm Land (figs 1 & 2). The specimen was preserved in, and developed from, a medium grey dense limestone (weathering red to red-brown) which, being extremely hard and partly silicified, is almost chert-like in appearance. The invertebrate fauna comprises brachiopods, crinoids and foraminiferans (DUNBAR *et al.*, 1962; ROSS & DUNBAR, 1962). Among the latter, *Profusulinella priscoidea* is type fossil for the zone from which the sample derives (fig. 2).

### Description

This small petalodont tooth is depicted on pl. 1, fig. E which shows it in lingual aspect. As may be seen there, its crown lacks the whole cutting division and a minor part of the crushing division. The features displayed by the remaining crown part (more precisely, its general shape and its lingual surface ornamentation composed of comparatively coarse transverse plicae) and by the well preserved tooth-base (crown and tooth-base subtend with each other at an angle of approximately 140°) clearly recall those characteristic for teeth referred to the genus *Petalodus*.

## ***Lagarodus*** sp.

(Pl. 1, figs G–K)

### Material and locality

One defective tooth (MMHVP 1003) from collection $F_1$ 233 of profile $F_1$ in Amdrup Land (figs 1 & 2). Lithologically the horizon is a yellow, medium grained sandstone containing indeterminable foraminiferans and badly preserved crinoid remains. Stratigraphically it belongs to the *Wedekindellina* zone (fig. 2).

### Description

The specimen, as preserved, shows a portion of the crown and the adjoining tooth-base (pl. 1, figs G, I). The coronal surface is much abraded but it may originally have appeared slightly rugose.

When seen in occlusal view (pl. 1, fig. I) the crown is shaped at one end into a prominent and gently rounded gibbosity, the coronal surface of which is produced downwards, towards the outer extremity (see pl. 1, fig. G). Towards the other end of the crown, the coronal surface descends and rapidly expands into a broad and in part concave crushing surface (pl. 1, figs I–K). Along one side of the tooth (?the labial) there appears to be only a slight constriction between the crown and the tooth-base (pl. 1, figs G–H) whereas various features seem to indicate that such a constriction, and probably a deep one, occurred at the crown/tooth-base junction along the other ( ? the lingual) side.

The tooth may accordingly be restored somewhat like that shown in figs G & H (pl. 1), displaying it in supposed labial and in occlusal views, respectively.

### Affinity of the specimen

Due to its general shape and various peculiarities it is difficult to affiliate this fragmentary tooth with any known kind of tooth type other than that described under the genus name *Lagarodus* (cf. *Lagarodus angustus* (ROMANOVSKY); IVANOVA, 1958, pl. 9, figs 3a–b; OBRUCHEV, 1967, pl. 1, figs 1a–b). This affiliation of the specimen can for obvious reasons only be tentative. It may, however, seem reasonable enough, not only from the observed morphological features, but also from the fact that teeth of the *Lagarodus* type are common among the elasmobranch remains occurring in the marine Upper Carboniferous deposits of the Russian platform (e.g. at Myachovo near Moscow, see IVANOVA, 1958; Myachovo horizon belongs, according to Russian terminology, to the uppermost Middle Carboniferous, cf. NALIVKIN, 1973). It may be presumed that the ichthyofauna of these latter deposits and that of the 'Lower Marine group' in Holm Land — Amdrup Land, was this ichthyofauna better known than at present, would be found to show an equivalent degree of similarity as has been shown to be the case with regard to the invertebrate faunas of the two regions (DUNBAR *et al.*, 1962).

## Dental-plate of cochliodontid or menaspid derivation

(Pl. 1, fig. F)

### Material and locality

A single dental-plate (MMHVP 1004) from collection $F_1$ 238 of profile $F_1$ in Amdrup Land (figs 1 & 2). Mechanical preparation has exposed, but not freed the fragile specimen from the surrounding medium grey limestone (weathering dark grey with a brownish tinge) which contains also many foraminiferans, i.a. *Wedekindellina dutkevichi* of the so-called *Wedekindellina* zone (fig. 2).

### Description

As preserved, the specimen appears to show most of its original outline which is somewhat ovate when seen in occlusal view (pl. 1, fig. F). It is incomplete at its narrow (?anterior) end where it presumably tapered into an apex. There remains along one side (?the medial) a comparatively narrow coronal ridge which apparently extended to the tapering (presumed anterior) extremity of the plate. A shallow, elongate depression sets off this coronal ridge from the main part of the dental-plate, which is longer than broad and has a moderately convex coronal surface. The hard tissue which constitutes the coronal part is clearly 'tubular dentine' (*sensu* ØRVIG, 1967, p. 105). No information can be given as to the basal part of this dental-plate which is still concealed in the tough limestone. The dental-plate could not be further prepared owing to the risk of the specimen's destruction. Nevertheless, the features quoted above make it reasonable to believe that this dental-plate, when complete, would have been fairly similar in shape to that known as *Sandalodus minor*, described by DAVIS (1884). This species occurs in the Upper Carboniferous limestone of Yorkshire and belongs, like the specimen described here, presumably to a member of the cochliodontid or menaspid groups (*sensu* BENDIX-ALMGREEN, 1971).

## ***'Helodus'*** sp.

(Pl. 2, figs F–S)

### Material and locality

Three teeth (MMHVP 1008–1010) of which two are defective. All are from the collection G 337 of profile G in Amdrup Land (figs 1–2 & 4), i.e. the same that yielded '*Cladodus*' sp. dealt with above, to which the reader is referred for further relevant information.

### Description

The teeth described here under the heading '*Helodus*' sp. differ from each other with regard to shape, to be dealt with below, but agree with each other in histological structure, as far as could be ascertained from high power examination under the binocular microscope. Thin sections were not made because of the limited material at hand. According to this inspection the composite hard tissue constituting the crown parts (preserved in two of the teeth: MMHVP 1008–1009; pl. 2, figs. M–Q, Q–S) is of the kind termed 'tubular dentine' (*sensu* ØRVIG, 1967, p. 105), while the tooth-base, in its lower part, consists of a dense, lamellar hard tissue which passes upwards into one which is strongly vascularisized and whose intercommunicating vascular canals penetrate into the tooth-base exclusively from the marginal faces (pl. 2, figs M–N, Q, S).

Concerning the shape of these three teeth and other features such as their preservation and original location within a dentition pattern, one can state the following: The two best preserved teeth (MMHVP 1008 –1009) are clearly 'lateral' ones (compare pl. 2, figs M–S) belonging to tooth-files which covered either a left lower or a right upper jaw ramus. Both are antero-posteriorly elongated and, in each, the crown protrudes laterally to all sides beyond the periphery of the tooth-base. This latter tooth part exhibits, in both cases, a concave basal surface which bears transversally (labio-lingually) situated ridges and grooves (pl. 2, figs P–Q). In both teeth the top face of the crown is produced, in a superficial direction, into a subcentral coronal elevation, the highest point of which is located posterior to the labio-lingual centreline of the crown (pl. 2, figs M–O, Q–S). However, in respects other than those just mentioned, these two teeth diverge much from each other in shape. The larger tooth (MMHVP 1009; which lacks its postero-lingual quaterpart, cf. pl. 2, figs M–P) is broad and stout with well defined anterior and posterior crown/base surfaces. Its occlusal surface is almost smooth and is convex in the vertical transverse (labio-lingual) plane. Its anterior and posterior crown borders bear pressure scars from contact with teeth of the adjacent tooth-files (pl. 2, figs N–O). The comparatively thick tooth-base has a strongly concave labial face, while its anterior face and what remains of its lingual and posterior faces appear slightly convex.

The specimen numbered MMHVP 1008 (pl. 2, figs Q–S) is, on the other hand, a remarkably long and narrow tooth which has its crown raised so as to form a fairly sharp, longitudinal, occlusal crest dividing the occlusal surface into a lingual and a labial zone. These zones are almost equal in size, with smooth surfaces, and both are concave in the vertical transverse (labio-lingual) plane (pl. 2, fig. R). The labial crown border and marginal tooth-base surface are both concave in the horizontal plane whereas those of the lingual side appear slightly convex in the same plane.

The third and last tooth (MMHVP 1010; pl. 2, figs F–H) lacks the entire crown part which was apparently split off, rather than worn down during use. In accordance with this, the rolled and abraded appearance of the specimen, indicates that it had been subject to some transportation or other current action prior to ultimate deposition. As preserved, the specimen shows the almost bilateral symmetrically shaped tooth-base which, being deeply concave from side to side (pl. 2, figs G–H), has its labial and lingual faces sloping downwards and forwards, the lingual face more strongly so (pl. 2, fig. F). The lower surface of the tooth-base is completely smooth. It seems likely that this tooth, when complete, was perfectly bilaterally symmetrical in shape and, accordingly, it may have appeared somewhat like that shown by figs I–L (pl. 2). This may, in turn, indicate that the present tooth could hardly have occupied another location within the dentition than in one of the symphysial tooth-files.

### Affinity of the material

The three specimens described here obviously agree in shape and structure of hard tissue (so far as this is known) with a vast number of detached durophagous elasmobranch teeth known from Carboniferous and Permian deposits elsewhere, and referred to the morphogenera *Helodus*, *Helodopsis*, *Lophodus* and *Chomatodus* under a large variety of species names (see e.g. Agassiz, 1833–43; Romanowsky, 1864; Newberry & Worthen, 1866, 1870; Trautschold, 1874, 1879; Koninck, 1878; Waagen, 1879, 1880; Davis, 1883, 1884; Woodward, 1889; Branson, 1916, Branson & Mehl *in* Branson, 1938; Teichert, 1943). Further comments concerning these similarities should be unnecessary. It is, on the other hand, necessary to comment on the designation *durophagous elasmobranchs* used above (pp. 2, 10), here and in the following text to encompass representatives of the helodontid, cochliodontid, menaspid and edestid groups essential for the comparison and present discussion of fauna compositions. This designation is chosen in order to avoid commitment, thereby avoiding the use of such tainted term as Bradyodonti. All taxonomical questions related to these groups are likewise avoided in the present context. The recent classification proposed by Patterson (1965, 1968; see also Patterson *in* Andrews *et al.*, 1967) referred late Palaeozoic durophagous elasmobranchs such as the above mentioned, together with extinct and extant chimaeriforms, to the class Holocephali. It should be mentioned in passing that this classification is manifestly inconsistent with published evidence (Bendix-Almgreen, 1968, 1971) and new unpublished observations, partly concerned with dental histology. Patterson's classification has consequently been abandoned.

Though the teeth under discussion were collected close to each other there are no good reasons to suggest that they were originally associated in one and the same dentition; a conclusion that finds further support in the extent to which their preservation actually varies. It is likewise impossible to maintain that they belong to a certain durophagous elasmobranch genus and species since teeth of much the same kind as the 'lateral' ones of the above description (i.e. MMHVP 1008–1009) may occur in a large variety of late Palaeozoic durophagous elasmobranchs as is positively known to be the case in the few better known members of the cochliodontids (e.g. *Cochliodus latus*, *Psephodus magnus;* Newberry & Worthen, 1866; Traquair, 1885), the menaspids (e.g.

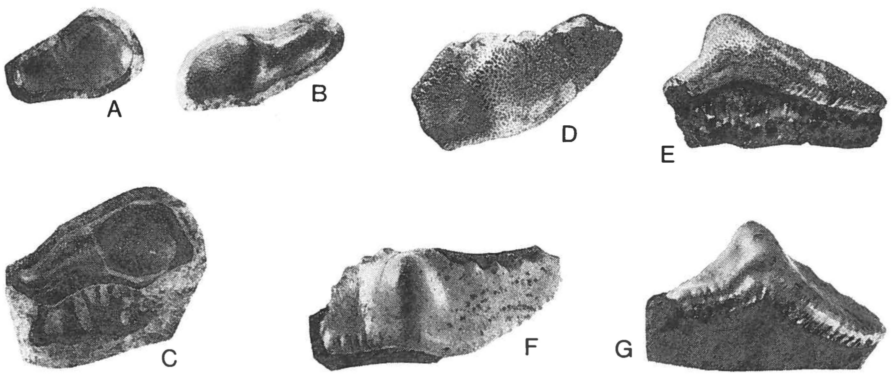

Fig. 6: Two detached teeth (A–B; MMHVP 2295 & 2296; Lower Carboniferous, Ireland), representing types that are referred usually to such morphogenera as *Helodus*, *Lophodus* or *Chomatodus*, are figured here (in occlusal aspects) for comparison with the described '*Helodus*' sp. teeth (see pl. 2, figs. F–S) and wlth teeth and articulated dentition parts (C–N) on the Upper Permian (Araksian) edestid *Fadenia crenulata* NIELSEN from East Greenland. C, F–L show teeth and articulated dentition parts belonging to the upper jaws of which the complete dental pattern is illustrated by the accompanying reconstruction of the neurocranium (rostro-ethmo-ido-orbital part) and the holostylically suspended palatoquandrates of *Fadenia crenulata*, in ventral aspect. The symphysial tooth file (*sym. t. f*) of which three successional teeth are figured in lateral (H) and occlusal (J) aspects, is much smaller in size than the lower one. It is adjoined on each side by a pair of antero-posteriorly extending tooth files (*t. f. a* & *t. f. b*) of considerable length and composed of large, heavy, crushing teeth. Considerable parts of the left side pair of these tooth files are shown by K (*t. f.* $a_1$ & *t. f.* $b_1$). The consecutive teeth are seen in occlusal or oblique occlusal view and are orientated with their labial margins towards the top, matching with those in the reconstruction. C shows the labial side of a slightly abnormally shaped tooth belonging to one of these anterior tooth files. L shows consecutive teeth in occlusal view of six articulated tooth files from the posterior left side part of the dentition, cf. *t. f. x* on the reconstruction. The remaining figured teeth are shown in occlusal (D, F, M) and lingual (E, G, N) views, respectively.

The *Fadenia crenulata* specimens are figured from: MMHVP 2297 (C; from GGU sample no 20536), MMHVP 2298 (D–E; from GGU sample no 9396), MMHVP 2299 (F–G; from GGU sample no 20510), MMHVP 2300 (L; from GGU sample no 29663), MMHVP 224 (H–J), MMHVP 228 (K) and MMHVP 270 (M–N); all were collected from the Upper Permian deposits (*Posidonia* Shale Member, Foldvik Creek Formation) at River 14, Kap Stosch. The reconstruction is based on several specimens and reproduced from an unpublished manuscript by the author. All specimens approx. ×3/2; reconstruction much diminished.

*a.qu*, articular condyle of the quadrate; *caps.n*, nasal capsule; *fe.end*.c, fenestra endonarhina communis; *qu*, quadrate part of the palatoquadrate; *r*, rostral part of snout; *sym.t.f*, upper symphysial tooth file; *t.f.a* & *t.f.b*, first and second lateral tooth file of the left side upper dentition; *t.f.x*, tooth files of the posterior left side upper dentition.

*Note:* In figs H–L the main light source has been placed in positions different from that normally used in photographic presentation of specimens.

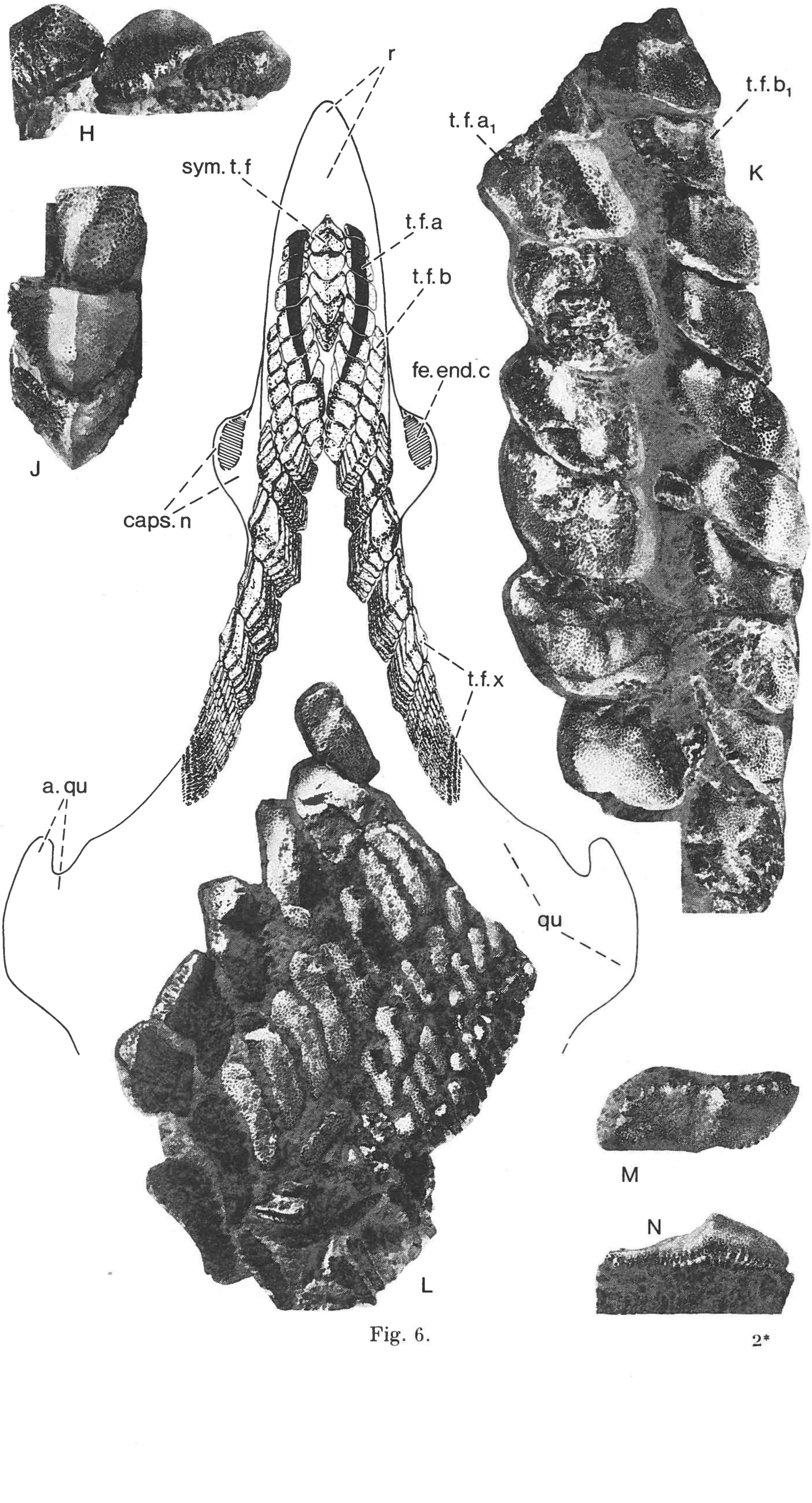

Fig. 6.

*Deltoptychius armigerus;* Moy-Thomas, 1936b; Patterson, 1965), and the helodontids (e.g. *Helodus simplex;* Moy-Thomas, 1936a; Patterson, 1965). Even some of the edestids (e.g. *Fadenia crenulata*, fig. 6; see also Nielsen, 1932) have in their 'lateral' dentition teeth which in almost every respect recall those under consideration. In other words, the teeth could represent either of the four mentioned groups. However, as far as our present knowledge goes, cochliodontids and menaspids are characterized by the absence in their dentition (both upper and lower) of a symphysial tooth-file (Bendix-Almgreen, 1968, 1971). The third tooth in the present '*Helodus*' sp. material, the symphysial tooth (MMHVP 1010), can therefore only be compared with those from helodontids and edestids. The only helodontid in which the diversification within the dentition pattern has to some degree been clarified is the Upper Carboniferous *Helodus simplex* (Moy-Thomas, 1936a; Patterson, 1965) where the symphysial teeth, so far found only in the lower jaw, are of the so-called *Diclitodus* type and, therefore, not comparable to the one under consideration. Other helodontids may perhaps have symphysial teeth shaped like the Greenland one, as may be inferred from the occurrence of the *Lophodus* type teeth, but decisive evidence in support of this is still lacking.

The edestid group is, in effect, the only where the available evidence (in part unpublished) concerns forms (e.g. *Fadenia crenulata*, *Erikodus groenlandicus*) where the dentition, upper as well as lower, comprises symphysial teeth of a kind reminiscent of the tooth discussed here (cf. fig. 6). The tooth itself possesses some features that might point towards its affinities being with the edestids.

Meagre and inconclusive as it is, the above evaluation serves at least to emphasize that the few '*Helodus*' sp. teeth at hand may well indicate a vertebrate faunal assemblage from the *Athyris amdrupi* zone in Amdrup Land of a rather more varied kind than appears to be the case on the face of the actual specimens (cf. also below, p. 24).

## ***Acrolepis*** ? sp.

(Pl. 1, figs L–O)

### Material and locality

Several detached palaeoniscoid scales (MMHVP 1007), apparently representing parts of the same scale-covering, from collection $F_1$ 218 of profile $F_1$ in Amdrup Land (figs 1 & 2). The scales are seen, mostly as impressions, scattered over the bedding plane in a slab of dense, hard, fine-grained, calciferous sandstone which is buff in colour, and originating from the middle part of the *Wedekindellina* zone (fig. 2). The slab contains no other fossils.

### Description

The rhomboidal shaped scales are thick and have, where it can be ascertained, a broad overlapped area which in most of them is produced upwards into a pointed process (pl. 1, figs L, N–O). An articular peg is seen in some of the scales (pl. 1, fig. N) which may accordingly belong to the abdominal and caudal regions of the squamation. The exposed scale-surface is ornamented by comparatively few, but prominent, ridges passing obliquely over the surface, some of them joining each other (pl. 1, fig. M). No denticulation appears along the posterior scale-margin and the basal scale-surface is smooth (pl. 1, figs N–O).

### Affinity of the material

Taken as a whole these scales are similar to those in acrolepids. They are in particular reminiscent of scales described and figured from such acrolepids as *Acrolepis* cf. *murchisoni*, *Acropholis stensioei* and *Plegmolepis kochi* (ALDINGER, 1937) and *Acrolepis sedgwicki* (TRAQUAIR, 1909). However, closer determination of the scales is hardly possible on basis of the material at hand.

## Biostratigraphical evaluation

The fact that the Upper Carboniferous and Lower Permian marine fish remains dealt with in this paper represent the most northerly of their kind and age yet encountered, enevitably raises expectations of them as potential source material of value for biostratigraphic considerations. The material is small and poorly preserved which may, of course, have several explanations. Perhaps the main reason is that its collecting was not a result of an intense search devoted to vertebrate remains, but was effected during the course of a systematic collection of fossils and rock samples for purely stratigraphical purpose. The manyside consequences of this are clear enough in respect to the issue now under discussion where the material, as duly demonstrated below, only to some degree fulfils the expectations.

The 'Lower Marine group' fish remains include *Ctenacanthus* sp. and *Petalodus* sp. (both from the *Profusulinella priscoidea* zone; fig. 2), and *Lagarodus* sp., *Acrolepis* ? sp. and a cochliodontid (or menaspid) dental-plate (all from the *Wedekindellina* zone; fig. 2). Rich invertebrate collections from these deposits provide a fairly good basis for their age determination and for biostratigraphical correlation of them with parts of the late Palaeozoic sequence in western Spitsbergen (the *Profusulinella priscoidea* zone ∼ the Passage beds of the Campbellryggen group;

the *Wedekindellina* zone ~ the Black Crag limestone of the Wordiekammen group) and with the Kashira and the Podolsk stages, respectively, of the Moscovian, as known from the Moscow Basin (DUNBAR *et al.*, 1962).

The Spitsbergen beds referred to have, to the author's knowledge, not yielded any fossil fishes, but such are fairly abundant in beds belonging to the Vereiian and Myachkovian stages underlying and overlying respectively, the Kashira and Podolsk stages (all four stages constitute according to Russian terminology parts of the Middle Carboniferous, cf. NALIVKIN, 1973). The deposits occur at various localities in the northern part of European U.S.S.R. (e.g. Severnaya Dvina), around Moscow (e.g. Alioutovo, Myachkovo) and from the Donets Basin on the Russian platform (ROMANOWSKY, 1864; TRAUTSCHOLD, 1874, 1879; CHABAKOV, 1928; BALEJEWA, 1932; IVANOVA, 1958; OBRUCHEV, 1967). These Russian ichthyofaunas may, therefore, be considered to be broadly contemporaneous with that from North-East Greenland, with which they share similarity in preservation (detached teeth, dental-plates, fin-spines, scales), but they are decidedly richer. With regard to elasmobranchiomorphs they include the following suite: *Cladodus mortifer* NEWBERRY & WORTHEN, *Ctenacanthus venator* CHABAKOV, *Petalodus* sp., *Polyrhizodus concavus* TRAUTSCHOLD, *Polyrhizodus longus* TRAUTSCHOLD, *Sandalodus minor* (TRAUTSCHOLD), *Lagarodus angustus* (ROMANOWSKY), *Solenodus* sp., *Lophodus marginalis* ROMANOWSKY, *Helodus mons-canus* TRAUTSCHOLD, *Poecilodus concha* TRAUTSCHOLD, *Orodus ineaquilaterus* TRAUTSCHOLD, *Protopirata protopirata* (TRAUTSCHOLD), *Petrodus barbotanus* ROMANOWSKY, and *Physonemus* sp. Comparison will show that the marine Upper Carboniferous fish assemblages of these two widely distant places have only three genera in common, namely *Ctenacanthus*, *Petalodus*, and *Lagarodus*, and none of the Greenland representatives can be identified with any of the Russian species.

Exactly the same conclusion is arrived at when comparing the Greenland fish assemblage under consideration with Upper Carboniferous marine ichthyofaunas (including acrolepids) from western Europe (see e.g. DAVIS, 1884; WOODWARD, 1889; TRAQUAIR, 1909) and North America (see e.g. RAYMOND, 1910; ROMER, 1942, 1952; cf. also HAY, 1929).

The shared genera are obviously of little use in the present context. Both *Ctenacanthus* and *Petalodus* are genera of considerable vertical stratigraphical range, as are also acrolepids. With regard to the Greenland specimen referred to *Lagarodus*, a genus otherwise known only from the U.S.S.R. (where the author during a visit to Moscow in 1964 studied material of this genus which he found cannot possibly include the Belgian specimen referred to it by de KONINCK, 1878), its identification may still be considered somewhat doubtful.

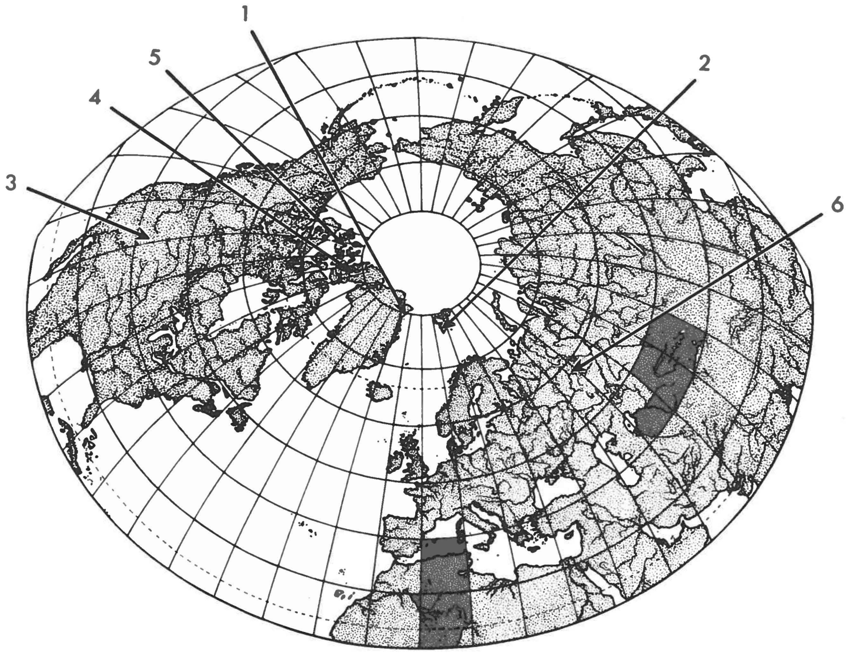

Fig. 7: Map to show the location of the various late Lower Permian marine sequences considered in context with the biostratigraphical evaluation of the fossil fish material from Amdrup Land (1). 2: The Brachiopod Cherts of western Spitsbergen; 3: Idaho — Wyoming occurrences of the Phosphoria Formation Meade Peak Member; 4 & 5: Occurrences of the Assistance Formation on Ellesmere Island (loc. Blind Fjord) and Melville Island, respectively; 6: The Artinskian deposits at Krasnoufimsk, U.S.S.R.

Summarizing the above, one finds that in terms of biostratigraphy the 'Lower Marine group' fish assemblage adds nothing tangible to support or to contradict the correlation offered by the invertebrates of these parts of the Holm Land — Amdrup Land late Palaeozoic marine sequence.

The 'Upper Marine group' fish assemblage is derived from beds of profile G exposed in Amdrup Land where these beds, together with those of profile H form the top part of the marine sequence referred to as the *Athyris amdrupi* zone (fig. 2). The dating of these deposits has remained uncertain from previous investigations (Frebold, 1950; Dunbar *et al.*, 1962; see also Dunbar, 1961), a situation which can now be adjusted on the basis of the presently studied fossil fishes.

The sparse material includes elasmobranch teeth of two principal types referred to above as '*Cladodus*' sp. and '*Helodus*' sp. respectively. Of these, the *Cladodus* type teeth show very close similarity to teeth of this morphogenus reported by Branson (1916) from the Meade Peak

Member which belongs to the middle part of the Phosphoria Formation in western Wyoming, U.S.A. (McKelvey *et al.*, 1956, 1959; cf. also Yochelson, 1968). On basis of its ammonoid fauna known from localities in S.E. Idaho that are situated in proximity to the Wyoming vertebrate yielding ones (fig. 7), the Meade Peak Member is now placed in the Roadian stage, the closing stage of the Lower Permian (Furnish, 1973). If in these circumstances the *Cladodus* type teeth from Amdrup Land are conspecific with those from Wyoming, as the writer tends to believe despite the sparse material available for study, then this provides the first clue to an age determination, in the broader sense, of the yielding *Athyris amdrupi* zone. Indeed, it might perhaps even justify an approximate correlation of this zone with the above-mentioned North American deposits. It will also be the first element that the 'Upper Marine group' fauna has been found to share with any of the roughly contemporaneous faunas so far recorded from the interior of North America (cf. Dunbar *et al.*, 1962).

The western Wyoming Meade Peak Member fish fauna also includes, among others, teeth of *Helodus* types (*Helodus subpolitus*, *Helodus rugosus;* Branson, 1916) but none of these are particularly similar to those from the Amdrup Land material. Though they offer no direct evidence in relation to the issue of age determination and correlation under discussion, these *Helodus* type teeth nevertheless deserve a short comment in the present context. It has been suggested above (p. 20) that the presence in the *Athyris amdrupi* zone of teeth of this type could be indicative of a somewhat varied elasmobranch fauna which, in addition to early selachians with *Cladodus* type dentition, might include a variety of durophagous elasmobranch types representing perhaps such groups as helodontids, cochliodontids, menaspids, and even edestids. The same may, of course, apply also to the detached teeth of this kind (i.e. *Helodus subpolitus*, *Helodus rugosus*) from western Wyoming where the recorded fossil fishes, exclusively of elasmobranch derivation with representatives such as *Crassidonta stuckenbergi* (cochliodontid), *Deltodus mercurii* (part of that material is, in the author's opinion, of menaspid derivation), and *Campodus* sp. undet. (edestid), cover the majority of the aforementioned durophagous elasmobranch groups, and all of them if the *Helodus* type teeth are proper representatives of that group. It is not here intended to pursue further the problems of what relation or affiliation there might exist between anyone of these dentition elements or the many others present in the Wyoming fossil fish fauna. For several reasons this would be out of place, since the salient point is that the faunal aspect presented by this particular part of the Wyoming Meade Peak Member fossil fishes tallies well with that suggested for the 'Upper Marine group' by its sparse fish assemblage from Amdrup Land. In such circumstances, the approximate dating and correlation suggested by the '*Cladodus*' sp. teeth stands unimpaired.

Turning to matters involving invertebrates, it is essential to note that the brachiopods *Yakovlevia impressus* (TOULA), *Waagenoconcha irginaeformis* STEPANOV, *Spiriferella draschei* TOULA, and *Athyris amdrupi* (DUNBAR) all occurring in the deposits of profiles G & H in Amdrup Land, in the opinion of DUNBAR *et al.* (1962, p. 13) "justify a firm correlation [with] the Brachiopod Cherts of Spitsbergen". These deposits of western Spitsbergen (fig. 7) are, owing to recent find of *Helicoprion* (*Helicoprion svalis;* SIEDLECKI, 1970), now believed to be of late Artinskian age (*sensu* FURNISH, 1973) which seems a sound dating based as it is on a most critical, up-to-date evaluation of WHEELER's (1939) '*Helicoprion* Bizone' concept.

It was likewise on the basis of brachiopod faunal similarity that THORSTEINSSON and HARKER (1960) considered the Amdrup Land deposits under discussion (and the Brachipod Cherts of Spitsbergen) to be correlatives of their Assistance Formation of Arctic Canada (fig. 7). Though DUNBAR *et al.* (1962, p. 14) found this 'to be extremely doubtful' there may be good reasons to reconsider it as very likely, also in the light of newly found ammonoid evidence which places the Assistance Formation in the uppermost late Lower Permian, i.e. the Roadian stage (NASSICHUK *et al.*, 1965; FURNISH, 1973), and provides a firm correlation with the Phosphoria Formation Meade Peak Member deposits as known from S. E. Idaho (for detail description see MCKELVEY *et al.*, 1956, 1959; YOCHELSON, 1968).

Closely related to, and essential for, the matters of correlation under discussion are some observations made (but not commented upon elsewhere) by the author in connection with his studies of North American *Helicoprion* and *Physonemus* material (including specimens from Arctic Canada kindly made available by Dr. W. W. NASSICHUK of the Geological Survey of Canada, Calgary), which are given here in short. Among the *Helicoprion* finds that have recently been reported (NASSICHUK & SPINOSA, 1970; NASSICHUK, 1971) from exposures of the Assistance Formation at various localities in the Canadian Arctic Archipelago (fig. 7) is a specimen (NMC 12248; fig. 8B) which, in features of its preserved crown parts, corresponds closely to the same crown parts in the younger volution of one particular *Helicoprion* tooth-whorl (fig. 8A) from the Meade Peak Member deposits of S.E. Idaho (Waterloo Mine) described by the author as *Helicoprion* cf. *ferrieri* (BENDIX-ALMGREEN, 1966). NASSICHUK (1971) assumed that this Assistance Formation specimen was, in fact, a detached part of another one (NMC 12247) because of circumstances related to their collecting. This serves to emphasize further the strong similarity between these Canadian specimens

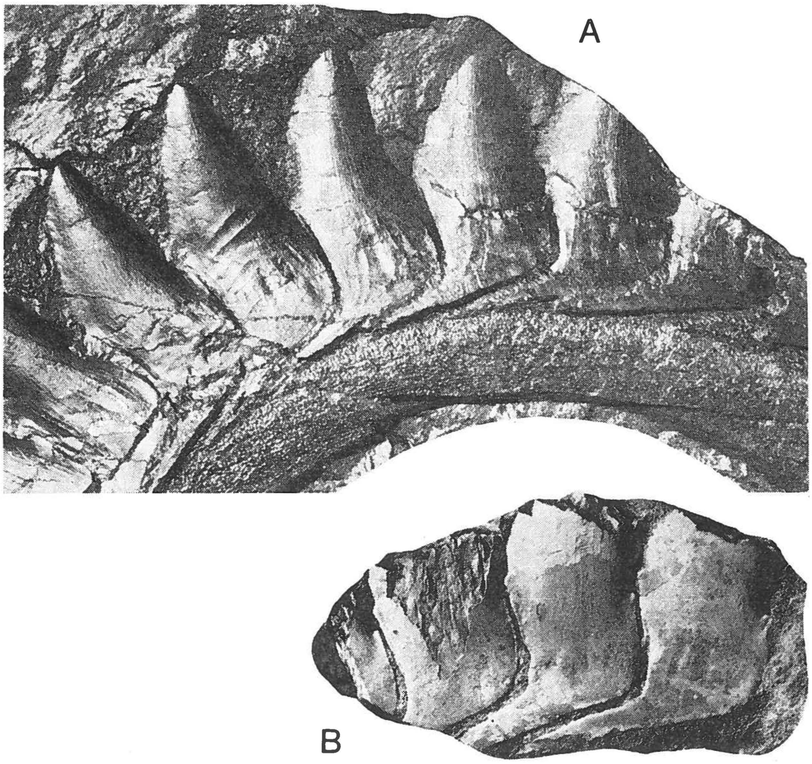

Fig. 8: Parts of the tooth-whorls of, A: *Helicoprion* cf. *ferrieri* (Sp. Idaho no. 8; cf. Bendix-Almgreen, 1966) and B: *Helicoprion* sp. (NMC 12248; cf. Nassichuk, 1971) showing similarity in features indicating their assignment to one and the same species. Approx. nat. size.

and the one from Idaho which, to all intents and purposes, are so alike as to be regarded as belonging to one and the same species. This evidence, to which can be added that of the common occurrence in these widely distant located stratigraphical units of the peculiar elasmobranch spine *Physonemus* (Assistance Formation specimen, see Nassichuk, 1971; Wyoming Meade Peak Member specimen, see Branson, 1916: *Batacanthus* syn. *Physonemus*), fully agrees with and offers essential support to the correlative evidence of the ammonoids. Turning to the Spitsbergen *Helicoprion svalis* (fig. 9B), which Siedlecki (1970) found to resemble closely the late Artinskian ('Krasnoufimskian') *Helicoprion bessonowi* (fig. 9C) from the U.S.S.R. (Karpinsky, 1899), it is important to note that the author considers this to be so similar to *Helicoprion ergasaminon* (Meade Peak Member, S.E. Idaho; Bendix-Almgreen, 1966; compare fig. 9A) that he believes that the two species cannot stand far remote from each other in terms of phylogeny or time.

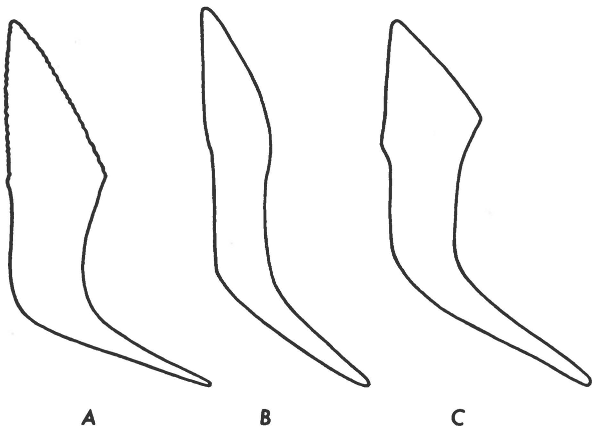

Fig. 9: Outline drawing to show tooth crowns from approximately the same part of the tooth-whorl in three *Helicoprion* species (A: *H. ergasaminon;* B: *H. svalis;* C: *H. bessonowi*). Redrawn from: KARPINSKY, 1899 (C); BENDIX-ALMGREEN, 1966 (A); SIEDLECKI, 1970 (B).

By virtue of the variety of faunal similarities now presented the author finds it reasonably justified to correlate, as broadly contemporaneous stratigraphical units, the Spitsbergen Brachioped Cherts, the Assistance Formation of Arctic Canada and the Meade Peak Member beds of south-east Idaho and western Wyoming from interior North America. This conclusion, in its turn, implies the same broad contemporaneity for, and approximate correlation of, the top part (profiles G & H) of the 'Upper Marine group' in Amdrup Land which is, in fact, the very same outcome that was indicated by the small fish assemblage described above.

Be this as it may, in the author's opinion, the evaluation shows beyond doubt that the *top part of the 'Upper Marine group' does not belong to the early Lower Permian (Sakmarian) as* DUNBAR *et al. (1962) were inclined to believe. Rather it is to be referred to the late Lower Permian within which stratigraphical unit it presumably occupies a position that is closer to the top than to the bottom.*

## Relationship to Peary Land and central East Greenland

The Holm Land — Amdrup Land marine late Palaeozoic sequence can be traced towards the north through more or less equivalent strata exposed in various places. The northernmost yet known locality is at Hellefiskefjord (just south of 83°) in eastern Peary where an apparently Pennsylvanian to Upper Permian sequence is developed (PEEL *et al.*, 1974; gives all relevant references). No vertebrate remains have so far been detected in any of the available samples from these various outcrops which all yield an abundance of invertebrate fossils.

In southern Holm Land, subjacent to the 'Lower Marine group' strata, outcrops of continental deposits are met with in the Sortebakker. They contain an abundance of fossil plants and some coal seams (NIELSEN, 1941; see figs 1 & 2) and are, according to NATHORST's (1911) palaeobotanical investigation of the early collection from this 'Terrestrial group', of Lower Carboniferous (Dinantian) age. The 'Terrestrial group' may thus be considered broadly contemporaneous with some of the oldest Carboniferous deposits exposed in central East Greenland (leaving aside here the upper part of the Mount Celsius series, the dating of which, in the author's opinion, remains doubtful) where the widespread Carboniferous to Lower Permian strata are all continental in origin (BÜTLER, 1961). Any attempt at correlation of this succession with the marine sequence of Holm Land — Amdrup Land must perforce depend on what chronostratigraphical evidence there may be available.

Plant fossils occur abundantly at many levels within the central East Greenland succession in question and have so far been the exclusive source material for dating of the deposits (see RAUNSGAARD PEDERSEN, 1976). More recent attempts of this kind are related to that part of the succession which is located roughly between southwestern Traill Ø and Scoresby Sund, and for which PERCH-NIELSEN *et al.* (1972) has proposed the name Mesters Vig Formation. Applying what palaeontological and in particular lithological evidence there was available, this succession was provisionally subdivided into gross units (Members), and the main occurrences within the whole region were tentatively correlated (PERCH-NIELSEN *et al.*, 1972, table 1). Though this stratigraphic scheme may be considered unsatisfactory in many respects, it is for the time being the best and most thorough yet attempted. In so far as the region as a whole, and this part of central East Greenland Carboniferous — Lower Permian succession in particular is concerned, this is the only area where new data, relevant in the present context, have been presented.

In some of the strata of the Mesters Vig Formation fossil fishes (pleuracanthids, acanthodians, palaeoniscoids) are by no means rare while even stegocephalian remains occur sparsely (BENDIX-ALMGREEN, 1976). This exclusively non-marine vertebrate fauna (which yields no indications whatsoever of marine influence on the deposition of the sediments containing it, as has been maintained by BÜTLER, 1961; a.o.) comprises the highly characteristic acanthodian genus *Traquairichthys*. On account of its very restricted stratigraphical occurrence elsewhere, more precisely in the Westphalian D (JENSEN, 1975) and Stephanian

Table 1.

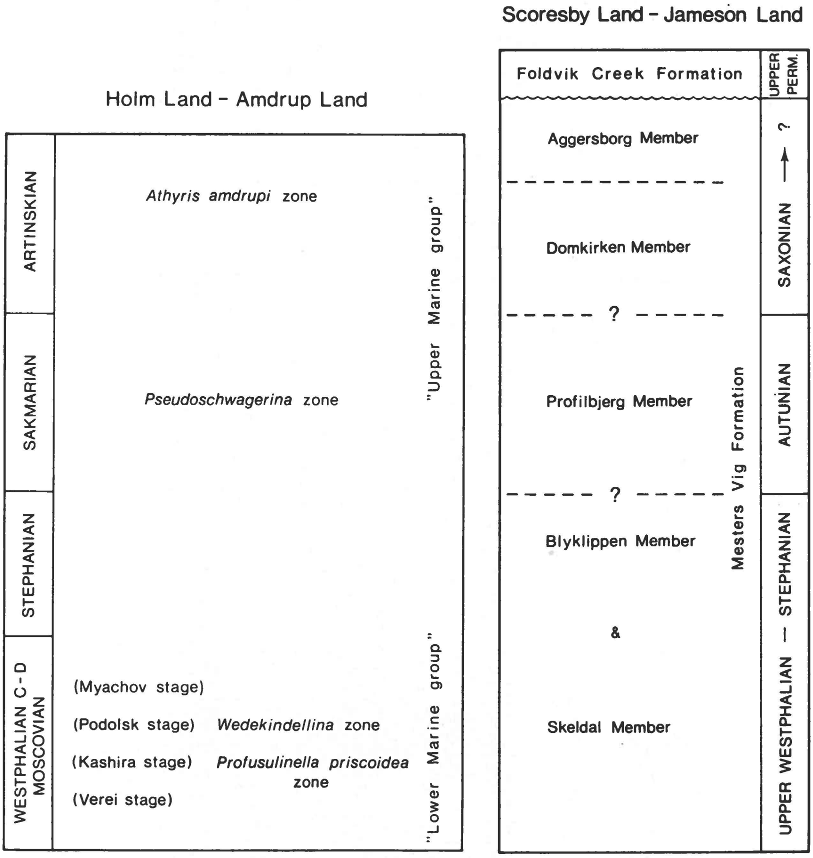

Table 1: Attempted chronostratigraphical correlation between Upper Carboniferous to Lower Permian marine and continental sedimentary sequences of East Greenland.

(Zidek, 1973b) strata of Czeckoslovakia (the poorly preserved acanthodian specimen from Texas that Zidek assumed to belong to this genus is too dubious to be considered here), *Traquairichthys* provides a fairly good clue for a broad Westphalian-Stephanian age determination for the yielding deposits of the Skeldal Member lithostratigraphical unit of the Mesters Vig Formation (table 1).

By virtue of this newly achieved age indication, in conjunction with earlier ones from palaeobotanical investigations already applied to the Mesters Vig Formation dating (see Perch-Nielsen *et al.*, 1972; also for full references), it may be reasonable to make a slight revision of age relations of the lower parts, i.e. the Skeldal Member and the superjacent Blyklippen Member, of that formation (table 1). The Blyklippen Member (fig. 10) might accordingly be slightly younger than believed until now;

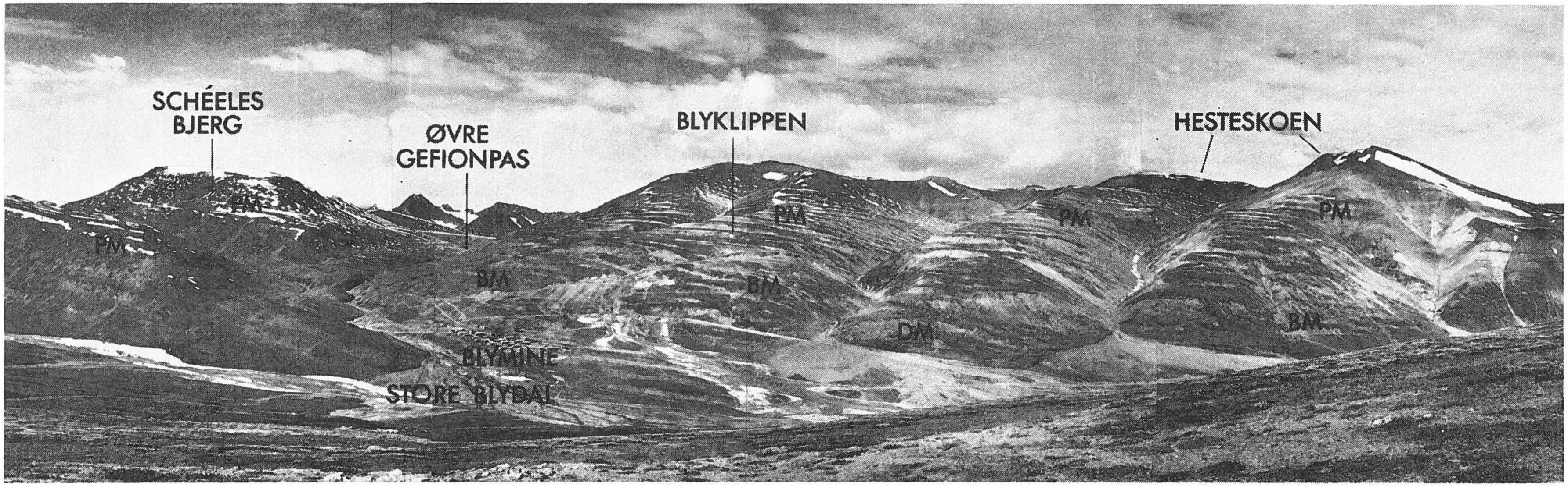

Fig. 10: Exposures of the Mesters Vig Formation at the type locality of the Blyklippen Member (BM) and the abovelying Profilbjerg Member (PM). DM marks an occurrence of the downfaulted Domkirken Member. Western side of Store Blydal, Mesters Vig area, northern Scoresby Land. Photo: Bente Soltau Bang, 1959.

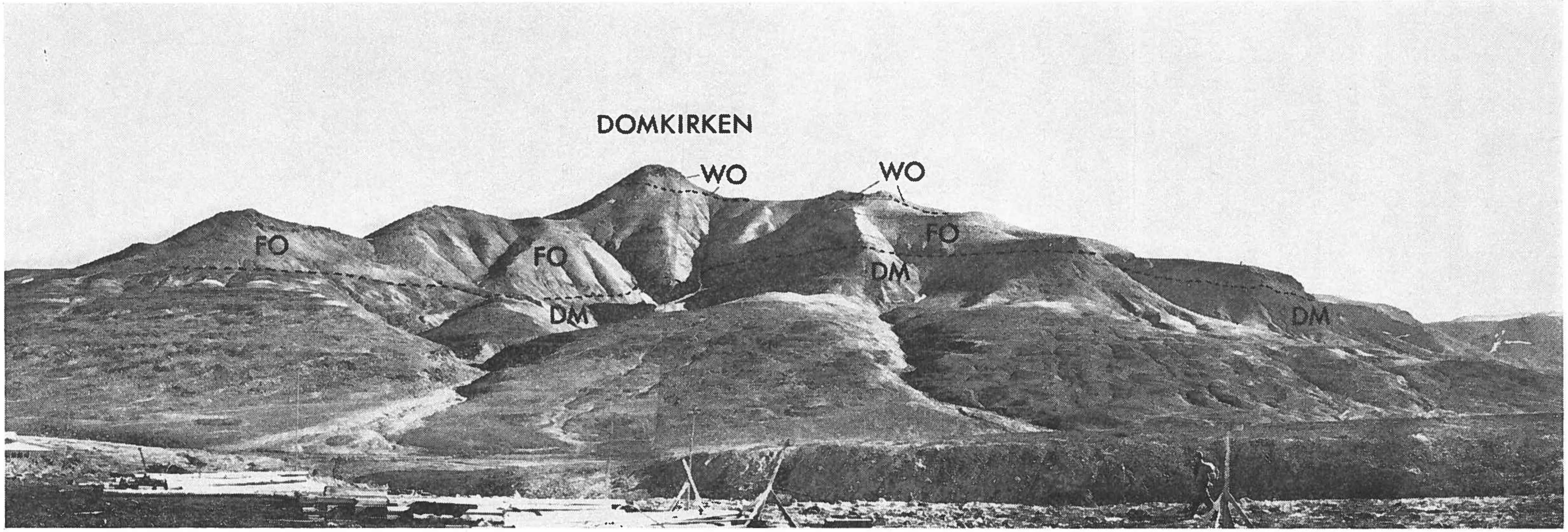

Fig. 11: The several hundred metres of barren strata constituting the Domkirken Member (DM) of the Mesters Vig Formation are unconformably overlain at the type locality on the southwestern slopes of Korsbjerg (Mesters Vig area, northern Scoresby Land) by strata of the Upper Permian (Araksian) Foldvik Creek Formation (Fo), superceded by deposits of the Lower Scythian Wordie Creek Formation (Wo). Photo: Bente Soltau Bang, 1958.

a suggestion which is not out of harmony with the age indication supplied by the various fossil plants from these particular deposits (cf. WITZIG, 1951, p. 28). This might, in its turn, support the assumption that also the lower part of the Profilbjerg Member (fig. 10), following next in the lithostratigraphical succession, has its proper time-stratigraphical position within the Lower Permian (Autunian), such as is apparently the case with its upper part judging from palynological data (cf. PERCH-NIELSEN *et al.*, 1972). Now for the formation's upper part, comprising the Domkirken Member (fig. 11) and the overlying Aggersborg Member, it obviously still remains a task for future research to provide evidence that could demonstrate how far up into Lower Permian time this particular succession part ranges. It is, on the other hand, not inconceivable that the current view postulating these deposits to be in their uppermost part close to Lower — Upper Permian boundary may find support from such future work.

Summarizing what knowledge is now available, it seems appropriate to make a tentative gross chronostratigraphical correlation between the marine sequence in Holm Land — Amdrup Land and the continental Mesters Vig Formation succession of southern central East Greenland (70°–72°) such as is given, translated into practical terms, in the accompanying tabel 1.

To round up the present discussion one should point out that the marine elasmobranch fauna which appeared in central East Greenland with the submergence of that region and the deposition there of the Foldvik Creek Formation in Upper Permian time, and which comprises cladodontids, edestids, petalodontids, and some few other forms including possible early hybodontids (BENDIX-ALMGREEN, 1976; gives also full references), shares no specific similarity with that of the 'Upper Marine group' deposits of Amdrup Land. In view of the sparse fossil fish material at present available from the latter deposits one should, of course, be most circumspect not to overestimate the importance of this observed elasmobranch faunal diversity though it is a fact that, as far as this indication now goes, it tallies well with the diversity pattern that was ascertained for the brachiopod faunas by DUNBAR (1961; DUNBAR *et al.*, 1962) in his studies of the extensive material of that group which originates from the very same deposits (and localities) of these two East Greenland regions.

## Acknowledgements

The author is most grateful to the director of the Geological Survey of Greenland, K. Ellitsgaard-Rasmussen and to Count Eigil Knuth and the late Mr. Ebbe Munck, leaders of the 'Dansk Nordøstgrønlands Ekspedition 1938–39', for their permission to publish on the currently described material. Parts of the figured material were collected in central East Greenland (Kap Stosch region) during the summers 1958, 1959, and 1967 on expeditions financially supported by the Geological Survey of Greenland. The author was at two of these occasions assisted by his wife Mrs. Bente Soltau Bang and by cand. mag. K. Schou Jørgensen; to both of whom cordial thanks are extended for good cooperation in the field.

At the Mineralogical Museum technical assistance of the usual high standard was rendered by Konservator Bente Soltau Bang (preparation and photography), Mrs. Ragna Larsen and Mr. Chr. Rasmussen (drawings).

Dr. J. S. Peel (G.G.U.) improved the English manuscript. The Danish Natural Science Research Council (Statens naturvidenskabelige forskningsråd) supported this work by grant nos. 511–1735 and –2859 which enabled visits to the British Museum (Natural History), London (inspection of *Helodus simplex* and other late Palaeozoic durophagous elasmobranchs) and the Institut de Paléontologie, Paris (comparisons with Palaeozoic elasmobranch material kept in the collections of the Muséum National d'Histoire Naturelle).

The aerial photograph of Amdrup Land (fig. 4) is published with permission (A 649/72) of the Geodetic Institute, Denmark.

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Færdig fra trykkeriet den 12. dec. 1975

# PLATES

## Plate 1

Fossil fishes from the ‘Lower Marine group’.
Upper Carboniferous (Moscovian). Holm Land and Amdrup Land.

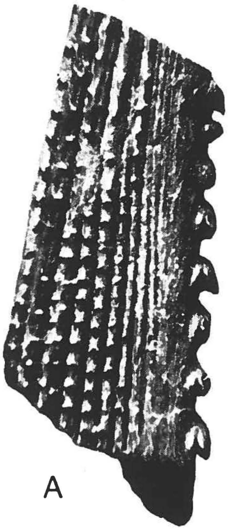
A–D: *Ctenacanthus sp.* (MMHVP 1006); imperfect fin-spine shown in lateral left side (A) and anterior (B) views. Details of ornamentation are displayed in D, while C shows the transverse section shape. Approx. ×4 (A–C); ×6 (D).

E: *Petalodus* sp. (MMHVP 1005); imperfect tooth shown in lingual aspect. Approx. ×4.

F: Cochliodontid (or menaspid) dental-plate (MMHVP 1004); imperfectly preserved, seen in occlusal view. Approx. ×2.

G–K: *Lagarodus* sp. (MMHVP 1003); imperfect tooth shown in labial (G) and occlusal (I) views. H and K display the specimen superimposed on drawings of the supposed outline of the complete tooth seen in the same aspects as above. Approx. ×2.

L–O: *Acrolepis* ? sp. (MMHVP 1007); scales from the abdominal and caudal squamation. L, N–O show individual scales in basal view. M shows a scale in superficial view to display the surface ornamentation. From a latex cast of the specimen. Approx. ×2.



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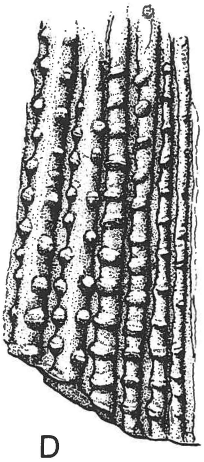

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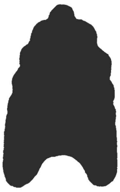

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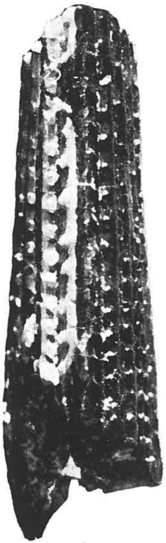

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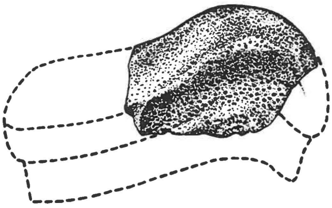

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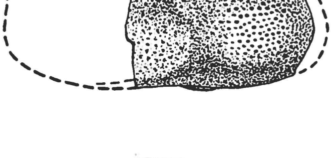

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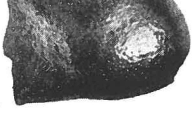
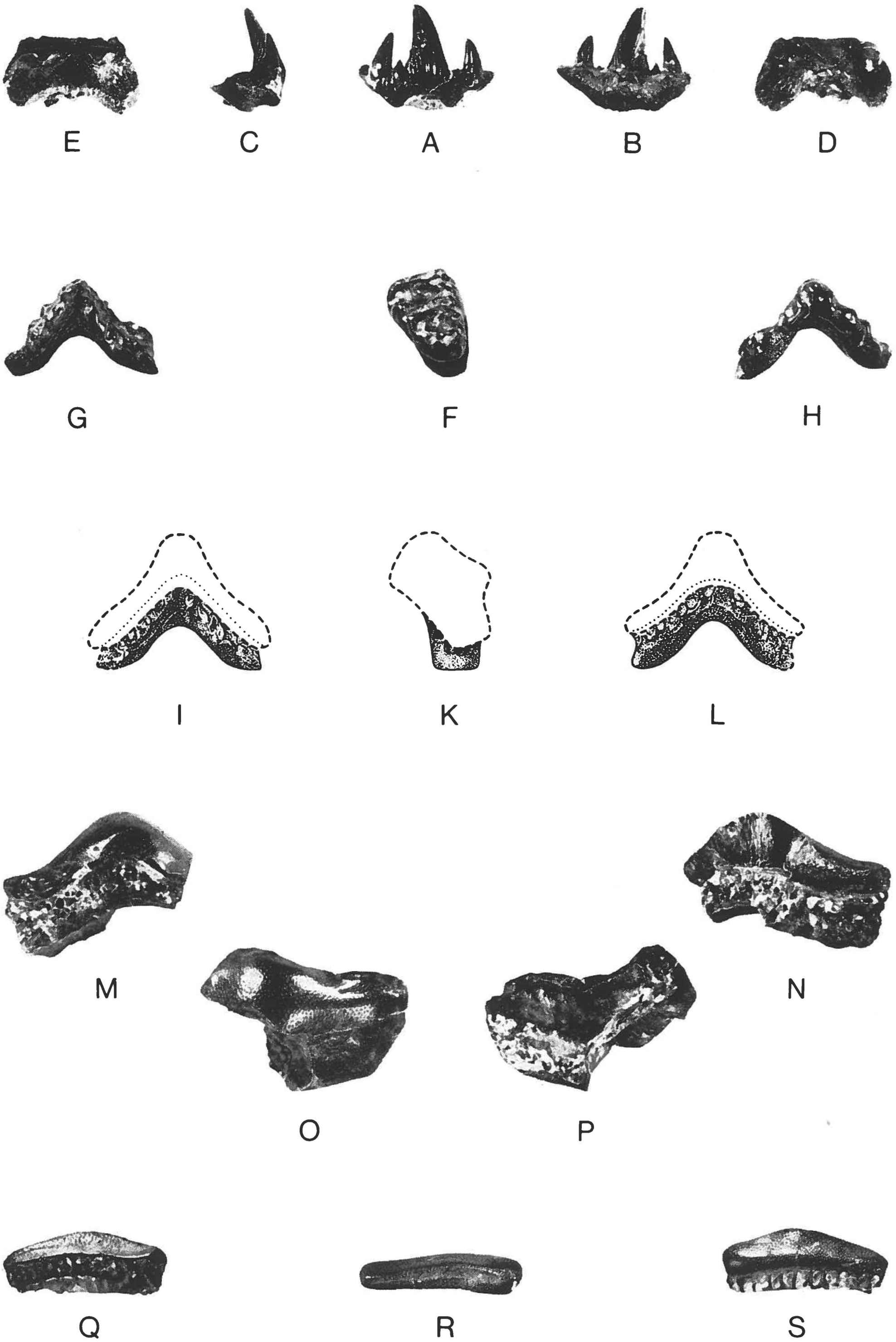


I

## Plate 2

Fossil fishes from the 'Upper Marine group'.
Late Lower Permian. Amdrup Land.

| | |
|---|---|
| A–E: '*Cladodus*' sp. | (MMHVP 1012); an almost perfectly preserved tooth shown in labial (A), lingual (B), anterior end (C), occlusal (D), and basal (E) views. Approx. × 2. |
| F–L: '*Helodus*' sp. | (MMHVP 1010); strongly abraded basal part (F–H) of an apparently bilaterally symmetrical tooth (*Lophodus* type) that may have occupied a symphysial location in the dentition. The missing crown part is tentatively restored in figs I–L. Specimen shown in lateral (F & K), labial (G & I), and lingual (H & L) aspects. Approx. × 2. |
| M–P: '*Helodus*' sp. | (MMHVP 1009); imperfect but otherwise well preserved 'lateral' tooth shown in labial (M), lingual (N), occlusal (O), and basal (P) aspects. Approx × 2. |
| Q–S: '*Helodus*' sp. | (MMHVP 1008); perfectly preserved tooth shown in labial (Q), occlusal (R), and lingual (S) aspects. Approx. × 2. |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