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FAUNAS AND CORRELATION OF THE LATE PALEOZOIC ROCKS OF NORTHEAST GREENLAND

PART I

GENERAL DISCUSSION AND SUMMARY

BY

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WITH 4 FIGURES IN THE TEXT

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
1962

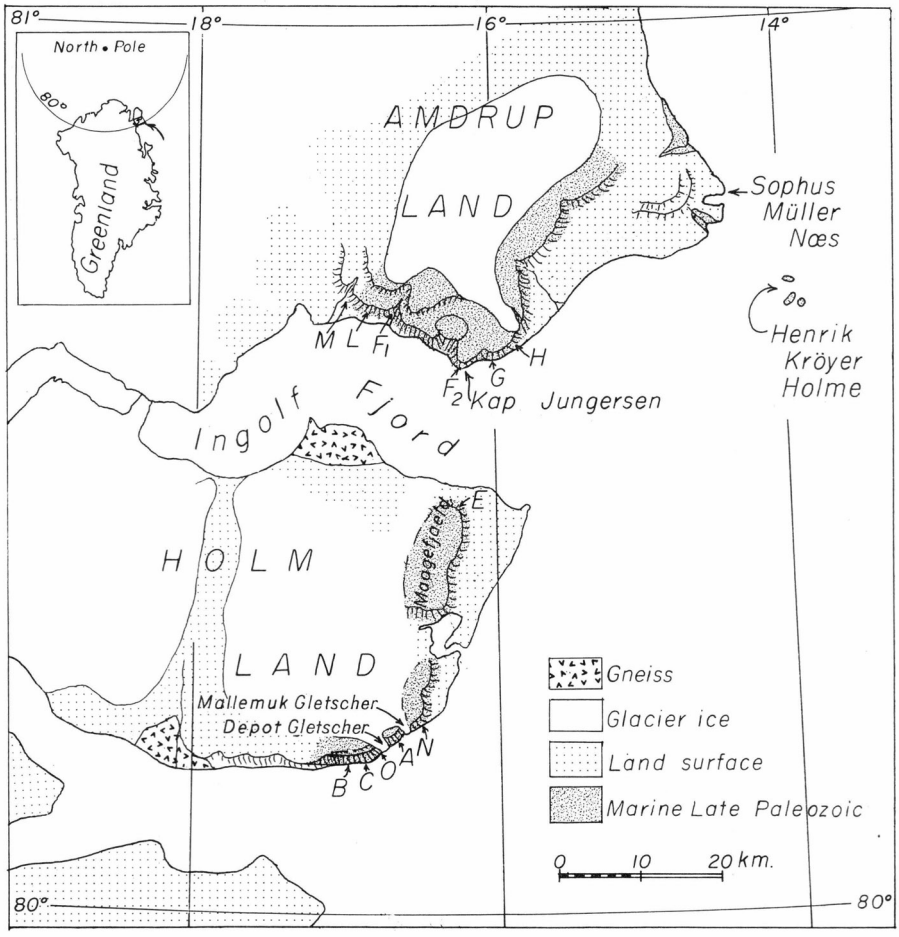

Figure 1. Map of Holm Land and Amdrup Land showing the location of Nielsen's measured profiles, (After NIELSEN, 1941).

Source materials.

This report is based on the collections and data secured by two Danish expeditions to extreme northeast Greenland. The first was the Danmark Expedition of 1906–1908 under the leadership of L. MYLIUS-ERICKSON; the second the Dansk Nordøstgrønland Expedition of 1938–39 under the leadership of EBBE MUNCK and EIGIL KNUTH.

On the first expedition Captain I. P. KOCH and ALFRED WEGENER discovered that the sea cliffs along the south of Holm Land and the southeast coast of Amdrup Land (Fig. 1) are composed largely of fossiliferous beds of late Paleozoic age dipping gently eastward from the Caledonian basement that forms the interior plateau (Fig. 2). They

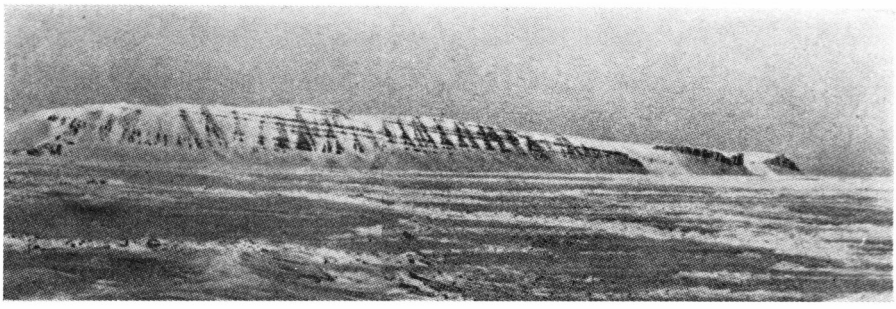

Figure 2. Photograph of the southeastern coast of Holm Land from a point opposite Depotfjæld (ie., opposite profile B), after NIELSEN.

made numerous small collections, mostly from loose blocks in the talus, and measured seven short profile sections. Their data was transmitted to HAKON JARNER, geologist of the expedition. Plant fossils secured from the basal part of the section were studied by A. G. NATHORST (1911) who prefaced his study with a brief account of the stratigraphy based on Jarner's notes. Brachiopods from the middle and upper part of the section were later described by KARL A. GRÖNWALL (1917) who gave a more extended account of the stratigraphy based again on the notes of Jarner and on communications from Koch and Wegener.

In this account, GRÖNWALL estimated that the late Paleozoic strata probably have a thickness of 1300 meters or more, and proposed a three-fold subdivision as follows:

C. Upper Marine group, 500–1000 meters thick.
B. Lower Marine group, 200–300 meters thick.
A. Terrestrial group, 200 + meters thick.

The Terrestrial group consists of sandstones and conglomerates with interbeds of dark shale and several beds of coal. The base of the section is covered by talus and its outcrop is separated by an interval of low ground from the nearest outcrop of older rocks so that the full thickness of the Terrestrial group is unknown and may be somewhat greater than 200 meters.

The Lower and Upper Marine groups are composed largely of alternating units of sandstone and limestone. On the expedition of 1938–1939, EIGIL NIELSEN measured a series of 12 profile sections of the marine beds (six in Holm Land and six in Amdrup Land). He also made many small collections, nearly all of which he accurately located in the sections. He later published an excellent map of the region (NIELSEN, 1941) but did not discuss the stratigraphy. For this we are indebted to HANS FREBOLD (1950) who studied the brachiopods collected

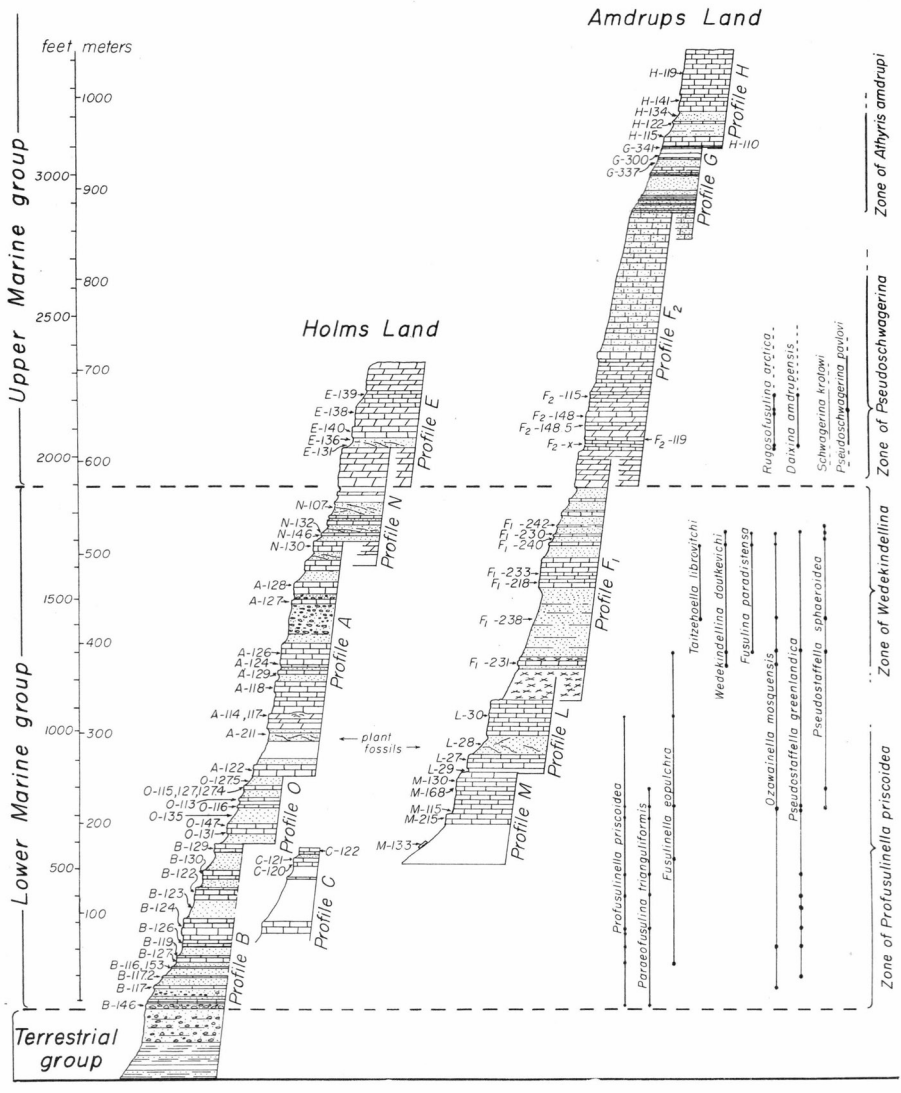

Figure 3. Composite sections for Holm Land and Amdrup Land built up from the several profile sections measured by NIELSEN (based on data from FREBOLD, 1950).

by Nielsen and prefaced his paper with an account of the stratigraphy based on Nielsen's notes.

At no single locality along the bold sea cliffs is it possible to measure the entire section, since the base is talus covered and the higher part is steep and unscalable; but the gentle eastward dip brings successively higher strata down into the lower slope so that partial sections spaced progressively eastward along the cliffs provide a composite section of

the whole sequence. Since many distinctive units stand out as ledges or vertical walls in the cliffs (Fig. 2), the upper unit in one section could be followed eastward until it descended to the base of the exposure, and the next section was selected so its base overlapped the top unit of the first or rested directly upon it. In Figure 3 we have represented graphically the composite sections, one for Holm Land and another for Amdrup Land.

NIELSEN identified his sections by letter. Those in Holm Land are in sequence from west to east, Profiles B, C, O, A, N, and E; and those in Amdrup Land are M, L, F_1, F_2, G, and H. The position of each profile is indicated in Figure 1. Each collection was identified by the appropiate letter and a numeral (eg.B-126), and the position of each was accurately recorded in Nielsen's notes (see Fig. 3).

Authorship and Scope of the Present Report.

The collections made by both expeditions show that brachiopods and corals are the most conspicuous fossils, but that fusulines are the most abundant and ubiquitous element of the faunas. Bryozoans are locally abundant. Molluscs were reported to be abundant in certain beds, especially bellerophontid gastropods and small pelecypods, but only a few were collected and these are internal molds and are not even generically identifiable. Crinoidal debris is also common at certain levels but no identifiable remains were collected.

The brachiopods of the first expedition were described by GRÖNWALL in 1917 and those of the second expedition by FREBOLD in 1950, but the rest of the fauna remained unworked until 1957 when JOHN TROELSEN initiated a study of the fusulines. He had cut about 100 thin sections from the collections of Koch and Wegener before taking leave from the University in Copenhagen for work in Brazil. He then arranged to have all the collections sent to Dunbar and invited him to complete the study. During the school year 1958–1959 BRIAN NORFORD, then a graduate student assistant to Dunbar, cut about 350 oriented fusuline sections from the Nielsen collections. During the summer of 1960 CHARLES Ross, working with DUNBAR on a grant from the National Science Foundation, drew up preliminary descriptions of the species, after which Dunbar and Ross cut additional sections, where needed, and reworked the taxonomic manuscript into its final form.

In the meantime JUNE PHILLIPS Ross was engaged in a research project on bryozoans and, having studied late Paleozoic bryozoans of Australia while at the University of Sidney, kindly consented to examine the bryozoans from northeast Greenland. This task she has completed with the collaboration of her husband, Charles Ross.

The brachiopods studied by Grönwall and Frebold now need restudy, especially since some of these have taken on added significance following recent work in Spitzbergen (FORBES, HARLAND, and HUGEHS, 1958), and a short section commenting on these has been added by Dunbar who has also written the general discussion that precedes the taxonomic sections.

STRATIGRAPHIC SUMMARY

Terrestrial group.

This, the lowest group of GRÖNWALL, was shown by NATHORST (1911) to be of Lower Carboniferous age, and since it has yielded no marine fossils it is not discussed further in this report.

Lower Marine group.

The Lower Marine group is fully exposed in Holm Land where its thickness is about 575 meters (1900 feet). It begins with a basal conglomerate some 30 meters thick, about 275 feet above the base of Profile B, and extends up to the base of a cliff-forming dolostone about the middle of Profile N. In Amdrup Land the lower part of the group is not exposed (or was not studied). The exposed part in profiles M, L, and F_1 is about 380 meters (1250 feet) thick.

This group consists chiefly of alternating units of sandstone and limestone. Some of the limestones are sandy and the sandstones commonly include thin interbeds of limestones or calcareous layers.

The limestones tend to stand out as ledges or vertical walls but the sandstones, being weaker, commonly form steep slopes partly covered by talus.

In Holm Land the group begins with a basal conglomerate about 10 meters thick, and a second conglomerate, about 32 meters thick, occurs near the middle of Profile A. The latter includes pebbles of igneous rocks and quartzites obviously derived from outside the immediate area. Several of the sandstones are red or include reddish bands, a number of them are conspicuously crossbedded, and some of these bear plant fossils. The coral, *Chaetetes*, occurs in many of the limestones, ranging from the base to the top of the group, and locally forms small banks or patch reefs.

The lower part of the group is not exposed in Amdrup Land. Here Profiles M and L contain thick units of limestone separated by a crossbedded sandstone bearing plant fossils. A massive bed of gypsum,

more than 100 feet thick, forms the top of Profile L and the base of Profile F_1. In the succeeding part of Profile F_1 sandstones predominate and, with one exception, the limestone units are thin and in part dolomitic. No conglomerate was recorded in this region but a thick sandstone occurs at the level of the big conglomerate exposed in Holm Land.

Correlation between Holm Land and Amdrup Land.

In Figure 3 we have arranged the columns for these two areas with the boundary between Lower and Upper Marine groups as a common datum plane. This relation seems obvious; but correlation in detail of the units below this level is less certain. The exposures in Amdrup Land are about 35 miles north of those in Holm Land and, since the lower part of the group is not exposed in Amdrup Land, its full thickness here cannot be compared with that in Holm Land.

Nevertheless, there is some evidence for the approximate correlation of the sections as they stand. A cross-bedded sandstone bearing plant fossils occurs at the same level in both sections (collections A-211 and L-28). The big gypsum in Amdrup Land seems to have no counterpart in Holm Land but a limestone at the same level is described as "shot through with fractures" and a sample (A-129) is oolitic. The big conglomerate in Holm Land stands opposite the major sandstone unit in Amdrup Land.

The faunas tend to support this correlation. In Holm Land there are two quite distinct fusuline zones. The lower one is dominated by *Profusulinella priscoidea* which is commonly associated with *Paraeofusulina trianguliformis* and *Fusulina eopulchra;* the upper zone is dominated by *Wedekindellina dutkevichi* and by *Taitzehoella librovitchi* and the large *Fusulina paradistensa.* In Amdrup Land profiles M and L carry the lower fauna in abundance. Profile F_1 contains but few fusulines, apparently because the environment was unsuitable. The thin limestones in the upper part carry abundant tiny pelecypods that have been much broken up before deposition and have generally been dissolved out, leaving hollow molds. The only collection with abundant fusulines is number F_1-238 and it is filled with the single species *Taitzehoella librovitchi* and therefore belongs in the upper faunal zone. This species occurs also in collection F_1-240.

Correlation with the Moscow Basin.

The faunas of the Lower Marine group are closely allied with those of the Moscow Basin and have almost nothing in common with the interior of North America. *Profusulinella priscoidea*, *Paraeofusulina trianguliformis*, *Fusulina paradistensa*, *Taitzehoella librovitchi*, *Ozawainella mosqu-*

ensis, *Wedekindellina dutkevichi*, and *Pseudostaffella sphaeroidea* were all described from the Russian Platform, and *Pseudostaffella greenlandica* is closely similar to *P. paradoxa* of the U.S.S.R. and unlike anything in the interior of North America.

The zone of *Profusulinella priscoidea* is tentatively correlated with the Kashiria Stage of the Moscovian and the zone of *Wedekindellina* with the Podolsk Stage.

Among the brachiopods the commonest form is the typical Moscovian species, *Choristites fritschi*, which ranges from near the base to the top of the Lower Marine group.

Upper Marine group.

The Upper Marine group is best developed in Amdrup Land where it is represented by the top unit of Profiel F_1 and all of Profile F_2, G, and H. Profile F_2 was measured up the slope at Kap Jungersen and the upper half consists of sandy limestone that makes a bold cliff. Profile G, measured about 4 km farther northeast begins near the top of this unit and extends 250 feet higher to a distinctive red limestone about $1^1/_2$ meters thick that includes a thin orange colored band. From this place the cliffs formed by the Upper Marine group swing inland in a north and then northeast direction leaving a low coastal belt without exposures. Section H was measured about 3 km north of Profile G, beginning with the distinctive red and yellow limestone found near the top of Profile G and extending almost 400 feet higher. The upper part of this section is a steep cliff. It is not reported whether higher beds come in farther north.

Low outcrops appear along a stream at the shore near Sophus Müller Næs which is about 22 km east northeast of Profile H, and on Henrik Kröyer Holme which are 10 to 12 km off shore to the southeast of Sophus Müllers Næs.

In Holm Land the cliffs swing inland and north from Profile N, and Profile E was measured at the north end of Maagefjæld, about 25 km due north of Profile N and on strike about 20 km due south of Profile F_2 in Amdrup Land. Profile N ends with a cliff-forming dolostone about 160 feet thick and Profile E begins with this unit, overlapping the top of Profile N. This prominent dolostone is the basal unit of the Upper Marine group in both Holm Land and Amdrup Land. Only about 475 feet of the lower part of the group is exposed in Holm Land, all included in Profile E.

The lower third of the Upper Marine group (Profile E and the lower half of Profile F_2) consists of dolostone and interbedded limestone and

dolostone, and stands in strong contrast to the sandy upper part of the underlying Lower Marine group. This lower part of the Upper Marine group carries only scattered brachiopods, but some of the limestone layers carry abundant fusulines that clearly indicate a Lower Permian, Sakmarian, age. Collection E-138, for example, is packed with *Pseudoschwagerina pavlovi* and *Rugosofusulina arctica.* The latter occurs also in Collections E-131.5 and E-139. F_2-X and F_2-115 are rich in *Daixina amdrupensis.*

The middle part of the Upper Marine group (upper half of Profile F_2) consists of sandy limestone forming a great scarp, and probably was not accessible since no collections were made from it.

Profile G and the lower half of Profile H, on the contrary, are largely detrital and carry a rich and distinctive brachiopod fauna, but have yielded no fusulines. Most of the brachiopods of this zone occur also in the Brachiopod Cherts which form the top of the fine section in Spitzbergen.

The upper part of Profile H, on the contrary, consists of cliff-forming limestone and probably was largely inaccessible since only two small collections (H-141 and H-119) were made from it, both consisting of large brachiopods.

Considerably east of the measured profiles WEGENER and Captain KOCH made collections from low outcrops near Sophus Müller Næs and on Henrik Kröyer Holme, mostly from loose blocks on the surface. If the gentle eastward dip displayed along the south coast of Amdrup Land were projected eastward it should carry Profile H below the exposures at Sophus Müller Næs and Henrik Kröyer Holme. On the contrary, GRÖNWALL studied thin sections of the rocks from these exposures and thought them to be very similar to those at Kap Jungersen (lower part of Profile F_2 of Nielsen) and older than Profiles G and H. The fusulines support this correlation. *Pseudoschwagerina pavlovi* occurs abundantly in Collection 191 from Henrik Kröyer Holme, in Collection 214 from the mainland opposite the islands, and in collections 178a and 169 from near Sophus Müller Næs. In collections 178a and 214 it is associated with *Schwagerina krotowi.*

It appears probable, therefore, that a fault or a reversal of dip occurs in the lowland between the great scarp and the low exposures about Sophus Müller Næs and the islands, and that the beds exposed here belong in the horizon of Profile F_2.

If this be true it is possible that Profiles G and H with their rich brachiopod fauna are post-Sakmarian (post-Wolfcampian).

Correlation of the Upper Marine group.

The faunal affinities of this group, as in the Lower Marine group, are all with the U.S.S.R. Profile E in Holm Land is correlated with the lower half of Profile F_2 in Amdrup Land on both lithologic and faunal bases. Both rest disconformably on the upper unit of the Lower Marine group, both consist of interbedded limestone and dolostone, and both include early Sakmarian fusulines which have not been found in higher beds. In Profile E, *Rugosofusulina arctica* is abundant in collections E-131.5, E-138, and E-139, and in collection E-138 this species is associated with abundant specimens of *Pseudoschwagerina pavlovi*. In the limited collections from the lower part of Profile F_2 these species were not observed, but *Daixina amdrupensis* is abundant in collections F_2-X and F_2-115 and this species occurs with *Rugofusulina arctica* in Collection E-139. In the low exposures about Sophus Müller Næs and on Henrik Kröyer Holme *Pseudoschwagerina pavlovi* is associated with *Schwagerina krotowi* and *Schubertella transitoria*. All these fusulines clearly indicate Lower Permian (Sakmarian) age.

A single collection (F_2-148), it must be noted, was recognized as from a boulder embedded in the limestone. It carries a fauna of *Wedekindellina dutkevichi* and *Fusulina paradistensa* and was clearly derived from the underlying Lower Marine group and was redeposited and has no bearing on the age of the Upper Marine group.

Profiles G and H form a very distinctive faunal zone characterized by abundant brachiopods and lacking fusulines. Among the brachiopods are such distinctive Permian forms as *Waagenoconcha irginiformis* Stepanov, *Spiriferella draschei* (Toula), *S. parryana* (Toula), *Athyris amdrupi*, n. sp., *Sowerbina granulifera*, and *Kochiproductus freboldi* (Stepanov). Some of these were described from Sakmarian beds in the Ural region and the general character of the fauna suggests Lower Permian age.

Correlation with Spitsbergen.

Spitzbergen lies about 500 miles east-southeast of Holm Land and Amdrup Land, and includes a thick section of late Paleozoic rocks (about 4500 feet) that in parts is more closely allied to that of northeast Greenland than any other known. Although fossils have been described from Spitzbergen by a number of paleontologists, beginning with Toula in 1875, we had little knowledge of the stratigraphic relations and the and the positions of the faunas until recent work by Gee, Harland and McWhae (1952), and Forbes, Harland and Hughes (1958). A generalized section based upon these recent works is represented in Figure 4.

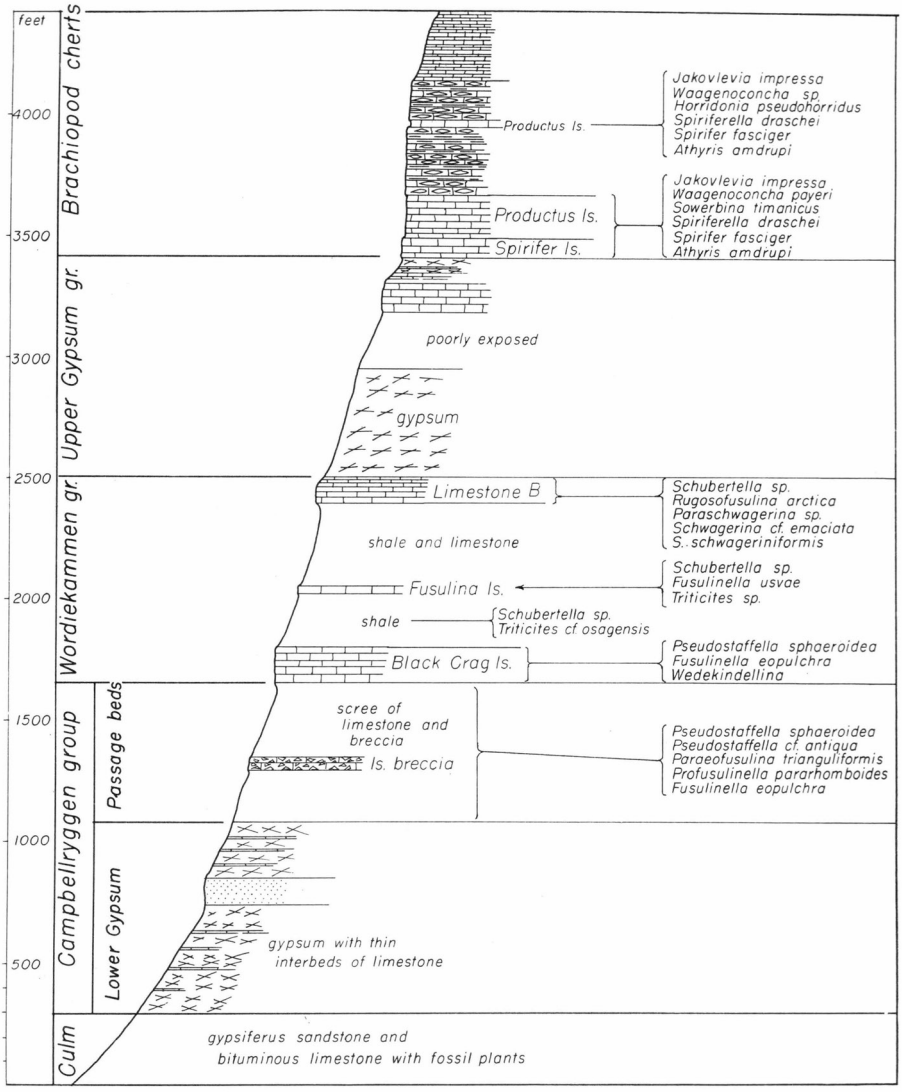

Figure 4. Idealized profile section of the late Paleozoic strata in western Spitzbergen constructed from data given by GEE, HARLAND and MCWHAE (1952) and FORBES, HARLAND and HUGHES (1958).

The Culm group of Spitzbergen, bearing plant fossils, is apparently to be correlated with the Terrestrial group of Greenland. The Lower Gypsum Series of the Campebellyggen group is not dated but the Passage beds (570 feet thick) clearly correlate approximately with the *Profusulinella priscoidea* zone of the Lower Marine group in Greenland; and the Black Crag limestone at the base of the Wordiekammen group, bearing *Wedekindellina*, correlates with the upper part of the Lower Marine group.

The middle and upper part of the Wordiekammen group includes a more varied fusuline fauna than is now known in Greenland, and some of Dr. FORBES' identifications are difficult to accept. *Triticites osagensis* Newell, for example, occurs in the Missouri Series of the Pennsylvanian System in the Mid-Continent region of the U.S.A. and in a faunal province otherwise totally unrelated to the Arctic province; it is distinctly more slender and appears to be more primitive in structure than the form so identified by Forbes. The form identified by Forbes as *Schwagerina princeps* we would identify as a new species of *Paraschwagerina;* its tightly coiled juvenarium is well shown in Plate 33, fig. 9 of Forbes. And the form tentatively identified by Forbes as *Parafusulina lutugini* is probably not that Artinskan species. Forbes' *Triticites arcticus*, nevertheless, appears to be identical with the form we have identified as *Rugosofusulina arctica* (SCHELLWIEN). It appears probable that the upper limestone of the Wordiekamman group correlates with the lower faunal zone of the Upper Marine group of Greenland. The brachiopods justify a firm correlation of the Brachiopod Cherts of Spitzbergen with Profiles G and H in Amdrup Land; both regions share such distinctive forms as *Yakovlevia impressus* (TOULA), *Waagenoconcha irginaeformis* Stepanov, *Spiriferella draschei* Toula, and *Athyris amdrupi* n. sp.

Relation to Central East Greenland.

The faunas of Central East Greenland (DUNBAR, 1955) have little in common with northeast Greenland. The Foldvik Creek formation is believed to be highest Permian and much younger than anything in northeast Greenland. In Central East Greenland it rests on non-marine beds that have been dated by fossil plants (T. G. HALLE, 1931) as Lower Carboniferous, probably ranging up into the Namurian. In part therefore they may be equivalent to the Terrestrial group of northeast Greenland, but there is at present no basis for correlation with any part of the Lower Marine group.

Relation to Grinnell Peninsula.

An important section of Permian rocks nearly 1000 feet thick has been described recently by P. HARKER and R. THORSTEINSSON (1960) on Grinnell Peninsula in the Arctic Archipelago. This is about 1000 miles almost due west of Amdrup Land. Here the Permian beds rest on Ordovician limestones and are divided into 2 formations. The lower of these, the Belcher Channel formation, bears abundant fusulines and corals, and the upper, the Assistance formation, bears a large fauna of brachiopods but no fusulines. Harker and Thorsteinsson correlated

the lower part of the Belcher Channel formation with the upper Sakmarian and its upper part with the Artinskan. The well preserved fusulines of this formation are larger and more advanced than those of Amdrup Land and have no species in common with the latter. It appears probable that the Belcher Channel formation is younger than the beds in Profile G and H of Amdrup Land. (It must be noted that the form identified by Thorsteinsson as *Pseudoschwagerina grinnelli* is not a *Pseudoschwagerina* but a *Pseudofusulina* (*Daxina*)).

On the basis of its brachiopods the Assistance formation was correlated by Harker and Thorsteinsson with the Kungurian Stage of Russia and with the Brachiopod Cherts of Spitzbergen. Although there may be a few species in common, the faunas are essentially different and correlation with the beds of Profiles G and H of Amdrup Land appear to us to be extremely doubtful.

Correlation with Interior North America.

Although the Greenland faunas belong to a faunal province entirely distinct from that of the United States and, with the possible exception of *Profusulinella regia*, no species are common to both provinces, nevertheless the stage of evolution makes it evident that the Lower Marine group is approximately equivalent in age to the upper part of the Atokan Series and the Desmoinesian Series, and the Upper Marine group is Wolfcampian in its lower part and is probably all Wolfcampian, though the upper part (Profiles G and H) are possibly as young as Leonardian.

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