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THE STRATIGRAPHY OF THE WESTPHALIAN C AROUND PRIORO (PROV. LEON, SPAIN)

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(WITH PALAEONTOLOGICAL NOTES BY G. E. DE GROOT,**
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ABSTRACT

The sedimentary succession described falls within two formations, the Prioro and the Pando formations, consisting of some 1000 m of marine sediments, which crop out in the eastern Tejerina Syncline in NE. León. The succession starts with predominant mudstones followed by alternating sandstones and mudstones, limestones and calcareous mudstones, and, finally, alternating sandstones and mudstones. Varied marine fossils occur throughout and drifted plant fragments are also relatively common. Stratigraphic dating, based mainly on brachiopods, fusulinid foraminifera and land plants, suggest a Westphalian C age for both formations. Some trilobites and goniatites were also found. They indicate an older age, but it appears that the background information on these fossils is still rather scanty for this stratigraphic level.

Comments and some descriptions of coral, lamellibranch and plant material are provided, and a number of fossils are illustrated (pls. 1-8). The stratigraphic sequence is represented in text-fig. 4, and the geological setting can be found in text-fig. 2.

A separate description is provided of an easily accessible road section through a part of the Pando Formation.

RESUMEN

La sucesión sedimentaria descrita abarca dos formaciones: la Formación de Prioro y la de Pando, que consisten en unos 1000 m de sedimentos marinos que afloran en la parte oriental del Sinclinal de Tejerina (provincia de León). La sucesión se inicia principalmente con lutitas masivas, a las que siguen areniscas y lutitas alternantes, calizas y lutitas calcáreas, y, finalmente, una alternancia de areniscas y lutitas. Por toda la secuencia se encuentran fósiles marinos variados así como fragmentos de plantas. La determinación estratigráfica, basada principalmente en braquiópodos, foraminíferos (Fusulínidas) y plantas continentales, sugiere una edad Westfaliense C para ambas formaciones. También han sido encontrados algunos trilobites y goniatítidos, que indican una edad más vieja, pero la información específica sobre estos fósiles es bastante escasa para este nivel estratigráfico.

También se hacen algún comentario y descripciones de coralarios, lamelibranquios y plantas, figurándose varias especies (láminas 1-8). La sucesión estratigráfica está representada en la fig. 4 y la situación geológica en la fig. 2, intercaladas en el texto.

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Luego se presenta una descripción aparte de un corte estratigráfico a lo largo de una carretera de fácil acceso que cruza una parte de la Formación de Pando.

INTRODUCTION

The biostratigraphy of the marine Westphalian in the southern Cantabrian Mountains is still poorly known. A reasonably fossiliferous section through the Westphalian Prioro and Pando formations near Prioro has provided the means for an evaluation of the stratigraphic succession.

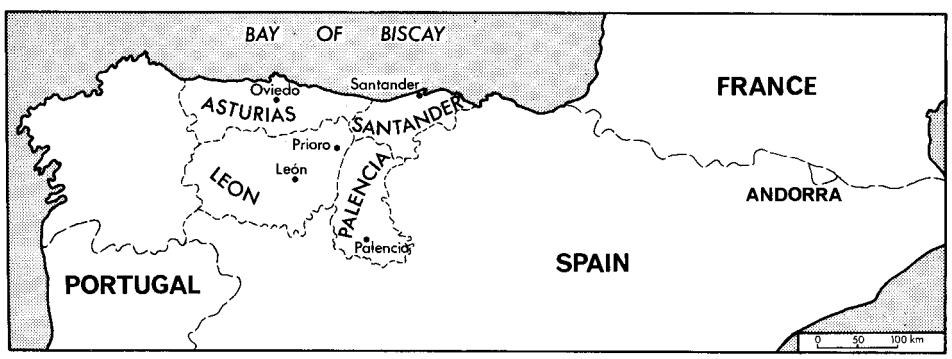
Prioro lies in the upper reaches of the Río Cea, in the southern part of the Cantabrian Mountains (text-fig. 1). It is situated in the southern flank of the Tejerina Syncline.

Due to the rapid subsidence of the basin, as indicated by the deposition of approximately 1000 m in only a part of Westphalian C and possibly including the transition from Westphalian B, large quantities of sediments supplied by a nearby land mass slid into the basin by mass movements. When the basin was nearly filled, or did no longer subside so quickly, more stable conditions prevailed.

These marine sediments are unconformably covered by mainly continental upper Westphalian D and lower Cantabrian, which are not discussed in the present paper. The Cantabrian Stage was introduced by WAGNER (1966a), and a proposed stratotype section for the Lower Cantabrian, situated north of Tejerina (text-fig. 2), has recently been described by WAGNER, VILLEGAS & FONOLLÁ (1969).

The stratigraphic data concerning the older Westphalian form part of the results of a sedimentological investigation undertaken by the present author (VAN LOON, in prep.).

A c k n o w l e d g e m e n t s. The author wishes to express his thanks to all those who identified the numerous fossils for him and who provided helpful discussion: Mr. H. W. J. van Amerom (Heerlen): pelecypods and plants; Dr. A. Breimer (Amsterdam): crinoids; Dr. J. Gandl (Würzburg): trilobites: Dr. A. C. van Ginkel (Leiden):



Text-fig. 1.—Situation map.

fusulinids; Dr. W. J. E. van de Graaff (Leiden): sponges; Dr. G. E. de Groot (Leiden): corals; Dr. G. Hahn (Berlin): trilobites; Dr. J. Kullmann (Tübingen): cephalopods; Mr. J. J. de Meyer (Leiden): algae; Dr. R. H. Wagner (Sheffield): plants; and Dr. C. F. Winkler Prins (Leiden): brachiopods.

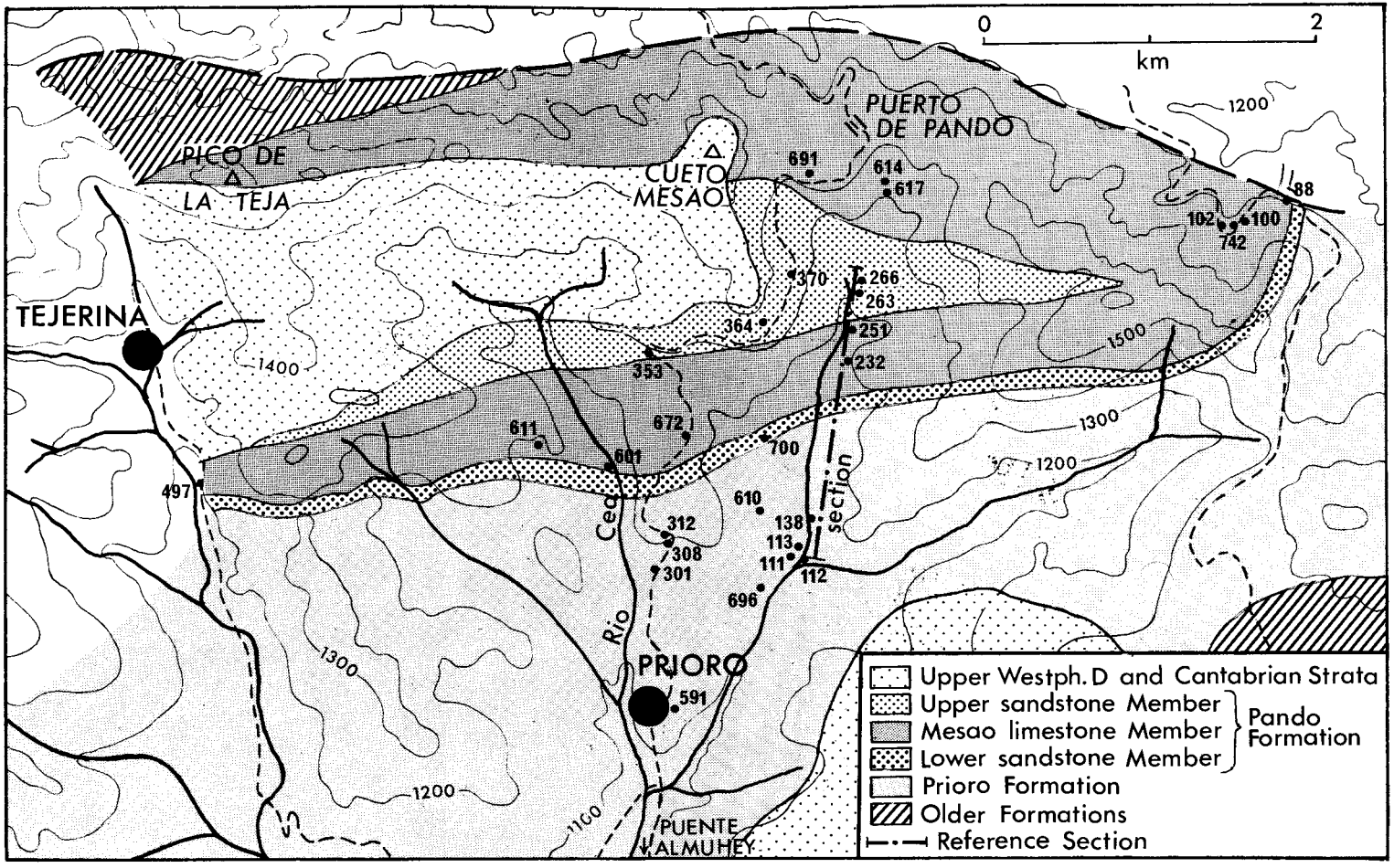
STRATIGRAPHY

A representative stratigraphic column is difficult to establish for this region, because of rapid lateral facies changes. This situation as well as the lack of identifiable fossils in the older part have led to different interpretations. BROUWER & VAN GINKEL (1964) distinguished two formations, the Prioro and the Pando formations, separated by an unconformity. This view was followed by HELMIG (1965) and RUPKE (1965). VAN GINKEL (1965), however, considered the lower conglomeratic part of the Pando Formation as a separate formation and identified this unit with the Curavacas Formation. The latter occurs 15 km to the east in the Cantabrian Mountains as a thick conglomeratic formation, up to 1200 m thick near the Curavacas Mountain (VAN HOEFLAKEN, pers. comm.).

A more detailed investigation carried out by the present author (VAN LOON, in prep.) has shown that an unconformity between the Prioro and Pando formations does not exist. There also seems to be no reason to identify the Curavacas Formation in this region, although some part of the sequence might be a time equivalent of the latter.

The rapid lateral facies changes in both the Prioro and Pando formations have resulted in no two sections being quite identical in this region. The most complete and generally best exposed section will be described here first. This section, situated in the southern flank of the Tejerina Syncline (text-fig. 2), differs from the type sections of the Prioro and Pando formations as described by BROUWER & VAN GINKEL (1964), but our section, to be referred to henceforth as the reference section, shows a more usual sedimentary development and is more fossiliferous. The fossils collected indicate Westphalian C and Upper Moscovian ages. The presence of the fusulinids *Schubertella* ex gr. *kingi* (the nearest relative is *S. subkingi* Putrja) *(det.* VAN GINKEL) and of the leaf *Linopteris obliqua* (BUNBURY) *(det.* VAN AMEROM) in the Prioro Formation (VAN LOON 1970) proved that this formation was considerably younger than was assumed by previous authors (e. g. BOSCHMA & VAN STAALDUINEN 1968). The fusulinid was quoted tentatively as *S. subkingi* in the cited paper.

Three members can be distinguished in the overlying Pando Formation. Their probable places in the chronostratigraphic column are shown in text-fig. 3, and a description of the various lithostratigraphic units is given below. For each unit the stratigraphic data of the reference section (text-fig. 4) will be discussed first, and then those of the same unit for the entire region. Finally, the most important section will be indicated for each of the units.



Text-fig. 2.—Diagrammatic geological map of the Prioro region, showing fossil localities mentioned in the text. Faults are not indicated.

I. Prioro Formation.

1. Reference section.

The total measurable thickness is *ca.* 470 m, but since the basal part is cut out by faulting, this is only a minimum value for the thickness of the Prioro Formation. The succession consists almost entirely of well-bedded mudstones, in which no members can be distinguished. The grain size of the quartz in the mudstones very rarely exceeds 40μ. There are a few silty layers however, with grains of up to 60μ, and a few rare sandstones are found at 30 and 280 m *). The top part is slightly coarser and contains some levels with pebbly mudstones.

Linopteris obliqua (BUNBURY), already found in the first few metres as well as higher in the sequence, allows dating. Also the occurrence of the fusulinid *Hemifusulina* sp. at 240 m indicates a Westphalian C age.

2. Entire region.

Both east and west of the reference section, the Prioro Formation is less well bedded and contains more coarse-grained elements. Pebbly mudstones, some showing an erosive base, are more common outside the reference section.

The thickness of the Prioro Formation is estimated as being at least 600 m, but a fault zone, running more or less NE. — SW. through the village of Prioro, precludes an exact measurement. From this formation were collected:

brachiopods: *Productus* cf. *carbonarius* DE KONINCK.
Reticulatia cf. *huecoensis* (KING).
Rugosochonetes cf. *acutus* (DEMANET).
Linoproductus sp.
Wellerella sp.
Spirifer sp.
Orthotetes sp.

pelecypods: *Pernopecten carboniferum* (HIND) DEMANET (Plate 1, fig. 5).
Pecten (Pseudamusium) sp. (Plate 1, fig. 4).
Edmondia aff. *arcuta* (PHILLIPS) DEMANET (Plate 1, fig. 2).
E. sp. (Plate 1, fig. 1).
Annuliconcha interlineata (MEEK & WORTHEN) (Plate 1, fig. 3).

gastropods: *Bellerophon* sp.

corals: *Lophophyllidium* sp.

fusulinids: *Schubertella* ex gr. *kingi* PUTRJA.
Hemifusulina sp.

According to SIESWERDA (1964 b int. rept.):
Beedeina bona (RAUSER-CHERNOUSSOVA) subsp. *lenaensis* VAN GINKEL.
Staffella sp.
Pseudostaffella sp.

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*) The thicknesses quoted belong to the reference section (text-fig. 4).

Schubertella sp.
Profusulinella sp.
Ozawainella sp.
other forams: *Bradyina* sp.
Palaeotextularia sp.
Ammodiscidae (all acc. to SIESWERDA 1964 b).
algae: *Divinella comata* CHVOROVA.
Uraloporella sieswerdai RÁCZ.
Ungdarella cf. *conservata* KORDE.
plants (*det.* VAN AMEROM):
Linopteris obliqua (BUNBURY).
(*det.* WAGNER):
Linopteris obliqua (BUNBURY).
L. obliqua var. *bunburyi* BELL.
L. neuropteroides (VON GUTBIER) POTONIÉ.
L. subbrongniarti GR.'EURY.
L. neuropteroides var. *minor* POTONIÉ (Plate 7, fig. 5).
L. neuropteroides var. *linearis* WAGNER.
Neuropteris cf. *scheuchzeri* HOFFMANN.
N. cf. *loshi* BRONGNIART (Plate 7, fig. 3).
cf. *N. rarinervis* BUNBURY.
Mariopteris muricata (*non* VON SCHLOTHEIM) ZEILLER (Plate 8, fig. 3).
Reticulopteris munsterifolia (NĚMEJC) (Plate 8, fig. 2).
Taeniopteris sp. (Plate 8, fig. 6).
No fossils were found in growth position.

3. Other sections.

The most fossiliferous and best exposed section in this formation is the reference section, which is also the most complete. Only the lowermost 150 metres are absent. These crop out south of Prioro but cannot be connected with any other section as a result of faulting. In this part the only specimen of *Mariopteris muricata* was found.

Another rather well exposed section, but one with a different development of the Prioro Formation, occurs in the valley running from Prioro to the NW. The lower 200 to 250 m consist here of alternating pebbly mudstones, conglomerates, and mudstones. The upper part of this section has the same development as the reference section.

4. Age.

The brachiopod *Reticulatia huecoensis* indicates Lower Bashkirian-Kashirian (Namurian - lower Westphalian C); the fusulinids indicate *Fusulinella* A subzone (lower Westphalian C); the algae suggest *Fusulinella* A subzone or lowermost *Fusulinella* B 1 subzone (lower and middle Westphalian C); the plants point to Westphalian C, and most likely lower C (see Table 1, p. 260).

The fusulinid *Beedeina bona* subsp. *lenaensis* was found by SIESWERDA (1964 b, int. rept.) some two kilometres north of the Peñas Prietas (text-fig. 2), in a limestone lens within conglomerates of the Prioro Formation. It is a primitive form of the genus *Beedeina*. This subspecies was described by VAN GINKEL (1965) from the Lena Formation (Kashirian). Therefore, it is probably not younger than *Fusulinella* A subzone. According to VAN GINKEL (pers. comm.), the genus *Hemifusulina* has not been found in NW. Spain with a fusulinid fauna definitely belonging to the *Profusulinella* Zone, so this genus probably has its first appearance in the *Fusulinella* A subzone. It thus seems likely that the Prioro Formation has a *Fusulinella* A age (lower Westphalian C). The species *Schubertella subkingi*, which is close to *S.* ex gr. *kingi* found here, has only been described in the Cantabrian Mountains from the Mesao Limestone Member of the Pando Formation (VAN GINKEL 1965), and there is no certainty that this species may not have appeared somewhat earlier. In Russia it is known from the Podolskian, or possibly earlier in the upper Kashirian, and it ranges into the Myachkovian (RAUSER-CHERNOUSSOVA *et al.* 1951), corresponding in age with Westphalian B-C to Westphalian D (after VAN GINKEL 1965).

The three algal species quoted belong to algal zone III of RÁCZ (1965). According to DE MEYER (pers. comm.) this zone does not end in the upper part of the *Fusulinella* A subzone, but in the lower part of the *Fusulinella* B subzone. In view of the absence of the genus *Epimastopora*, which is more frequent in the lower part of algal zone III than it is in the upper part, DE MEYER (pers. comm.) supposes that the Prioro Formation belongs to the upper part of zone III, corresponding to lower and middle Westphalian C.

The two pelecypod species, *Pernopecten carboniferum* and *Edmondia arcuata* are known from the Aegir Marine Band in Belgium, but may have a somewhat longer range.

A combination of palaeontological data thus suggests rather strongly that the Prioro Formation is of lower Westphalian C age (possibly Westphalian B-C at the base). This conclusion based on fusulinids, brachiopods and plants is not contradicted by the possible stratigraphic range of the pelecypods and algae.

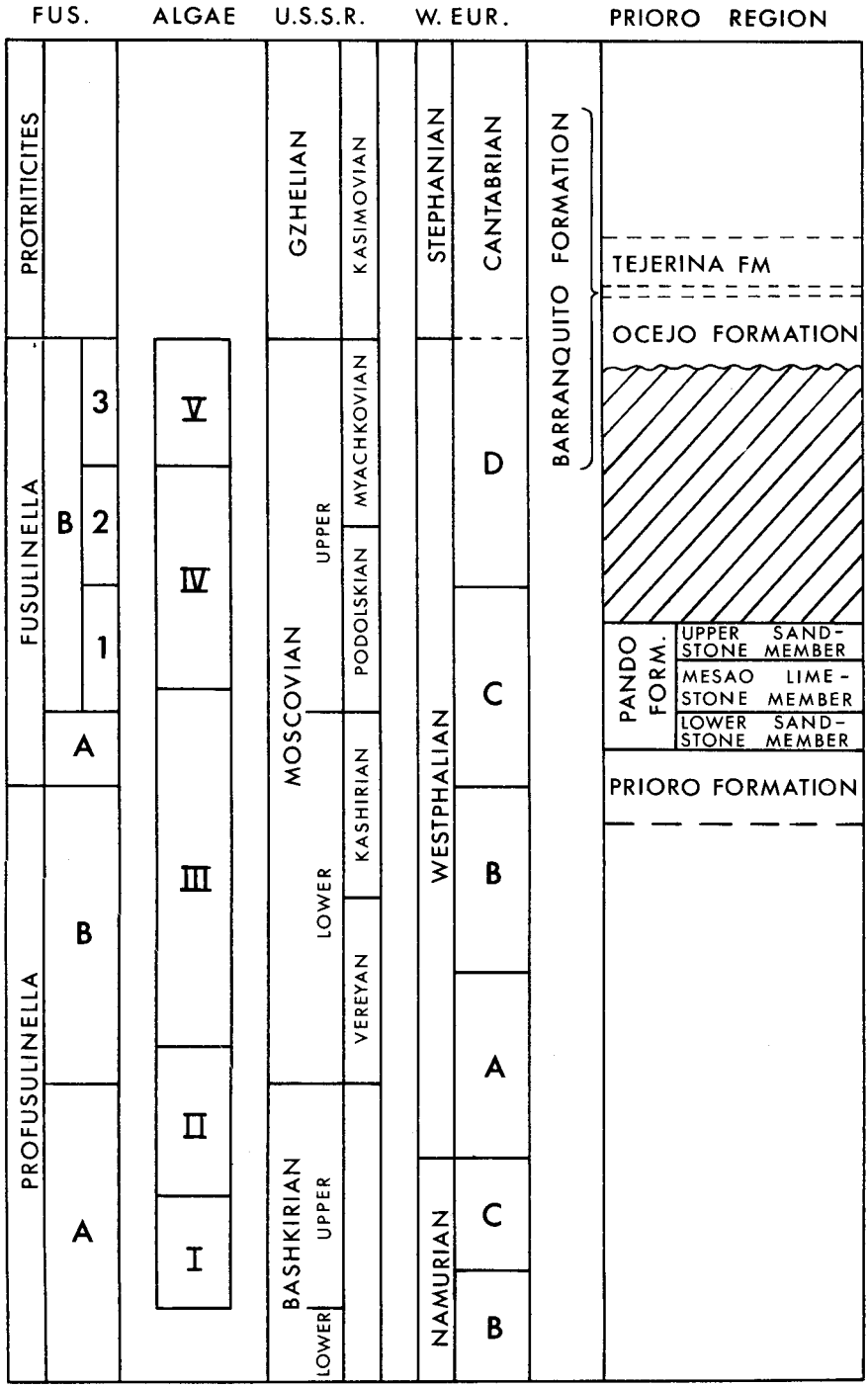
II. Pando Formation.

A. Lower Sandstone Member.

1. Reference section.

Although the top of the Prioro Formation becomes more sandy, there is still a rather sudden passage from the Prioro Formation to the Lower Sandstone Member of the Pando Formation, because pebbly mudstones no longer occur and the sandstone banks become much thicker (up to *ca.* 50 cm). Also, there is a sudden abundance of fossils, which is related to the transition into a shallower environment.

Apart from driftwood, no floral remains were encountered here in the Lower Sandstone Member. There is, however, a fauna with many individuals of the brachiopods *Orthotetes* sp. ex gr. *radiata* FISCHER DE WALDHEIM and *Schizophoria* sp.



Text-fig. 3.—Correlation chart showing correlations with western European and Russian standards. Partly after VAN GINKEL (1965), RÁCZ (1965), and WAGNER & WINKLER PRINS (1970).

2. Entire region.

The Lower Sandstone Member is everywhere developed in this region, but considerable differences exist from one place to another. The upward passage from the Prioro Formation can vary from very gradual to very sharp and the sandstone to shale ratio can differ from *ca.* 4 : 1 to about 2 : 3. Locally, some (usually rather thin) conglomerates occur. Everywhere, the sudden abundance of fossils is characteristic. The following fossils are recorded:

brachiopods: *Dictyoclostus? aegiranus* BÖGER & FIEBIG (Plate 2, fig. 1).
Orthotetes sp. ex gr. *radiata* FISCHER DE WALDHEIM.
Schizophoria sp.
Linoproductus latiplanus IVANOV.
pelecypods: *Pecten (Pseudamusium) medium* (HERRICK) *sensu* FEDOTOV.
fusulinids: *Hemifusulina* sp.
plants (*det.* VAN AMEROM):
Linopteris cf. *obliqua* (BUNBURY).
Lepidophloios sp.
(*det.* WAGNER):
Linopteris neuropteroides var. *minor* POTONIÉ.
L. cf. *subbrongniarti* GRAND'EURY.
Neuropteris sp.
Lepidophloios sp.

3. Other sections.

The best exposed section lies in the valley between the road from Prioro to the Pando pass and the valley of the reference section (text-fig. 2).

The transition from the Prioro Formation to this member of the Pando Formation is very sharp here. At the base of the latter occur strongly channelling sandstone beds, sometimes calcareous or muddy, alternating with some mudstone banks. A rich fauna is encountered. It consists mainly of brachiopods, but pelecypods, gastropods, fusulinids, and algae also occur, as well as unidentifiable driftwood, spicules, and tracks. The abundant sedimentary structures indicate a shallow marine environment and this agrees with the fauna. Towards the top, the sediments become somewhat less fossiliferous, and between the sandstones some conglomeratic layers appear.

4. Age.

Hemifusulina points to a Westphalian C age. The brachiopod *Dictyoclostus aegiranus* is only known from the Aegir Marine Band in Germany, on the Westphalian B-C boundary. *Linoproductus latiplanus*, however, is known from the Vereyan of Russia (Westphalian A-B). It probably ranges into Westphalian C, since the occurrence of *Hemifusulina* and the superposition on the Prioro Formation make a (lower?) Westphalian C age most likely.

B. Mesao Limestone Member.

1. Reference section.

The Mesao Limestone Member consists of an alternation of limestones (sometimes muddy) and calcareous mudstones (sometimes sandy). Clastic limestones occur as well as biogenetic banks.

The biogenetic banks are mainly constructed by algae, but corals, brachiopods, crinoids, and fusulinids are almost always present. At 360 m one finds the lateral and vertical transition from such a bank into an oolitic barrier.

The clastic limestones consist mainly of transported crinoidal fragments, but brachiopods, corals, fusulinids, and even plant leaves occur as well. Parallel lamination is common, and grading is sometimes present. Fossiliferous mudstones occur between the limestones and as their lateral equivalents. Brachiopods often still possess spines, and this is taken as proof that there has been little transport. On the other hand, the plant remains were of course washed into the deposit.

2. Entire region.

The calcareous development is variable, and one usually finds fewer and thinner limestones in the southern flank of the syncline than in the northern one. Sometimes, there is no true limestone, and only a change in the lime content of the mudstone horizons can be detected.

From several limestone levels the following fossils were collected:

brachiopods:	*Meekella* sp. (Plate 2, fig. 2).
pelecypods:	*Pterinopecten* sp.
corals:	*Rotiphyllum* sp.
	Pseudozaphrentoides sp.
	Chaetetes sp.
	cyathopsids
	aulophyllids
	syringoporids
fusulinids:	*Staffella* cf. *pseudosphaeroidea* DUTKEVITCH.
	Parastaffella sp.
	Pseudostaffela ex gr. *parasphaeroidea* (LEE & CHEN).
	Schubertella cf. *subkingi* PUTRJA.
	Hemifusulina ex gr. *moelleri* RAUSER-CHERNOUSSOVA.
	Fusiella cf. *praecursor* RAUSER-CHERNOUSSOVA.
	All these fusulinids are after VAN GINKEL (1965, loc. L 11).
crinoids:	Synerocrinidae
	Actinocrinitidae or Amphoracrinitidae
sponges:	*Amblysiphonella barroisi* STEINMANN.
algae:	*Uraloporella* sp.
	Petschoria sp.
	Girvanella sp.

Komia sp.

All these algae are after SIESWERDA (1964 a, int. rept.).

plants (*det.* VAN AMEROM):

Linopteris obliqua (BUNBURY).

L. neuropteroides (VON GUTBIER) POTONIÉ.

Neuropteris sp.

?Dicksonites pluckeneti (VON SCHLOTHEIM).

(*det.* WAGNER):

Linopteris neuropteroides (VON GUTBIER) POTONIÉ.

Sphenopteris polyphylla LINDLEY & HUTTON (Plate 8, fig. 1).

From the different mudstone horizons came:

brachiopods: *Rugosochonetes acutus* (DEMANET).

R. skipseyi (CURRIE).

Dictyoclostus ?aegiranus BÖGER & FIEBIG.

Karavankina rakuszi WINKLER PRINS

K. aff. *dobsinensis* (RAKUSZ) (Plate 2, fig. 5).

K. cf. *paraelegans* SARYCHEVA.

Productus cf. *carbonarius* DE KONINCK.

Linoproductus latiplanus IVANOV.

L. cf. magnispinus DUNBAR & CONDRA.

Kozlowskia aberbaidenensis (RAMSBOTTOM).

K. pusilla (SCHELLWIEN).

Reticulatia huecoensis (KING).

«Horridonia» sp. ex gr. *«H.» incisa* (SCHELLWIEN).

Levipustula breimeri WINKLER PRINS.

Fluctuaria undata (DEFRANCE) (Plate 2, fig. 4).

Brachythyrina cf. *strangwaysi* (DE VERNEUIL) (Plate 2, fig. 2)

Orthotetes sp. ex gr. *O. radiata* FISCHER DE WALDHEIM.

Schizophoria sp.

Spirifer sp.

Antiquatonia sp.

Martinia sp.

Rhipidomella sp.

Chonetinella sp.

Choristites sp.

marginiferids

chonetids

rhynchonellids (Plate 2, fig. 6).

DE ALVARADO, ZALOÑA & SAMPELAYO (1942) mentioned:

Chonetes sp.

Spirifer bisulcatus SOWERBY.

S. cf. *tornacensis* KONINCK.

Productus rugatus PHILLIPS.

pelecypods: *Edmondia* aff. *arcuata* (PHILLIPS) DEMANET (Plate 3, fig. 2).
E. aff. *gibbosa* MCCOY (Plate 3, fig. 3).
E. sp. (Plate 3, fig. 5).
Myalina verneuilii (MCCOY) HIND (Plate 4, fig. 4).
Aviculopecten delepini DEMANET (Plate 4, fig. 7).
Anthraconeilo sp. (Plate 3, figs. 8-9).
Grammatodon cf. *sangamonensis* (WORTHEN) (Plate 3, fig. 4).
G.? sp. (Plate 3, fig. 6).
Allorisma sp. (Plate 3, fig. 7).
Crenipecten foerstii HERRICK (Plate 3, fig. 1).
Pecten (Pseudamusium) cf. *purvesi* (DEMANET) (Plate 4, fig. 3).
P. (Pseudamusium) ufensis (TSCHERNYSCHEV) FEDOTOV (Plate 4, figs. 1-2).
P. (Pseudamusium) sp. (Plate 4, fig. 5).

corals: *Pseudozaphrentoides* sp.
Lophophyllidium sp. or *Stereostylus* sp.
Rotiphyllum sp.
Zaphrentites sp.

sponges: *Amblysiphonella barroisi* STEINMANN.
Cystauletes mammilosus KING.

trilobites: *Paladin mucronatus* (MCCOY).
Paladin cf. *shunnerensis* (KING).
Brachymetopus cf. *ouralicus* (VERNEUIL).
Ditomopyge sp. aff. *granulata* (WEBER).

goniatites: *Pseudoparalegoceras* sp. (Plate 5, figs. 5-5a).
cf. *Politoceras politum* (SHUMARD) (Plate 4, fig. 8).

nautiloids: *?Metacoceras* sp.

plants (*det.* VAN AMEROM):
Linopteris obliqua (BUNBURY).
Calamites sp.
Neuropteris sp.
N.? veeni STOCKMANS & WILLIÈRE.
Palmatopteris ?furcata (BRONGNIART) (Plate 8, fig. 5).
?Taeniopteris sp.

(*det.* WAGNER):
Linopteris obliqua (BUNBURY).
L. obliqua var. *bunburyi* BELL.
L. neuropteroides (VON GUTBIER).
L. neuropteroides var. *minor* POTONIÉ (Plate 7, fig. 4).
L. neuropteroides var. *linearis* WAGNER.
L. subbrongniarti GR.'EURY (Plate 7, figs. 1, 2, 6-6a).
Neuropteris cf. *scheuchzeri* HOFFMANN.
Alethopteris cf. *davreuxi* (BRONGNIART) GOEPPERT.

Lobatopteris (Pecopteris) waltoni (CORSIN) WAGNER (Plate 8, fig. 4).
Palmatopteris furcata (BRONGNIART) (Plate 8, fig. 5).
Reticulopteris munsteri (EICHWALD) GOTHAN.
Calamites sp.
Sphenophyllum sp.
?Pterophyllum sp. (Plate 8, fig. 7).
? Cordaianthus sp.

3. Other sections.

The description of a detailed section through the upper part of the Mesao Limestone Member in the northern flank of the syncline near the Puerto de Pando is given in the appendix (p. 263).

4. Age.

It is known (VAN GINKEL 1965) that the fossils of the Mesao Limestone Member give contradictory results. This is confirmed by the fossils here presented: the brachiopods indicate Podolskian (middle to upper Westphalian C); the fusulinids (sampled by VAN GINKEL 1965, locality L 11) from the very top of this member indicate upper Kashirian or lower Podolskian (lower to middle Westphalian C) and among the trilobites *Paladin mucronatus* points to upper Viséan to Namurian B, *Ditomopyge* aff. *granulata* to lower Bashkirian to Vereyan (Namurian A to lower Westphalian B), and *Brachymetopus ouralicus* to Viséan to lower Bashkirian (lower Namurian). The trilobite assemblage thus indicates Namurian A, which is at variance with all other fossil data. The goniatites indicate lower Westphalian C; the sponges suggest Upper Moscovian (upper Westphalian C to Westphalian D); and the plants indicate a probable Westphalian C age (Table 2, p. 260).

It appears likely that the stratigraphic range of some species is longer than was suspected, and this may be particularly true for the trilobites, which represent forms comparable to Viséan and Namurian species found in north-west and central Europe where the right facies for the preservation of trilobites is not present in Westphalian strata (GANDL, pers. comm.). It should also be borne in mind that the specimens recorded here are only identified tentatively.

For the Upper Carboniferous goniatites mentioned, rather few data are available. The range of the sponges is not very well known. *Amblysiphonella* has been recorded from the entire Moscovian (Westphalian A-D), but the genus *Cystauletes* in Europe has only recently been described from the Cantabrian Mountains (VAN DE GRAAFF 1969) from rocks of Upper Moscovian age. Too little is known for a precise dating.

Although the dating is tentative, the probable age of the Mesao Limestone Member is middle Westphalian C, or lowermost Upper Moscovian.

From beds on the boundary between the Mesao Limestone Member and the Upper Sandstone Member the fusulinid *Fusulina cylindrica* FISCHER (var. *?hispanica* GÜBLER) was collected (acc. to F. T. BARR, *in* WAGNER 1962). This should point to Westphalian C or D. The same samples were later examined by G. SCHMERBER (*in*

WAGNER 1966b) who identified *Pseudotriticites fusulinoides* PUTRJA, *Dutkevichella böcki* MOELLER, and *Hemifusulina moelleri* RAUSER. According to SCHMERBER, this points to Podolskian or Myachkovian (about Westphalian D, according to STEPANOV *et al.* 1962).

With respect to this fusulinid fauna from the transitional beds between the Mesao Limestone Member and the Upper Sandstone Member of the Pando Formation the following comment is made by VAN GINKEL (pers. comm.):

«The top of the Mesao Limestone Member yielded the fusulinid fauna quoted on page 240. This fauna has been compared with upper Kashirian or possibly lower Podolskian assemblages in the U. S. S. R. (VAN GINKEL 1965).

A publication by R. H. WAGNER (1962) unfortunately escaped my attention. According to this paper (p. 3383), *Fusulina cylindrica* FISCHER, probably the var. *hispanica* GÜBLER (identified by F. T. BARR), occurs in strata which most probably belong to the boundary of the Mesao Limestone Member and the Upper Sandstone Member. Illustrations and the description of *Fusulina cylindrica* FISCHER var. *hispanica* GÜBLER show that GÜBLER's variety has to be assigned to the genus *Hemifusulina*. A closely similar if not identical species occurs in my material from the Sama Formation, 10-15 km from the type locality at Lieres of GÜBLER's form (Central Basin of Asturias). It is not impossible that the population described by GÜBLER occurs also in the Mesao limestone, although up to the present all populations of *Hemifusulina* which I studied from this limestone belong to the slightly older group of *Hemifusulina moelleri*.

R. H. WAGNER also submitted the samples studied by F. T. BARR to G. SCHMERBER, who gave the following list of species (WAGNER 1966b, p. 25):

Pseudotriticites fusulinoides PUTRJA.
Dutkevichella böcki MOELLER.
Hemifusulina moelleri RAUSER.

Since SCHMERBER identifies the *Hemifusulina* with *H. moelleri* RAUSER —and I agree that this species is probably the nearest relative— we may conclude that the earlier identification with GÜBLER's variety was not the best possible fit.

Regarding the other two species of the list it should be noted that *Dutkevichella bocki* (MOELLER) and *Hemifusulina moelleri* RAUSER are synonymous, since they have the same type species, i. e. *Fusulina bocki* MOELLER. The choice for either binominen depends on whether one is inclined to accept the genus *Dutkevichella*.

Pseudotriticites fusulinoides PUTRJA (or *Quasifusulinoides fusulinoides* (PUTRJA)) (see RJAZANOV 1958) is a very interesting find although I doubt that it occurs in the Mesao Limestone Member or just above it. This genus is only known from the upper part of the Myachkovian and the lower part of the Kasimovian in the U. S. S. R. Its presence would imply that we have either to envisage a larger time span for this genus or to consider a much younger age for the Mesao limestone. The latter possibility conflicts however with most other palaeontological information now available with regard to the Mesao Limestone Member.»

C. Upper Sandstone Member.

1. Reference section.

At 739 m the last limestone disappears and, with a sharp boundary, the Upper Sandstone Member starts. It consists of alternating sandstones and mudstones with sandstone becoming more frequent towards the top. These sediments are poorly exposed in the core of the syncline, where there is a dense vegetation. Identifiable fossils are scarce. Only some brachiopods have been found: e. g. *Meekella eximia* (VON EICHWALD); and one pelecypod: *Pecten (Pseudamusium) medium* (HERRICK) *sensu* FEDOTOV.

2. Entire region.

The original thickness is unknown, since the axis of the Tejerina Syncline plunges westwards, where this member is unconformably covered by upper Westphalian

D and lower Cantabrian rocks (WAGNER *et al.* 1969). It could only be established that the sandstone to shale ratio always increases towards the top.

From this member were collected:

brachiopods: *Karavankina rakuszi* WINKLER PRINS.
K. aff. *dobsinensis* (RAKUSZ).
K. cf. *paraelegans* SARYCHEVA.
Kozlowskia sp. ex gr. *K. pusilla* (SCHELLWIEN).
Linoproductus neffedieui DE VERNEUIL.
L. cf. *magnispinus* DUNBAR & CONDRA.
Meekella eximia (VON EICHWALD) (Plate 2, figs. 7-8).
Brachythyrina cf. *strangwaysi* (DE VERNEUIL)
Zaissania aff. *zaissanica* SOKOLSKAYA.
Hustedia aff. *remota* (VON EICHWALD).
Juresania cf. *kalitvaensis* (LIKHAREV).
Levipustula cf. *breimeri* WINKLER PRINS.
? Fluctuaria undata (DEFRANCE).
Globosochonetes sp. aff. *G. waldschmidti* (PAECKELMANN).
Rugosochonetes cf. *acutus* (DEMANET)..
Orthotetes sp. ex gr. *O. radiata* FISCHER DE WALDHEIM.
«Horridonia» sp. ex gr. *«H.» incisa* (SCHELLWIEN).
Avonia (Quasiavonia) echidniformis (CHAO).
Schizophoria sp.
?Antiquatonia sp.
Cancrinella sp.
Rhipidomella sp.
Chonetinella sp.
?echinoconchids.
marginiferids.
rhynchonellids.

pelecypods: *Palaeoneilo* cf. *sharmani* (ETHERIDGE jun.) DEMANET (Plate 5, figs. 1-1a).
Pecten (Pseudamusium) medium (HERRICK) *sensu* FEDOTOV (Plate 5, fig. 2).
?Schizodus sp. (Plate 5, fig. 4).

corals: *Zaphrentites* sp.
Palaeacis sp.

trilobites: *Paladin* sp.
P. cf. *shunnerensis* (KING).
Ditomopyge sp.

goniatites: *Pseudoparalegoceras* sp. (Plate 5, figs. 5-5a)
Pseudoparalegoceras cf. *russiense* (acc. to KULLMANN, *in* VAN GINKEL 1965, p. 209).

plants (*det.* VAN AMEROM):
Linopteris obliqua (BUNBURY)

(*det.* WAGNER):

Linopteris neuropteroides var. *minor* POTONIÉ (acc. to R. H. WAGNER 1962, p. 3383).

3. Other sections.

By far the best exposed section lies along the road from Prioro to the Pando pass in the southern flank of the syncline. Due to plunging of the synclinal axis and the unconformable cover by younger sediments (text-fig. 2), this is also the most complete section, although some —probably insignificant— parts are absent as a result of faulting in the core of the syncline.

The boundary with the Mesao Limestone Member is sharp. The Upper Sandstone Member is characterized here, as everywhere, by an increasing sandstone content. Some tens of metres north of kilometre post 7, there is a calcareous mudstone band rich in fossils of many different groups (brachiopods, pelecypods, gastropods, crinoid stems and some calices, algae, bryozoa, corals, a few goniatites, and trilobites).

4. Age.

The brachiopods indicate uppermost Podolskian or lower Myachkovian (upper Westphalian C - lower Westphalian D). WINKLER PRINS (pers. comm.) comments:

«The faunas of the Pando Formation belong to the *Kozlowskia- Karavankina* Zone (WINKLER PRINS 1968, p. 67), the range of which is considerably larger than originally supposed. Instead of being confined to the lower part of Westphalian C, this zone is now considered to range throughout the Podolskian with parts of the Kashirian and Myachkovian probably included (compare WAGNER & WINKLER PRINS *in* BLESS 1971).

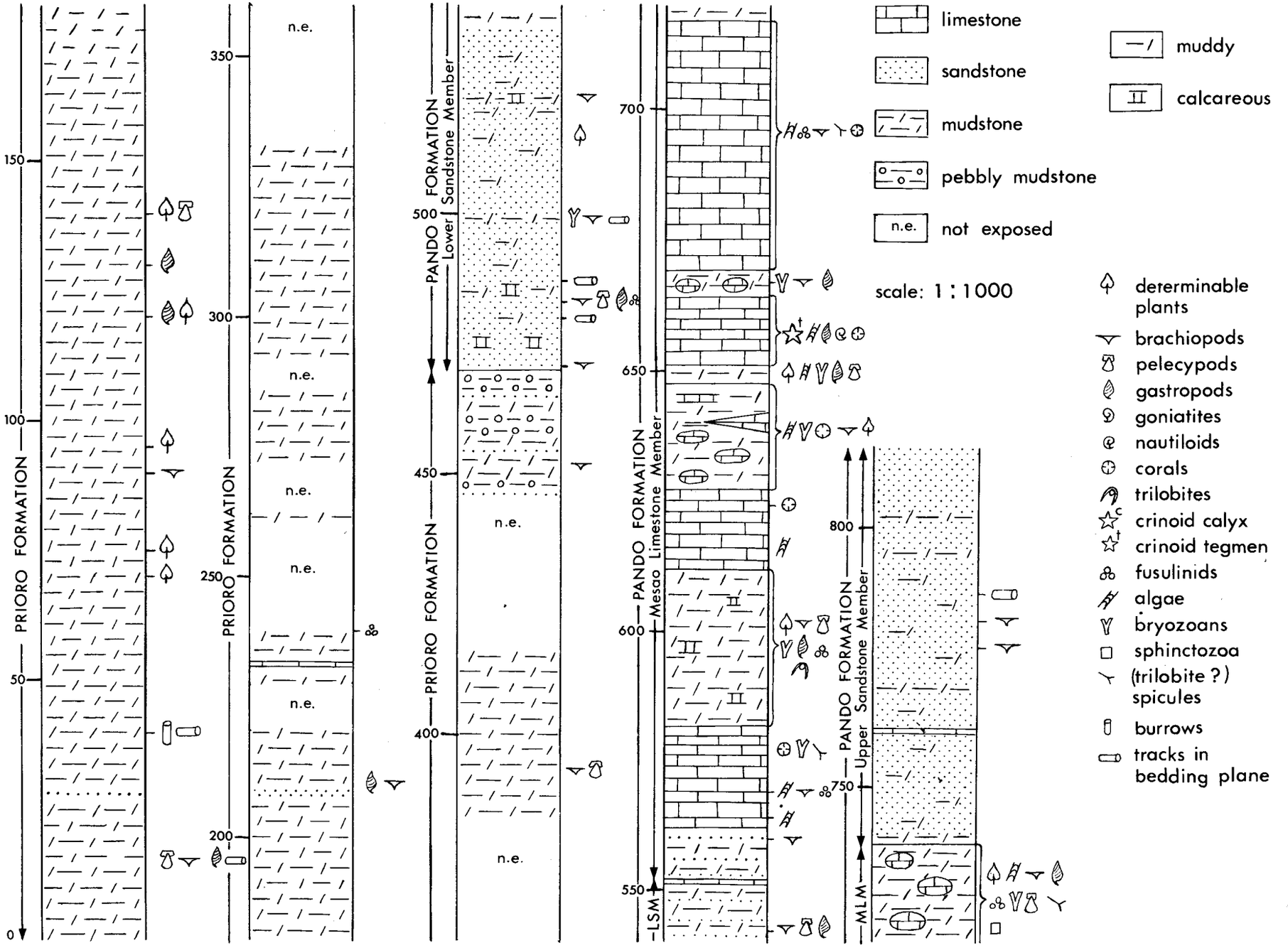
The fauna of the Mesao Lst. Mbr. appears to be slightly older than that of the Upper Sst. Mbr., as can be expected from the stratigraphic succession. The occurrence of *Kozlowskia aberbaidenensis*, known from the lower Westphalian C marine bands of northwestern Europe, and the presence of *Fluctuaria undata*, known from the Lower Carboniferous generally, and also from Bashkirian and Moscovian (up to Podolskian) in the U. S. S. R., indicate that the Mesao Lst. Mbr. cannot be younger than Podolskian. Since several Upper Moscovian species are also present, the Mesao Lst. Mbr. should be considered as Podolskian in age.

The Upper Sst. Mbr., on the other hand, contains several species which are compared, but not actually identified, with species known from the uppermost Moscovian and Kasimovian of the U. S. S. R. Examples are: *Juresania* cf. *kalitvaensis*, *Zaissania* aff. *zaissanica*, and *Hustedia* aff. *remota*. For this reason, the Upper Sst. Mbr. is considered to be at least of uppermost Podolskian age, but more probably lower Myachkovian. A more definite assignment of these brachiopod faunas may be possible when they have been studied more completely. Only the preliminary results of an examination of these faunas can be given here, before a comparison has been made with several late Moscovian and Kasimovian brachiopod faunas from the Cantabrian Mountains, which have only recently become available.

The occurrence of «*Horridonia*» sp. ex gr. «*H.*» *incisa* and *Karavankina* cf. *paraelegans* is remarkable since this shows affinity to some brachiopod faunas from the middle Cantabrian Brañosera Formation, correlated with the Kasimovian (see WAGNER & WINKLER PRINS 1970).»

The trilobites once again indicate Namurian A or B: *Paladin shunnerensis* is only known from one locality in lower Namurian rocks in Yorkshire, England; the goniatites indicate upper Bashkirian (Namurian B - Westphalian A) on the basis of *Pseudoparalegoceras* cf. *russiense* (according to KULLMANN *in* VAN GINKEL 1965); and the plants are too scarce to indicate more than a general upper Westphalian age.

A middle to upper Westphalian C age is considered likely.



Text-fig. 4.—Reference section of the Prioro and Pando formations.

CONCLUSIONS

A fossiliferous marine succession of *ca.* 1000 m has been dated as Westphalian C, probably ranging from lower to middle-upper C.

Although the sampling of fossils was not very extensive —it was done as part of a sedimentological investigation— some interesting finds were made. The brachiopod *Meekella*, for instance, was not previously mentioned from the Westphalian of the Cantabrian Mountains. Only one specimen in Spain was recorded by HELMIG (1965, p. 95) from the Cea Formation (upper Westphalian D and Cantabrian in the present area) of the Valderrueda Basin (*Meekella* sp., *det.* BREIMER). Another interesting fossil is the sponge *Cystauletes mammilosus* KING (*det.* VAN DE GRAAFF), the European occurrence of which is only known from Spain (VAN DE GRAAFF 1969).

A rare occurrence of a coral is described by G. E. DE GROOT, marine bivalves are described by H. W. J. VAN AMEROM, and comments on drifted plant remains are made by R. H. WAGNER.

The occurrence of plants and varied marine organisms in the same beds provides an opportunity to compare the stratigraphic ranges of these different fossils.

PALAEONTOLOGICAL NOTE: DESCRIPTION AND NOTES ON A CORALLUM

(G. E. DE GROOT)

The corallum 232-a (coll. VAN LOON) is of interest since either it represents a colony with its protocorallite preserved, which is a rare occurrence, or it is an example of «obvious budding in solitary forms», which is also a rare feature (compare ROWETT & MINATO 1968, p. 32).

The corallum is broadly turbinate, with an apical angle of 80 to 90 degrees. Its length is 35 mm and its maximum diameter 75 mm. The walls show interseptal grooves, 0.5 mm wide, and narrow interseptal ridges.

A section taken at a diameter of 16 mm (Plate 6, fig. 1) appears like a typical carcinophyllid: the cardinal septum is joined to the prominent columella and the dissepimentarium consists mainly of coarse, non-septate dissepiments. In the tabularium, which measures 6.5 mm in diameter, 60 septa are counted, most of which extend close to the columella. With a few exceptions, major and minor septa differ but little in length, and often less than 0.5 mm. The major septa are slightly thicker and many of them have somewhat thickened and sometimes forked axial ends.

More distally, young corallites are formed within the dissepimentarium. They may appear in clusters. Their earliest septa are formed from septa of the parent corallite. The parent corallite is stopped in growth, and the calyx is filled with mud. There

is no wall dividing the corallites. After the first stages they are separated from each other by lonsdaleoid dissepiments. Outside the tabularium the septa may be very thick. The thick parts are porous and have a granular structure, as a result of recrystallization (compare KATO 1963). The columella may consist of a strong median plate with many lamellae and several series of axial tabellae, regularly or irregularly arranged, or of a few thickened lamellae and some tabellae only. Muddy inclusions in the centre, observed in longitudinal sections, may have caused a degeneration of the columellar structure.

The tabularium consists of an outer zone of elongate or cystose clinotabellae, a narrow periaxial zone of transverse tabellae, and arched axial tabellae.

This coral shows in its solitary stage a close resemblance to *Axolithophyllum*, a subgenus of *Carcinophyllum*. Until more material becomes available, it seems most reasonable to regard it as a carcinophyllid coral in which budding occurs.

The specimen is now in the collections of the Rijksmuseum van Geologie en Mineralogie at Leiden, and can be found under Catalogue No. RGM-St. 143940.

PALAEONTOLOGICAL NOTE:

DESCRIPTIONS AND NOTES ON SOME MARINE BIVALVES

(H. W. J. VAN AMEROM)

Introduction.—In spite of the small number of specimens, the great variety of forms of the Lamellibranchiata studied is striking, and several forms could not yet be identified. A bivalve fauna of the Sama Formation (Westphalian C-D) of the province of Oviedo has recently been published by VAN AMEROM (*in:* VAN AMEROM, BLESS & WINKLER PRINS 1970), and this fauna should be compared with the one described here. Only five species were found to occur in both assemblages. This is not many considering the total number of species in each assemblage. Apparently each fauna represents, if not a different age, at least a different facies.

Most of what has been said in the introduction to the «Systematic description of Lamellibranchiata, etc.» (VAN AMEROM *in* VAN AMEROM *et al.* 1970) holds also with regard to the collection of VAN LOON: these descriptions and notes could only be a first approach to the knowledge of marine bivalve faunas in these areas of northern Spain. It will be attempted first to start the discussion on a proper recognition of the various species and then to discuss their stratigraphic usefulness.

The VAN LOON collection is stored in the Museum of the Geologisch Bureau at Heerlen (the Netherlands), and catalogue numbers of the Geologisch Bureau are quoted with the specimens.

Genus *Palaeoneilo* HALL & WHITFIELD 1869

Palaeoneilo cf. *sharmani* (ETHERIDGE jun. 1878)

Pl. 5, fig. 1

Material: One specimen of inner mould of left valve.

Discussion: This well preserved inner mould shows the taxodont hinge. The teeth of the hinge are largest in the anterior part and smaller and more numerous in the posterior part. For further comments and a recent synonymy see VAN AMEROM *in:* VAN AMEROM *et al.* 1970.

Occurrence: Pando Formation, Upper Sandstone Member, 165 m above the base. Loc. 370. G. B. Heerlen cat. no. 10105. Plate 5, fig. 1.

Genus *Anthraconeilo* GIRTY 1911

Anthraconeilo sp.

Pl. 3, figs. 8-9

Material: Several specimens.

Discussion: Two specimens are fully comparable with the specimens mentioned in VAN AMEROM *et al.* 1970 from the Sama Formation (Asturias, Spain) and registered under GB cat. no. 10134 and GB cat. no. 10133. Another specimen (GB cat. no. 10136) is somewhat larger. A specimen stored under GB cat. no. 10132 is an internal mould, showing very clearly the hinge with numerous small teeth. This cast is smooth and does not show the ornamentation of delicate concentrical growth lines on the shell.

Occurrence: Pando Formation, Lower Sandstone Member, 14 m below the base of the Mesao Limestone Member. Loc. 335 along the road from Prioro to the Pando pass. G. B. Heerlen cat. no. 10132. Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. nos. 10133, Plate 3, fig. 9; 10134, Plate 3, fig. 8; 10136.

Genus *Schizodus* DE VERNEUIL 1845

Schizodus? sp.

Pl. 5, fig. 4

Material: One badly damaged internal mould.

Discussion: Already mentioned in VAN AMEROM *et al.* (1970).

Occurrence: Pando Formation, Upper Sandstone Member, 165 m above the base. Loc. 370. G. B. Heerlen cat. no. 10102. Plate 5, fig. 4.

Genus *Grammatodon* s.l. MEEK & HAYDEN 1880

Grammatodon cf. *sangamonensis* (WORTHEN).

Pl. 3, fig. 4

Material: One specimen, which has been discussed already in VAN AMEROM *et al.* (1970). The reader is also referred to that paper for a list of synonymy.

Occurrence: Pando Formation, Mesao Limestone Member, 45 m above the base. Loc. 100. G. B. Heerlen cat. no. 10114. Plate 3, fig. 4.

Grammatodon sp. No. 1

Pl. 5, fig. 3

Material: Single cast of left valve.

Description: Rather small, elongate, suboval gibbous shell with obliquely truncated posterior part. High umbo about 1/3 in anterior side, smooth. Dorsal and ventral margins parallel. No hinge discernable.

Discussion: Some similarity with *Grammatodon fallax* (DE KONINCK) *sensu* HIND 1897 (see Plate XI, figs. 23-27a, b; Plate XII, fig. 14 and p. 161 of his text).

Occurrence: Pando Formation, Upper Sandstone Member, 2 m above the base. Loc. 353. G. B. Heerlen cat. no. 10137. Plate 5, fig. 3.

Grammatodon? sp. No. 2

Pl. 3, fig. 6

Material: One specimen, somewhat damaged. Original shell material partly preserved.

Description: Medium sized, gibbous shell with a suboval outline. Anterior part ornamented with some delicate radiating striae. Umbo high, not protruding over the hinge line. Ventral border strongly convex. The approximately straight hinge line seems to be prolonged in a posterior direction, forming a very small «ear». Hinge not discernable.

Discussion: The presence of an ear is unusual, and the generic assignment is uncertain.

Occurrence: Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no. 10139. Plate 3, fig. 6.

Genus *Edmondia* DE KONINCK 1842

Edmondia aff. *arcuata* (PHILLIPS) DEMANET

Pl. 1, fig. 2; Pl. 3, fig. 2

1836 *Sanguinolaria*? *arcuata* PHILLIPS, p. 209, Pl. V, fig. 4.
1938 *Edmondia arcuata* (PHILLIPS) DEMANET, p. 132, Pl. 112, figs. 30-33.
1941 *Edmondia arcuata* (PHILLIPS) DEMANET, p. 232, Pl. XIII, figs. 26-27.
1956 *Edmondia arcuata* (PHILLIPS) SHULGA, pp. 135-136, Pl. III, fig. 47.

Material: Two specimens.

Description: One of the two specimens is a well preserved right valve. Hinge consists of a long groove. Concentric growth lines rather coarse and clearly visible. Umbo situated at the anterior side of the centre. Hinge line straight. Shell outline oval with approximately parallel dorsal and ventral margins, elongate. Medium sized shell. Dimensions: L = 10.9 mm, H = 8 mm; L = 18.7 mm, H = 9 mm.

Discussion: *Edmondia arcuata* is mentioned by DEMANET (1943) from the Petit Buisson (= Aegir) Marine Band in Belgium, but no illustration was given at that time. He also refers to his earlier publication of 1941 (p. 232), with the addition of «cf.» The species thus appears to occur in the Namurian as well. A comparison of the Spanish specimens with figs. 26 and 27, Pl. XIII of DEMANET (1941) shows slight differences. The Spanish specimens have a more symmetrical appearance. Posterior and anterior parts are almost equally developed, and the beak is not so strongly curved forwards. A comparison with some specimens figured by HIND (1899, p. 310) shows the same slight differences. It is possible that DEMANET's specimens from the vicinity of the Petit Buisson Marine Band are conspecific with the Spanish material described here. This would explain the addition of cf. to the reference to his own material. There is also a faint resemblance with *Edmondia punctatella* (JONES) WILSON (1958). But this species is easily distinguishable, since it has a much higher and therefore less elongate shape than *Edmondia arcuata*. Perhaps the Spanish material represents a new species, but it is preferred, for the time being, to draw attention to its apparent affinity with *Edmondia arcuata* (PHILLIPS) DEMANET.

Occurrence: Prioro Formation, 200 m above the base. Loc. 308. G. B. Heerlen cat. no. 10101. Plate 1, fig. 2. Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no 10107. Plate 3, fig. 2. *Edmondia arcuata* is mentioned by DEMANET from the Petit Buisson Marine Band in Belgium, where it may also occur in the Namurian.

Edmondia aff. *gibbosa* (McCOY)

Pl. 3, fig. 3

1844 *Astarte gibbosa* McCOY, p. 55, Pl. VIII, fig. 11.

1866 *Astarte gibbosa* GEINITZ, p. 16, Tab. I, figs. 23-24.

1922 *Edmondia gibbosa* (McCOY) MORNINGSTAR, p. 197, Pl. X, figs. 4-5.

Material: One specimen.

Description: Somewhat deformed, small sized shell, both valves present and discernable. Due to deformation the original outline is difficult to examine. The shell had a suboval outline with a straight ventral border. Both valves are very gibbous. Almost smooth surface, with concentric growth lines very faintly visible. Shell somewhat more developed in dorsal-ventral direction.

Discussion: *Edmondia gibbosa* is not commonly mentioned in the palaeontological literature. The Spanish specimen has a strong resemblance with fig. 12, Pl. XIV as published by GIRTY (1915).

Occurrence: Pando Formation, Mesao Limestone Member, 10 m above the base. Loc. 88. G. B. Heerlen cat. no. 10103. Plate 3, fig. 3. Occurs in Westphalian D or Stephanian A sediments (Wewoka Formation, North America), but is also present in older rocks: Namurian (MORNINGSTAR 1922).

Edmondia sp. No. 1

Pl. 3, fig. 5

Material: One specimen of a right valve.

Description: Suboval, developed diagonally in ventral-posterior direction. Gibbous shell. Beak reaching over the slightly curved hinge line, slightly bent forward. Posterior side neatly rounded. A small part of the posterior rim is broken off. Concentric ornamentation consists of distinct ribs separated by one or several less pronounced, faintly developed growth lines. Small sized shell.

Discussion: Although the valve is sufficiently well preserved for a specific identification, the species could not be found. There is a faint similarity with the Upper Palaeozoic species *Edmondia rotunda* BEEDE which has the same small size: L = 11 mm, H = 8.8 mm (compare NEWELL 1940, p. 281).

Occurrence: Pando Formation. Mesao Limestone Member. 165 m above the base . Loc. 251. G. B. Heerlen cat. no. 10124. Plate 3, fig. 5.

Edmondia sp. No. 2

Pl. 1, fig. 1

Material: One specimen, both valves discernable.

Description: Medium sized shell with an obliquely trapezoid angular outline. Obtuse beak raised over practically straight hinge line, placed approximately in the middle of the valve. Rather straight posterior and anterior borders, approximately parallel. Rounded postero - and antero-ventral corners. Ventral border oblique. Ornamented with numerous concentric ridges. Hinge features not seen.

Discussion: The specimen is somewhat crushed, which could accentuate the oblique appearance of the shell. Some resemblance is noticed with *Edmondia rudis* McCOY and *E. unioniformis* (PHILLIPS). However, these have a much more suboval outline and lack also the obliquely truncated posterior margin as well as the angular dorsal corner of the specimen in hand. There is also some similarity to *Sanguinolites omalianus* HIND from the Carboniferous Limestone of Great Britain.

Occurrence: Prioro Formation, 140 m above the base of the reference section. Loc. 138. G. B. Heerlen cat. no. 10123. Plate 1, fig. 1.

Genus *Allorisma* KING 1849

Allorisma sp.

Pl. 3, fig. 7

Material: Cast of right valve, part of postero-ventral part broken off.

Discussion: This small sized shell seems to have a beak placed very far to the anterior. Distinct concentric grooves can be distinguished. The suboval outline of the shell resembles somewhat *A. barringtoni* THOMAS from the Middle Pennsylvanian (Tarma Group) of Perú. This species, however, has a larger size (see NEWELL 1937, p. 32, fig. 2c).

Occurrence: Pando Formation, Mesao Limestone Member, 55 m above the base. Loc 102. G. B. Heerlen cat. no. 10125. Plate 3, fig. 7.

Genus *Aviculopecten* McCoy (1851) *emend.* Hind 1901

Aviculopecten delepini Demanet

Pl. 4, fig. 7

1963 *Aviculopecten delepini* Demanet, pp. 125-126, Pl. XII, figs. 7-10.

1943 *Aviculopecten delepinei* (sic!) Demanet, Demanet, pp. 96-97, Pl. III, figs. 31-32.

Material: An almost complete specimen of a right valve. Posterior auricle partly broken off.

Discussion: This form is described by Demanet (e.g. 1936, 1943) from the Petit Buisson M. B. (= Aegir Marine Band) of Belgium. The Spanish specimen is most comparable to the figs. 31 and 32 of Plate III as published by Demañet (1943). The Spanish form also resembles *Aviculopecten verbeeki* Fliegel *sensu* Fedotov (1932) from the lower Westphalian C of the Donetz Basin.

Occurrence: Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no. 10104. Plate 4, fig. 7.

Genus *Annuliconcha* Newell 1937

Annuliconcha interlineata (Meek & Worthen) Newell

Pl. 1, fig. 3; text-fig. 5

1866 *Aviculopecten interlineatus* Meek & Worthen, p. 329, Pl. 26, figs. 7 a-b.

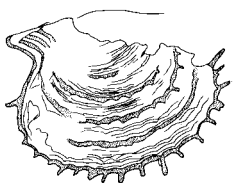
1932 *Aviculopecten interlineatus* Meek & Worthen, Fedotov, pp. 111-113, Pl. XIII, fig. 12.

1937 (1938) *Annuliconcha interlineata* (Meek & Worthen) Newell, p. 76, Pl. 13, figs. 6-10.

1968 *Annuliconcha interlineata* (Meek & Worthen), Bird, pp. 151-152, Pl. 13, figs. 14-15.

Material: One damaged valve (text-fig. 5).

Description: Suborbicular shell, anterior, posterior, and ventral margins gradually rounded; umbo broadly rounded, auricles triangular. Ornamentation of shell body consists of raised concentric spiny ridges and interspaced fila; concentric ornamentation extends onto auricles.



Text-fig. 5.—Annuliconcha interlineata (Meek & Worthen) Newell. Coll. van Loon no. 112 bn. G. B. Heerlen cat. no. 10122. Enlargement × 3.

Discussion: Although only one damaged specimen is available, it can be identified unhesitatingly as *Annuliconcha interlineata*, since the ornamentation

of the valve is fully characteristic. The resemblance to the figures of FEDOTOV (1932), who refers to further literature, is convincing. There is a good similarity with the figures of BIRD (1968).

Occurrence: Prioro Formation, 10 m above the base. Loc. 112. G. B. Heerlen cat. no. 10122. Plate 1, fig. 3; text-fig. 5. According to FEDOTOV *(loc. cit.):* in zones C $\frac{1}{2}$, C $\frac{6}{2}$, C $\frac{1}{3}$, C $\frac{3}{3}$ (Donetz Basin); Pennsylvanian of West Texas (BIRD 1968).

Genus *Crenipecten* HALL 1883

Crenipecten foerstii HERRICK 1887

Pl. 3, fig. 1

1970 *Crenipecten foerstii* HERRICK, VAN AMEROM *in* VAN AMEROM *et al.*

A list of synonyms is given in this publication, which also provides a discussion and a drawing of the one specimen available.

Occurrence: Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no. 10115. Plate 3, fig. 1.

Genus *Pernopecten* WINCHELL

Pernopecten carboniferum (HIND 1903) *sensu* DEMANET 1936

Pl. 1, fig. 5

1970 *Pernopecten carboniferum* (HIND) DEMANET, VAN AMEROM *in* VAN AMEROM *et al.* 1970 (see for synonyms: DEMANET 1936).

Material: Three specimens.

Discussion: A drawing of one of these specimens and a discussion have been published in VAN AMEROM *et al.* 1970.

Occurrence: Prioro Formation, 15 m above the base of the reference section. Loc. 113. G. B. Heerlen cat. nos. 10111 and 10112. Plate 1, fig. 5. Prioro Formation, 70 m above the base. Loc. 15 along the road from Pedrosa del Rey to the Monte Viejo pass. G. B. Heerlen cat. no. 10113.

Genus *Pecten* (KLEIN) OSBECK 1765

Subgenus *Pseudamusium* (KLEIN)

Pecten (Pseudamusium) cf. *purvesi* (DEMANET)

Pl. 4, fig. 3; text-fig. 6

1936 *Pseudamusium purvesi* DEMANET, p. 139, Pl. XIII, figs. 25-26; text-fig. 6.

1×

Text-fig. 6.—Pecten cf. *purvesi* DEMANET. Coll. VAN LOON, no. 102 bs, G. B. Heerlen cat. no. 10118.

Material: Three specimens.

Description: Subcircular, medium sized, somewhat gibbous shell. On the posterior part no distinct ear, on the anterior part a prominent ear with a sharp angular sinus, which separates the ear from the body. Concentric growth lines not very clear.

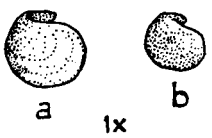
Discussion: The specimens of the VAN LOON Collection are all of a smaller size than the original type specimens of DEMANET. The specific identity of the Spanish specimens and those figured by DEMANET is not convincing. Perhaps, comparison with *Pecten ptychotis* (MCCOY 1847) should also be made. As both species are rarely used in the literature, no published comments on this subject are apparently available.

A specimen, discussed by the present author *in* VAN AMEROM *et al.* (1970) as *Pecten* sp. from the Sama Formation of Asturias, comes very near to these specimens of the VAN LOON Collection.

Occurrence: Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no 10118. Plate 4, fig. 3; nos. 10120 and 10121. Pando Formation, Mesao Limestone Member, 75 m above the base. Loc. 106, some 20 m north of Loc. 102. G. B. Heerlen cat. no. 10119. Mentioned from the Namurian of the Polish Lowland by BOJKOWSKI (1966); Namurian A in Belgium (DEMANET 1936).

Pecten (Pseudamusium) medium (HERRICK) *sensu* FEDOTOV 1932.
Pl. 5, fig. 2; text-fig. 7

1888 *Streblopteria media* HERRICK, pp. 56-57, Pl. III, figs. 8-9.
1932 *Pecten (Pseudamusium) medium* (HERRICK), FEDOTOV, p. 145, Pl. XVI, figs. 18-21.



Text-fig. 7.—Pecten medium (HERRICK) *sensu* FEDOTOV. (a) Coll. VAN LOON 612a. G. B. Heerlen cat. no. 10109. (b) Coll. VAN LOON 263a, G. B. Heerlen cat. no. 10110.

Material: Two specimens of right valves.

Description: Small sized oblique suborbicular shell, with a small anterior ear, separated from the body of the shell by an acute angular sinus ornamented by fine concentric striae. Posterior wing not developed. No distinct wrinkles. Protruding on the anterior side.

Discussion: All specimens show a close similarity to the specimen determined as *Crenipecten foerstii* HERRICK from the same area (VAN LOON Coll. no. 102 bg; see VAN AMEROM *in* VAN AMEROM *et al.* 1970). Particularly its size and outline is the same, but they differ in having no clear wrinkles and in possessing a smooth unornamented smaller anterior ear. They seem to lack the posterior auricle.

Occurrence: Pando Formation, Lower Sandstone Member, some 15 m above the base. Loc. 612, 1.5 km NW of Prioro, some 100 m S of Loc. 611. G. B. Heerlen cat. no. 10109. Pando Formation, Upper Sandstone Member, 55 m above the base. Loc. 163. G. B. Heerlen cat. no. 10110. Plate 5, fig. 2; text-fig. 7. Distribution according to HERRICK (1888): Pennsylvanian; FEDOTOV (1932): Donetz Basin, zones $C\frac{5}{2}$, $C\frac{6}{2}$. $C\frac{1}{3}$. $C\frac{2}{3}$.

Pecten (Pseudamusium) ufensis (TSCHERNYSCHEV) FEDOTOV 1932

Pl. 4, figs. 1-2

1970 *Pecten ufensis* (TSCHERNYSCHEV) FEDOTOV, VAN AMEROM *in* VAN AMEROM *et al.* 1970 (further synonyms in this paper).

Material: Two well preserved valves.

Discussion: Especially the specimen registered under GB cat. no. 10117 (Coll. VAN LOON no. 102 bm) is a cast of excellent quality. This specimen clearly shows delicate concentric lines, as well as radiating ones on the anterior ear. Less clearly marked is the radiating ornamentation, if compared to the specimen published by VAN AMEROM (*loc. cit.*).

Occurrence: Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no. 10117. Plate 4, fig. 1; G. B. Heerlen cat no. 10116. Plate 4, fig. 2.

Pecten (Pseudamusium) sp.

Pl. 1, fig. 4; Pl. 4, fig. 5

Material: Two single valves, incompletely preserved.

Description: Small suboval to subtriangular oblique shell, smooth to faintly concentric ornament. Rather gibbous umbo.

Discussion: Both specimens are not very well preserved and show slight differences between each other. A specific identification is hardly possible. However, there may be some resemblance (especially specimen no. 308 v) with *Crenipecten foerstii* HERRICK and with *Pecten (Pseudamusium)* cf. *purvesi* DEMANET 1936.

Occurrence: Prioro Formation, 200 m above the base. Loc. 308. G. B. Heerlen cat. no. 10109. Plate 1, fig. 4. Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no. 10127. Plate 4, fig. 5.

Genus *Myalina* DE KONINCK 1842

Myalina verneuilii (MCOY 1844) HIND

Pl. 4, fig. 4

1844 *Avicula verneuilii* MCOY, p. 85, Pl. XIII, fig. 19.

1897 *Myalina verneuilii* MCOY, HIND, pp. 115-117, Pl. 4, figs. 3-8.

Material: Only one fragmentary valve.

Description: This fragment of a left valve shows a straight hinge line and a part of the dorsal posterior area. Anterior part and beak broken off. Heavy growth lines and fine radial streaks can be observed as well as an indication of an auricle.

Discussion: Although the specimen in hand is only fragmentary, it is specifically identifiable. All features, as far as they can be observed, are strikingly similar to the published figures (e. g. fig. 5, Plate IV in HIND 1897, text: p. 115, etc.). Also its size and the direction of growth of the ornamentation fit very well. The specimen from the Stephanian of the Donetz Basin as figured by FEDOTOV (1932) on Plate XVIII, fig. 11, is also closely comparable.

Occurrence: Pando Formation, Mesao Limestone Member, 55 m above the base. Loc. 102. G. B. Heerlen cat. no. 10108. Plate 4, fig. 4. *Myalina verneuilii* is a long ranging species (Lower and Upper Carboniferous).

PALAEONTOLOGICAL NOTE: DRIFTED PLANT REMAINS

(R. H. WAGNER)

A substantial collection of small, drifted plant remains was brought together by A. J. VAN LOON from marine upper Westphalian rocks of the Prioro and Pando formations in north-eastern León, and submitted for identification to the present writer. The greater part of this collection had previously been examined by H. W. J. VAN AMEROM (Geologisch Bureau, Heerlen), and his identifications were taken into consideration.

The vast majority of specimens are detached pinnules and pinnule fragments of *Linopteris* (203 specimens) which are accompanied by occasional *Reticulopteris* (4) and generally isolated examples of other species (25 specimens). Additional specimens proved to be indeterminate. Such a predominance of *Linopteris* is characteristic of the classification that takes place when remains of land plants are being transported into a marine environment. Apart from woody stems, branches and petioles which are generally unidentifiable, only the more resistant leaf fragments can be expected to survive substantial maceration and current transport. *Linopteris* apparently possessed a thick cuticle and could withstand prolonged immersion in water and the consequent decay of tissue other than wood and cuticle without falling apart almost immediately. Even so, it appears that some selection of *Linopteris* pinnules took place, for it is noticeable that the size of the specimens is very small and not commensurate with the known range in size of pinnules of the species represented. Apparently, the larger pinnules fell apart sooner. Since the largely absent longer pinnules are the more distinguishable specifically, there is some difficulty telling the species apart in a number of the small pinnules collected. However, in most specimens, the elongate, rather steeply inclined vein meshes show the presence of *Linopteris neuropteroides* (VON GUTBIER). The small size of the pinnules and the straight sided margins indicate *L. neuropteroides* var. *minor* H. POTONIÉ. The narrow width of the vein meshes of a large number of specimens also agrees with this identification. A few specimens however show wider vein meshes and these show a marked resemblance to *Linopteris neuropteroides* var.

linearis WAGNER, a variety described from this area in northern León but from strata of a later age, viz. upper Westphalian D and basal Cantabrian. Perhaps, its total range is longer and it may be that this variety becomes individualized from Westphalian C onwards. Other specimens are clearly attributable to *Linopteris obliqua* (BUNBURY), since they show relatively wider and more isodiametric vein meshes. The specimens found are mainly showing the wide meshes which characterize *L. obliqua* var. *bunburyi* BELL. This species has a known range from upper Westphalian B to Stephanian A, but generally characterizes Westphalian C and D. The var. *bunburyi* probably becomes individualized within Westphalian C. Some specimens are identified (mainly tentatively) with *Linopteris subbrongniarti* GRAND'EURY. Since only the smaller pinnules are preserved in the assemblages, it is often hazardous to distinguish between this species and *Linopteris neuropteroides* var. *minor*, but an attempt at identifying *Linopteris subbrongniarti* has been made for those specimens which show elongate vein meshes which are less steeply inclined than those of *L. neuropteroides*.

VAN AMEROM had noticed the variability of the pinnules of *Linopteris* collected, but preferred to assign them all to a single species, *Linopteris obliqua*. The present writer assumes that the smaller pinnules of several species were washed together into the marine deposits and that a fair representation of Upper Westphalian species of *Linopteris* is present. Although *Linopteris obliqua* does occur, it appears that *Linopteris neuropteroides* var. *minor* has been found more commonly.

Apart from the ubiquitous *Linopteris* some other remains of neuropterids were collected. Two of these show the well developed midvein and partly pseudo-anastomosing veins of *Reticulopteris*. The species *Reticulopteris («Mixoneura») munsterifolia* NĚMEJC is almost certainly represented in the Prioro Formation (Pl. 8, fig. 2) and true *Reticulopteris munsteri* (EICHWALD) may also be present (Pando Formation). The preservation of the *Reticulopteris* pinnules is not always good enough to permit establishing the degree of anastomosis, so that the exact position in the evolutionary progression of *Neuropteris (Neurodontopteris) obliqua - Reticulopteris munsteri* cannot always be ascertained (compare JOSTEN 1962). Two specimens show the triangular shape of the pinnules of *Neuropteris scheuchzeri* HOFFMANN and also possess the fine nervation known to occur in this species. Preservation is not good enough however to allow observation of the epidermal hairs, and the identification has to remain tentative. One of these specimens was identified as *Neuropteris ?veeni* STOCKMANS & WILLIÈRE by VAN AMEROM. The latter species is a junior synonym of *Paripteris gigantea* (STERNBERG) (see LAVEINE 1967). Another pinnule fragment resembles *Neuropteris loshi* BRONGNIART (Pl. 7, fig. 3), and an even less positive identification is made of *Neuropteris rarinervis* BUNBURY.

A fragment identified as *Alethopteris* cf. *davreuxi* (BRONGNIART) is too incomplete to be seriously considered, even though the nervation is comparable. This species ranges from upper Westphalian A to lower Westphalian D.

Better preserved is a specimen of *Lobatopteris*, showing the characteristic nervation of this group of pecopterids as well as the gradual lobing which inspired the generic name. The bluntly subtriangular pinnules and the degree of lobing obtained

with the nervurary complexity shown by this specimen (Pl. 8, fig. 4) indicate *Lobatopteris waltoni* (CORSIN), a species hitherto recorded only from Westphalian D and lower Stephanian strata (WAGNER 1959).

One specimen of *Mariopteris* (Pl. 8, fig. 3) shows the elongate triangular pinnules with almost entire margins that are found in *Mariopteris muricata sensu* ZEILLER. Comparison can be made with *M. muricata* var. *elongata* DANZÉ-CORSIN, but the pinnules of the specimen in hand are clearly inrolled and therefore apparently more elongate than they were originally. *Mariopteris muricata* ranges from upper Westphalian A to lower Westphalian C.

A well preserved fragment of a pinna with several pinnules (Pl. 8, fig. 1) is assigned to *Sphenopteris polyphylla* LINDLEY & HUTTON. Comparison is made with the type specimen as figured by KIDSTON (1923, Pl. XI, figs. 1, 1a-c). This is a rare species in the group of *Sphenopteris obtusiloba* BRONGNIART and *S. nummularia* VON GUTBIER. The type specimen has been recorded from the Westphalian B of England, but the species is too uncommon to be useful stratigraphically. VAN AMEROM compared the specimen in hand with *Dicksonites pluckeneti* (v. SCHLOTHEIM).

Two specimens were found of a sphenopterid (Pl. 8, fig. 5) which shows the linear segments of lobing pinnules of *Palmatopteris furcata* (BRONGNIART), an identification made by VAN AMEROM with which the present writer concurs. This is a characteristic species of mainly Lower Westphalian age.

Most interesting is the presence of *Taeniopteris* (?) (Pl. 8, fig. 6) which has never been recorded below the Stephanian, but which probably represents a hill slope flora not likely to be present in ordinary coal measure assemblages and therefore unrecorded in standard Westphalian deposits of northwestern Europe. Another case of *Taeniopteris* washed into marine strata has been recorded recently for a locality of upper Cantabrian age (WAGNER & WINKLER PRINS 1970). H. W. J. VAN AMEROM also reported *Taeniopteris* from the collection made by A. J. VAN LOON, but this refers to a specimen not seen by the present writer. An alternative identification would be *Megalopteris* sp. This refers to a rare element from the American Carboniferous which in small fragments, such as the one found in the Prioro region, may be difficult to distinguish from *Taeniopteris*.

A similar case to the *Taeniopteris* discussed above is that of a fragment identified as *?Pterophyllum* (Pl. 8, fig. 7), another rare plant which may belong to the Cycadophyta.

The specimens recorded as *Lepidophloios* sp., *Calamites* sp., *Sphenophyllum* sp., and *?Cordaianthus* sp. need not be commented upon, since they are neither well preserved nor very special.

The plants collected by VAN LOON are permanently housed in the Geologisch Bureau at Heerlen, the Netherlands, and the catalogue numbers quoted with the figured specimens refer to this institution.

Table 1. Known stratigraphic ranges of plant species found in the Prioro Formation.

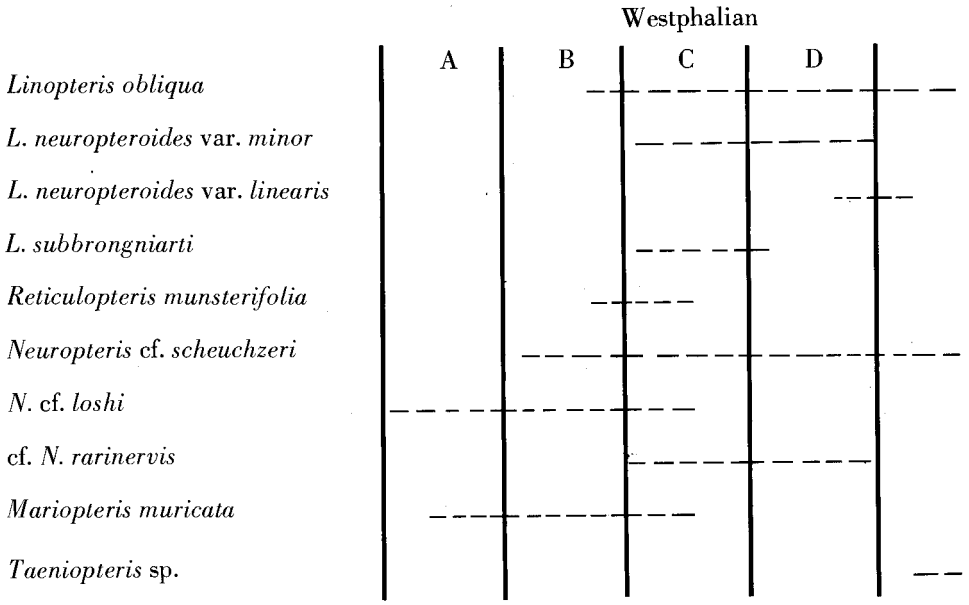
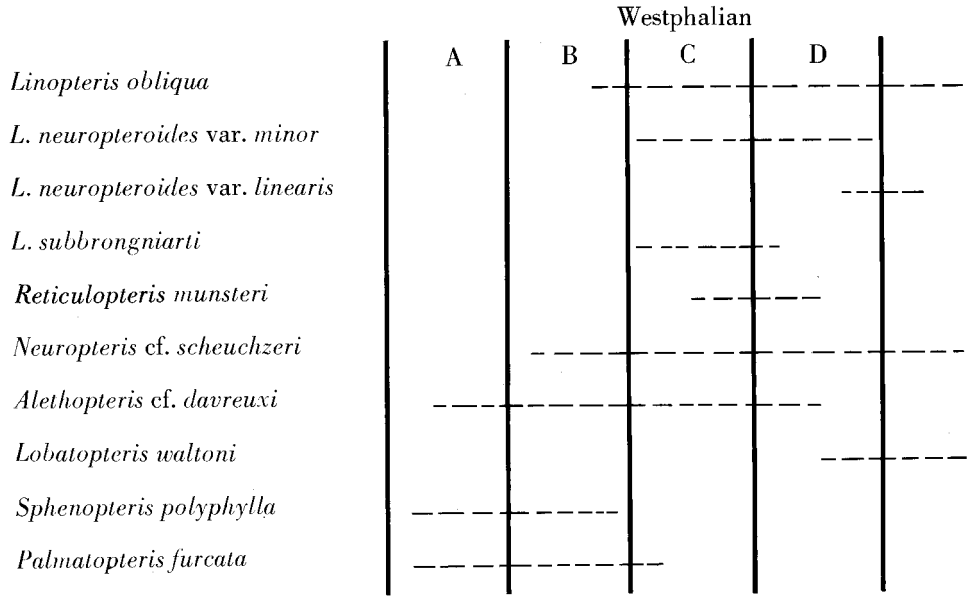


Table 2. Known stratigraphic ranges of the more important plant species found in the Pando Formation.



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APPENDIX

DESCRIPTION OF A SECTION THROUGH THE MESAO LIMESTONE MEMBER.

A good section is exposed in the northern flank of the syncline from the Puerto de Pando along the road to Prioro. The accessibility of this section and its abundance of fossils and sedimentary structures merit a visit.

The sequence starts at the Puerto de Pando with 27 m of calcareous mudstone. Sedimentary structures are scarce, but current ripples and parallel lamination are present. A single quartzite pebble measuring 5.5 cm in diameter was found here. Some fossils occur: brachiopods (among others *Karavankina rakuszi* WINKLER PRINS), pelecypods, corals (*Zaphrentites* sp.), bryozoa, trilobites (*Paladin mucronatus* (MCCOY), mainly in the lower part), gastropods, nautiloids (one specimen of *?Metacoceras* sp. was found here), and plants (acc. to WAGNER: *Linopteris* cf. *subbrongniarti* GRAND'EURY, *L.* cf. *neuropteroides* var. *minor* POTONIÉ and *Palmatopteris* sp.).

This is followed by a gradual transition into 23 m of organoclastic limestone. The occurrence of a few pebbles (a sandstone pebble of 5 cm and a quartzite pebble of 6 cm were found) proves that, occasionally, coarse-grained material reached this area. Structures suggestive of slumping occur here.

The lowermost limestone is irregularly bedded, and contains many fusulinids and algae. Birdseye structures, also indicating a shallow marine environment, are found. Gradually, some small solitary corals appear, and higher up larger ones (cyathopsids or aulophyllids) also occur. Thus a mixed algal/coral limestone is formed, with an admixture of crinoid stems and ossicles. Bryozoa are only present sporadically. The bedding plane is often difficult to see, but can be distinguished by observing corals lying parallel to the bedding.

This part changes into a nodular limestone with more mudstone intercalations. Reef debris also seems to be present. Large corals become less abundant; algae are still frequent. Towards the top of this nodular part, which is characterized by the more frequent presence of pyrite, very sporadic shell remains occur.

The upper part of this limestone is better bedded again. A few specimens of cyathopsids or aulophyllids still occur, and more crinoid ossicles are present. Algae are still abundant.

Brachiopods, gastropods (*Bellerophon* sp.), corals (mainly the large cyathopsids or aulophyllids), algae (also oncolites), and fusulinids were found in these 23 m.

Gradually, but within a few metres, this limestone passes into a 21 m thick mudstone possessing a rich fauna and drifted plant remains. This sequence becomes more calcareous towards the top. In the youngest part some small slumped reef limestones are found in the mudstone.

Flora: *Linopteris obliqua* (BUNBURY) (*det.* VAN AMEROM), and (*det.* WAGNER): *Linopteris obliqua* var. *bunburyi* BELL, *L. subbrongniarti* GRAND'EURY, and *Reticulopteris munsteri* (EICHWALD).

Fauna: brachiopods, pelecypods, gastropods, algae, bryozoa, corals, and trilobites (*Paladin mucronatus* (MCCOY), *Brachymetopus* cf. *ouralicus* (VERNEUIL), and *?Ditomopyge* aff. *granulata* (WEBER)).

Because of an increase in lime content, the mudstone gradually passes into a marly limestone in which the originally irregular bedding planes can be determined from mudstone intercalations. Here, crinoid stems and algae are common. Corals are less abundant, but some thin layers contain a higher concentration, mainly of *Pseudozaphrentoides*.

After a 10 to 15 m interval the bedding planes become more regular, but soon another nodular limestone starts with the same characteristics as mentioned above. There are some levels with wholly or partly silicified corals and algae. This part is followed by an alternation of mudstones and —usually clastic— limestone layers. The clastic limestones are often characterized by flat and sharp lower bedding planes and the occurrence of sedimentary structures such as lamination and current ripples. Graded bedding can also be observed, but is less frequent.

The top of this 40 m thick sequence again becomes nodular. In these 40 m were found:

Flora: *Linopteris* sp. (according to VAN AMEROM and WAGNER).

Fauna: brachiopods, corals (*Rotiphyllum* sp., cyathopsids, aulophyllids and syringoporids), algae, bryozoa, and fusulinids.

As the result of its increasing mud content, this limestone grades into a 23 m thick mudstone. Some limestones occur, probably slumped over a short distance.

Flora: (*det.* VAN AMEROM): *Linopteris neuropteroides* (VON GUTBIER); (*det.* WAGNER): *Linopteris* sp., *L.* cf. *obliqua* (BUNBURY), *L. obliqua* var. *bunburyi* BELL, *L. neuropteroides* (VON GUTBIER) and *L. neuropteroides* var. *minor* H. POTONIÉ.

Fauna: brachiopods (marginiferids), crinoids (synerocrinids), corals, algae, bryozoa, and trilobites (*Paladin* sp.).

A 29 m thick limestone follows, initially clastic. At first a rather considerable amount of mudstone is present and the limestone is nodular. The distortion of some marly intervals could be due to slumping. At the base fossils are scarce; only some algae occur. Some graded limestone banks also contain fusulinids and gastropods. Higher up in the sequence, more fossils are present, but there is an absence of drifted plant remains.

Fauna: pelecypods, gastropods, fusulinids (Locality L 11 of VAN GINKEL 1965:

Staffella cf. *pseudosphaeroidea* DUTKEVITCH, *Parastaffella* sp., *Pseudostaffella* ex gr. *parasphaeroidea* (LEE & CHEN), *Schubertella* cf. *subkingi* PUTRJA, *Hemifusulina* ex gr. *moelleri* RAUSER-CHERNOUSSOVA and *Fusiella* cf. *praecursor* RAUSER-CHERNOUSSOVA).

A mudstone layer of 20 cm is followed by a thin bank of algal limestone. This layer also contains pelecypods, fusulinids and bryozoa. After this limestone bank no more true limestone is developed for a while, so here we may draw the boundary between the Mesao Limestone Member and the Upper Sandstone Member of the Pando Formation. The Upper Sandstone Member is very calcareous at the base in this section. The presence of macro-fusulinids *(Hemifusulina)*, measuring up to about 5 mm, some 20 m above the base of the Upper Sandstone Member, should be mentioned.

Brachiopods were collected throughout this section by SIESWERDA (*det.* WINKLER PRINS), but the exact localities could not be traced. He found: *Kozlowskia aberbaidenensis* (RAMSBOTTOM), *K. pusilla* (SCHELLWIEN), *Linoproductus latiplanus* IVANOV, *Reticulatia huecoensis* (KING), *Rugosochonetes skipseyi* (CURRIE), *R. acutus* (DEMANET), *Karavankina* cf. *dobsinensis* (RAKUSZ), and *K. rakuszi* WINKLER PRINS.

PLATE 1

PELECYPODS FROM THE PRIORO FORMATION

Fig. 1.—*Edmondia* sp. No. 2. × 2. Reference section at 140 m above the base. Loc. 138. G. B. Heerlen cat. no. 10123.

Fig. 2.—*Edmondia* aff. *arcuata* (PHILLIPS) DEMANET. × 3. At 200 m above the base. Loc. 308. G. B. Heerlen 10101.

Fig. 3.—*Annuliconcha interlineata* (MEEK & WORTHEN) NEWELL × 3. Reference section at 10 m above the base. Loc. 112. G. B. Heerlen 10112.

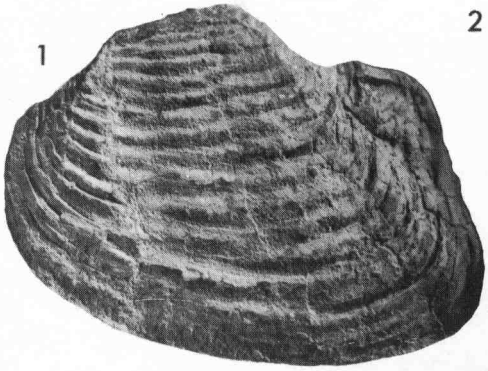
Fig. 4.—*Pecten (Pseudamusium)* sp. × 8. At 250 m above the base. Loc. 312. G. B. Heerlen 10109.

Fig. 5.—*Pernopecten carboniferum* (HIND) DEMANET. × 2. At 15 m above the base. Loc. 113. G. B. Heerlen 10112.

Fig. 6.—Unidentified × 12. At 200 m above the base. Loc. 308. G. B. Heerlen 10140.

Fig. 7.—Unidentified × 12. At 5 m above the base. Loc. 696. G. B. Heerlen 10131.

Fig. 7a.—*Ibid.* dorsal view, hinge showing numerous teeth.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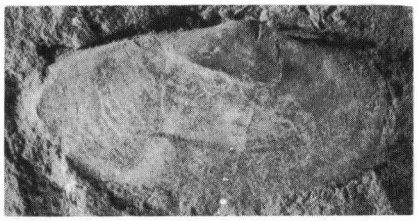
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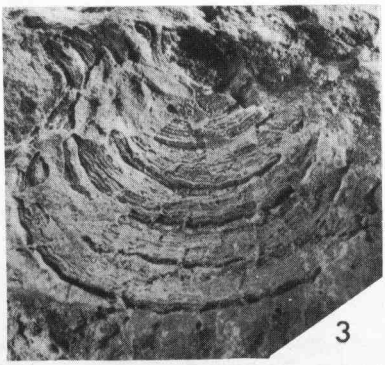
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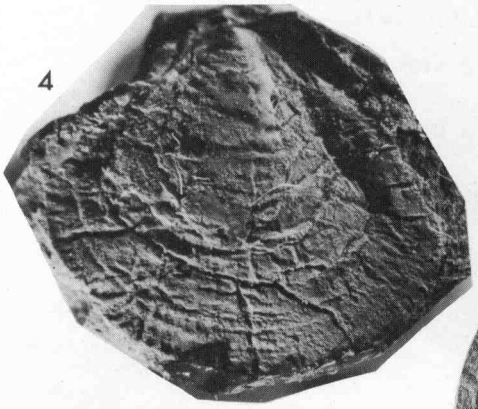
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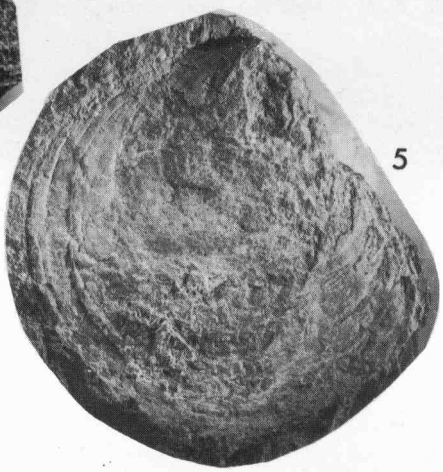
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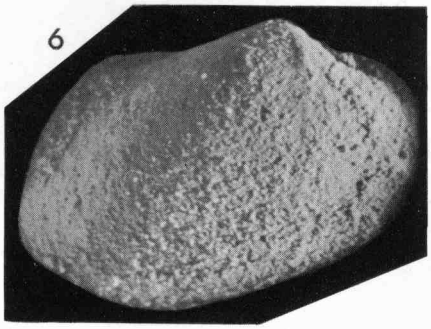
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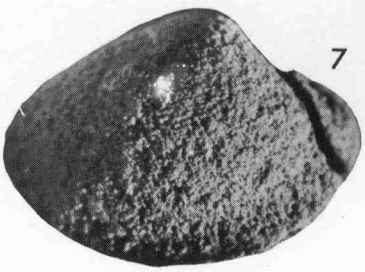
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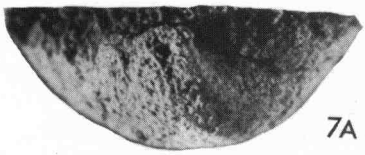
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PLATE 2

BRACHIOPODS FROM THE PANDO FORMATION

Fig. 1.—Dictyoclostus ?aegiranus (BÖGER & FIEBIG). × 2. Lower Sandstone Member (10? m above the base). Loc. 700. RGM-St. 143403. Coll. WINKLER PRINS.

Fig. 2.—Brachythyrina cf. *strangwaysi* (DE VERNEUIL). × 2. Mesao Limestone Member (about 175? m above the base). Loc. 691. RMG-St. 143406. Coll. WINKLER PRINS.

Fig. 3.—Meekella sp. × 3. Mesao Limestone Member (40 ? m above the base). Loc. 497. RGM-St. 14300.

Fig. 4.—Fluctuaria undata (DEFRANCE). × 3. Mesao Limestone Member (about 175 ? m above the base). Loc. 691. RGM-St. 143406. Coll. WINKLER PRINS.

Fig. 5.—Karavankina aff. *dobsinensis* (RAKUSZ). × 2. Mesao Limestone Member (55 m above the base). Loc. 102. RGM-St. 143401.

Fig. 6.—Stenoscismatocean rhynchonellid. × 3. Mesao Limestone Member (about 175 ? m above the base). Loc. 691. RGM-St. 143408. Coll. WINKLER PRINS.

Fig. 7.—Meekella eximia (VON EICHWALD). × 3. Upper Sandstone Member (55 m above the base). Loc. 263. RGM-St. 143402.

Fig. 8.—Meekella eximia (VON EICHWALD). × 3. Upper Sandstone Member (70 m above the base). Loc. 266. RGM-St. 143399.

N. B. RGM = Rijksmuseum van Geologie en Mineralogie, Leiden.

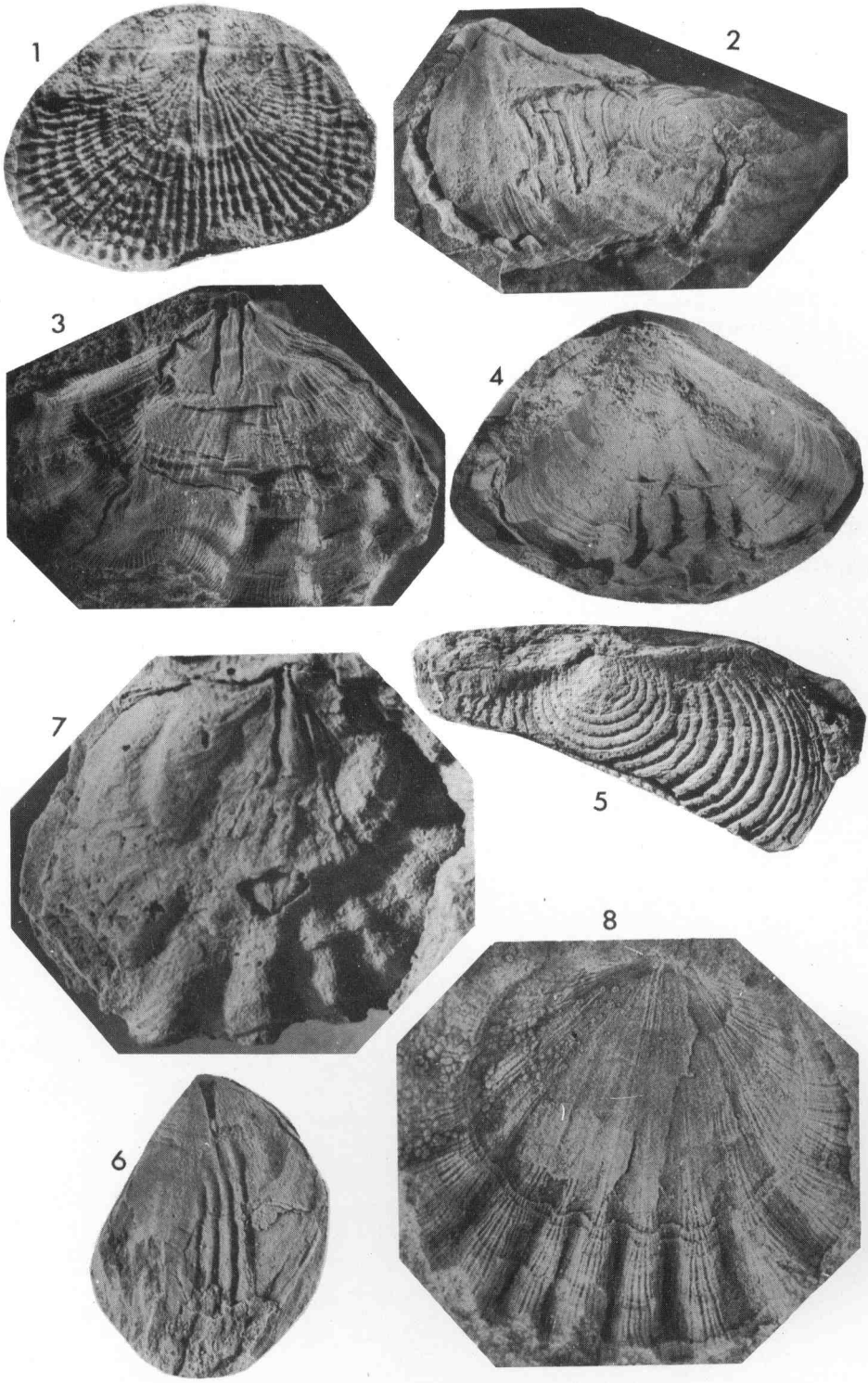
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PLATE 3

PELECYPODS FROM THE PANDO FORMATION: MESAO LIMESTONE MEMBER

Fig. 1.—Crenipecten foerstii HERRICK. x 6. At 55 m above the base. Loc. 102. G. B. Heerlen cat. no. 10155.

Fig. 2.—Edmondia aff. *arcuata* (PHILLIPS) DEMANET. × 3. At 55 m above the base. Loc. 102. G. B. Heerlen 10107.

Fig. 3.—Edmondia aff. *gibbosa* (MCCOY). x 3. At 10 m above the base. Loc. 88. G. B. Heerlen 10103.

Fig. 4.—Grammatodon cf. *sangamonensis* (WORTHEN). × 2. At 45 m above the base. Loc. 100. G. B. Heerlen 10114.

Fig. 5.—Edmondia sp. No. 1. × 3. Reference section, 165 m above the base. Loc. 251. G. B. Heerlen 10124.

Fig. 6.—Grammatodon? sp. No. 2. × 3. At 55 m above the base. Loc. 102 G. B. Heerlen 10139.

Fig. 7.—Allorisma sp. × 3. At 55 m above the base. Loc. 102. G. B. Heerlen 10125.

Fig. 8.—Anthraconeilo sp. × 6. At 55 m above the base. Loc. 102. G. B. Heerlen 10131.

Fig. 9.—Anthraconeilo sp. × 6. At 55 m above the base. Loc. 102. G. B. Heerlen 10133.

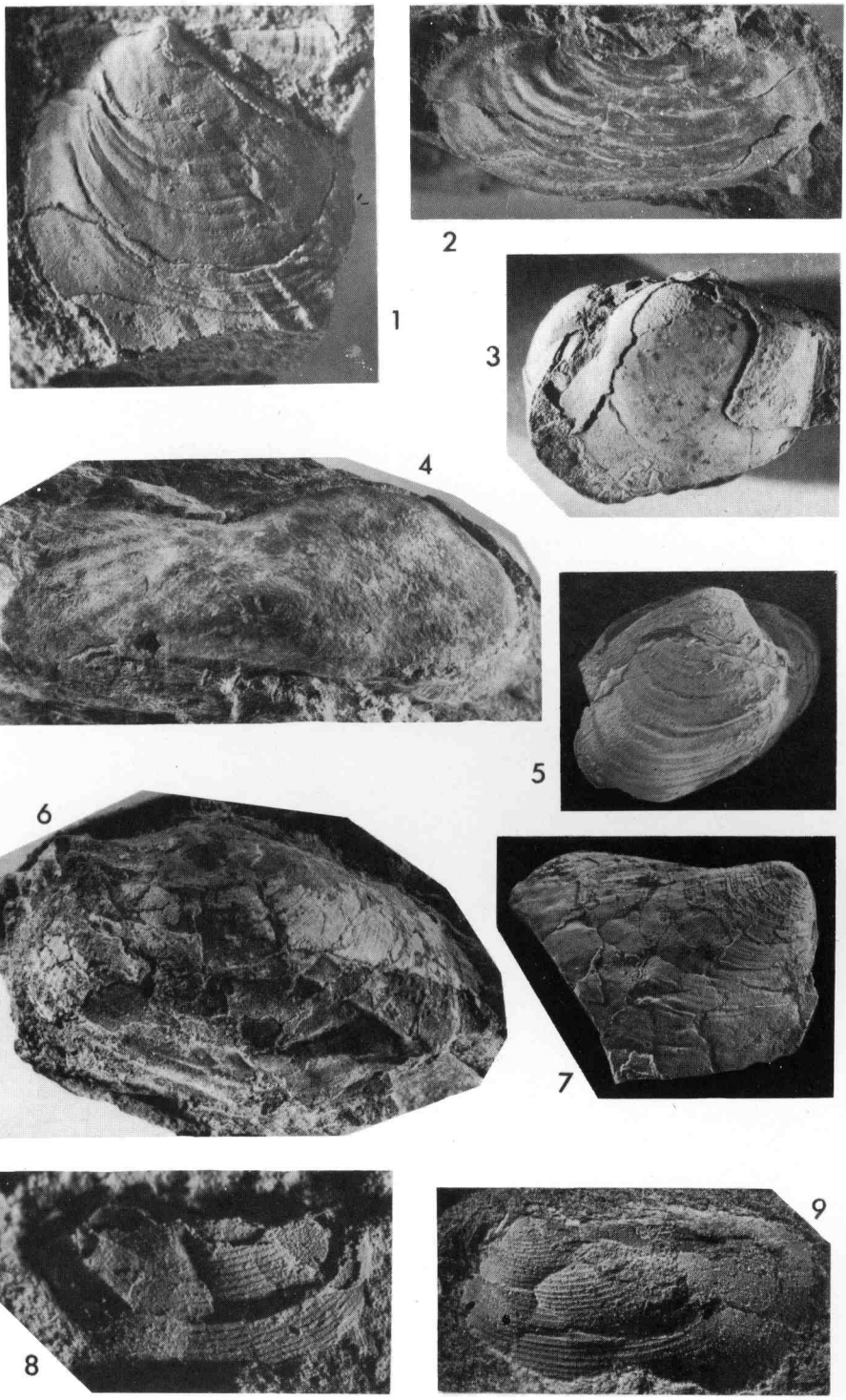
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PLATE 4

PELECYPODS AND GONIATITES FROM THE PANDO FORMATION: MESAO LIMESTONE MEMBER

Fig. 1.—*Pecten (Pseudamusium) ufensis* (TSCHERNYSCHEV) FEDOTOV. × 3. At 55 m above the base. Loc. 102. G. B. Heerlen 10117.

Fig. 2.—*Pecten (Pseudamusium) ufensis* (TSCHERNYSCHEV) FEDOTOV. × 3. At 55 m above the base. Loc. 102. G. B. Heerlen 10116.

Fig. 3.—*Pecten (Pseudamusium) purvesi* (DEMANET). × 3. At 55 m above the base. Loc. 102. G. B. Heerlen 10118.

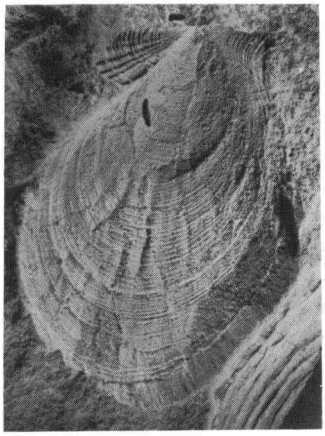
Fig. 4.—*Myalina verneuilii* (MCCOY) DEMANET. × 2. At 55 m above the base. Loc. 102. G. B. Heerlen 10108.

Fig. 5.—*Pecten (Pseudamusium)* sp. × 3. At 55 m above the base. Loc. 102. G. B. Heerlen 10127.

Fig. 6.—Unidentified. × 12. At 55 m above the base. Loc. 102. G. B. Heerlen 10141.

Fig. 7.—*Aviculopecten delepini* DEMANET. × 3. At 55 m above the base. Loc. 102. G. B. Heerlen 10104.

Fig. 8.—Cf. *Politoceras politum* (SHUMARD). × 1. Some 25 ? m above the base. Loc. 614. Coll. VAN LOON 614 n.



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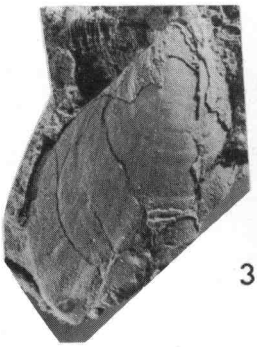

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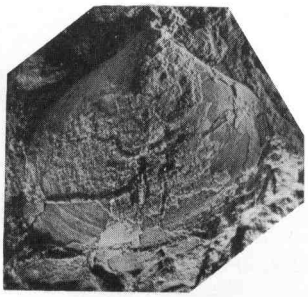

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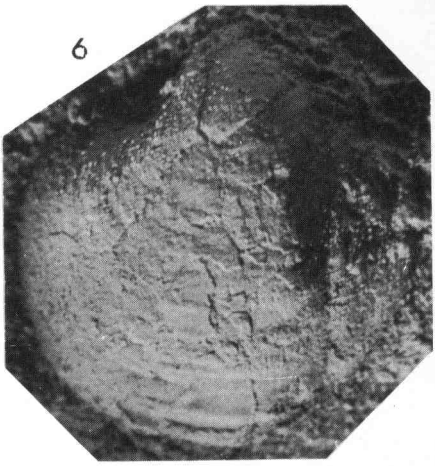

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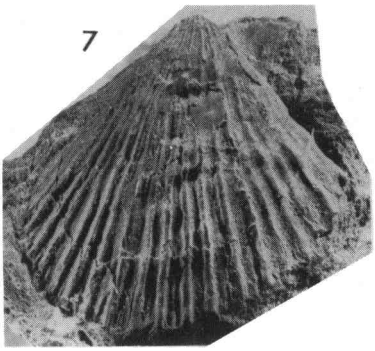

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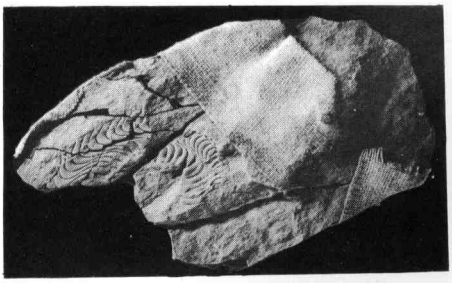


PLATE 5

PELECYPODS AND GONIATITES FROM THE PANDO FORMATION: UPPER SANDSTONE MEMBER

Fig. 1.—Palaeoneilo cf. *sharmani* (ETHERIDGE jun.) DEMANET. × 2. At 165 m above the base. Loc. 370. G. B. Heerlen cat. no. 10105.

Fig. 1a.—Ibid.; dorsal view showing hinge with numerous teeth. × 3.

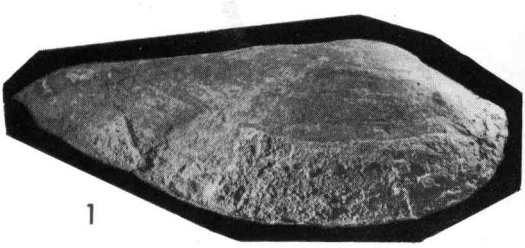
Fig. 2.—Pecten (Pseudamusium) medium (HERRICK) *sensu* FEDOTOV. × 6. Reference section. Some 55 m above the base of this member. Loc. 263. G. B. Heerlen 10110.

Fig. 3.—Grammatodon sp. No. 1. × 6. At 2 m above the base. Loc. 353. G. B. Heerlen 10137.

Fig. 4.—Schizodus ? sp. × 2. At 165 m above the base. Loc. 370. G. B. Heerlen 10102.

Fig. 5.—Pseudoparalegoceras sp. × 1. At 132 m above the base. Loc. 364. Coll. VAN LOON 354 a.

Fig. 5a.—Ibid. × 1. Ventral part.



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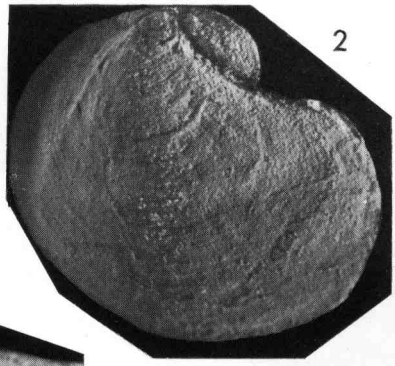

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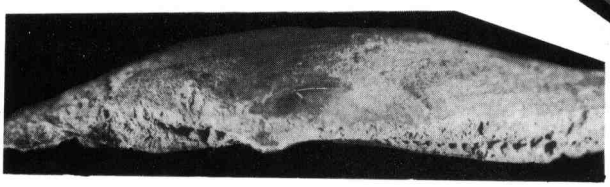

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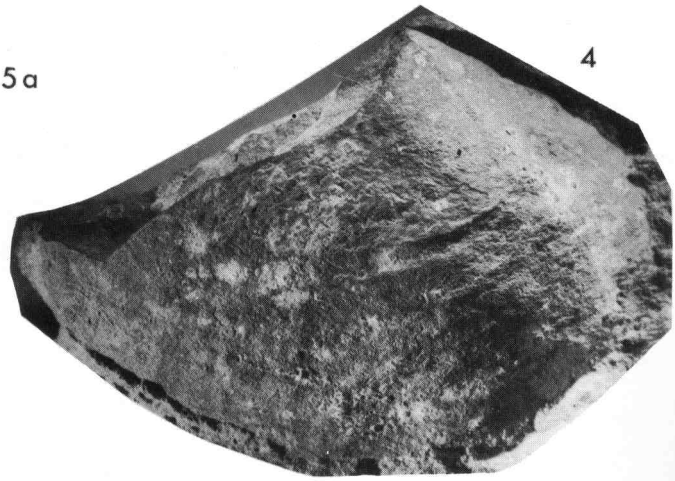

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PLATE 6

CORAL FROM THE PANDO FORMATION: MESAO LIMESTONE MEMBER

Fig. 1.—cf. *Axolithophyllum*. × 2. Transverse section. Reference section, 95 m above the base of this member. Loc. 232. RGM-St. 143940.

Fig. 2.—*Ibid.* × 2. Longitudinal section of parent corallite and offset.

Figs. 3-5.—*Ibid.* × 1 ½. Transverse thin sections.

Fig. 6.—*Ibid.* × 1 ½. Transverse section.

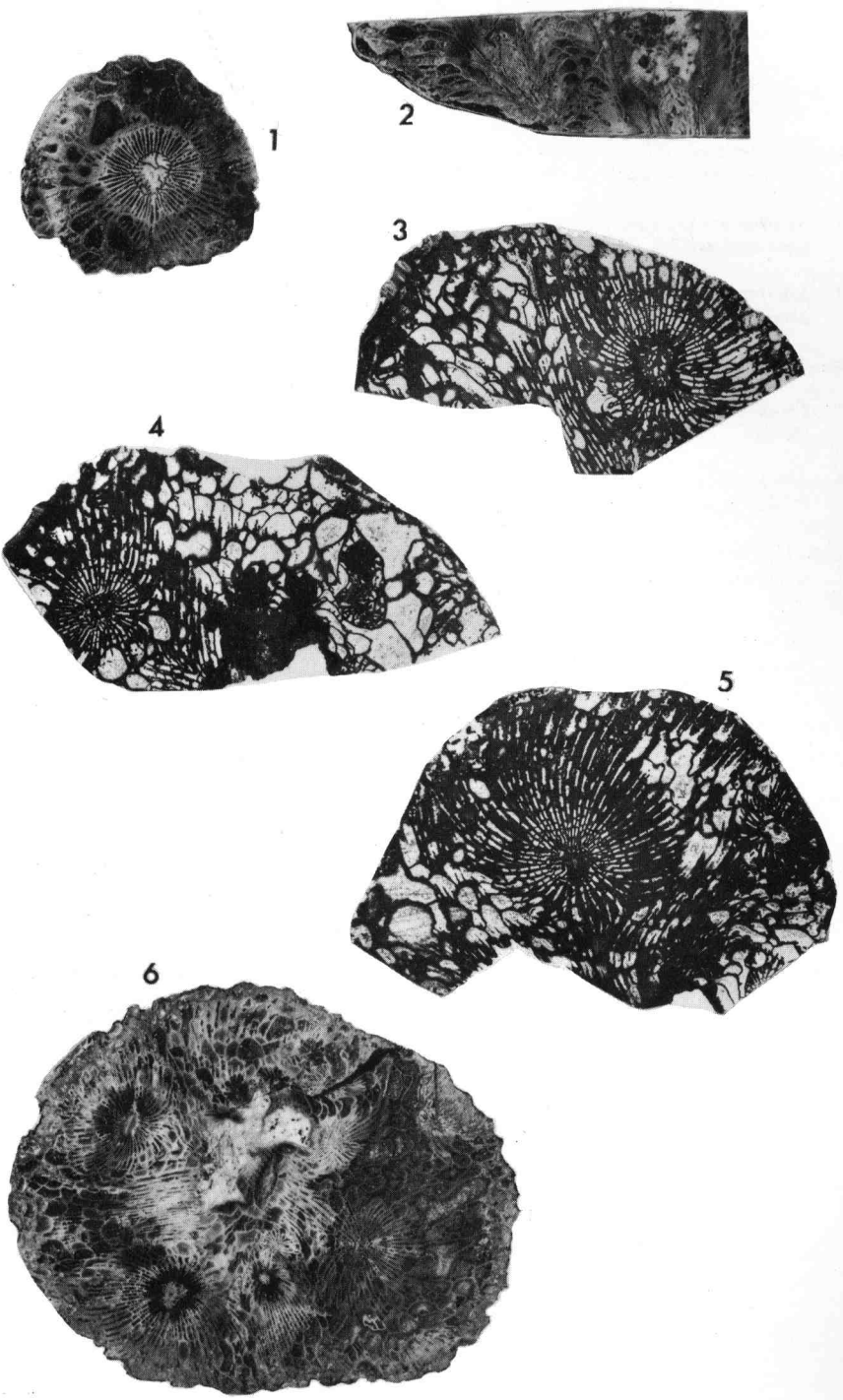
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PLATE 7

PLANTS OF THE PRIORO REGION

Fig. 1.—*Linopteris* cf. *subbrongniarti* GRAND'EURY. × 3. Pando Formation. Mesao Limestone Member (50 m above the base). Loc. 742. G. B. Heerlen 50448.

Fig. 2.—*Linopteris* sp. (cf. *subbrongniarti* GRAND'EURY). × 3. Pando Formation, Mesao Limestone Member (150? m above the base). Loc. 617. G. B. Heerlen 50449.

Fig. 3.—*Neuropteris* cf. *loshi* BRONGNIART. × 3. Prioro Formation (5 m above the base of the reference section). Loc. 111. G. B. Heerlen 50450.

Fig. 4.—*Linopteris* cf. *neuropteroides* var. *minor* POTONIÉ. × 3. Pando Formation, Mesao Limestone Member (50 m above the base). Loc. 742. G. B. Heerlen 50451.

Fig. 4a.—The same specimen, × 6, showing the elongate vein meshes.

Fig. 5.—*Linopteris neuropteroides* var. *minor* POTONIÉ. × 3. Prioro Formation (some 200 m above the base). Loc. 610. G. B. Heerlen 50452.

Fig. 6.—*Linopteris subbrongniarti* GRAND'EURY. × 3. Pando Formation, Mesao Limestone Member (7 m above the base). Loc. 601. G. B. Heerlen 50453.

Fig. 6a.—The same specimen, × 6, showing details of the venation. Note the relatively broad shape, accentuated by the broadly rounded apex. The wide angle at which the somewhat elongate vein meshes reach the pinnule border is characteristic. The specimen probably suffered some tectonic deformation, producing excessive elongation of the vein meshes on the left whilst those on the right hand side of the pinnule appear to be more isodiametric than they are in fact.

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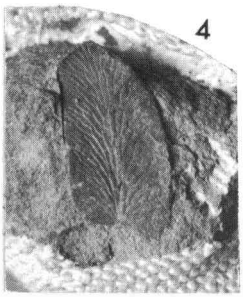

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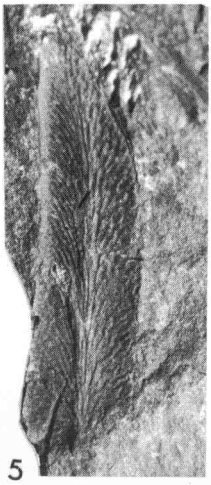

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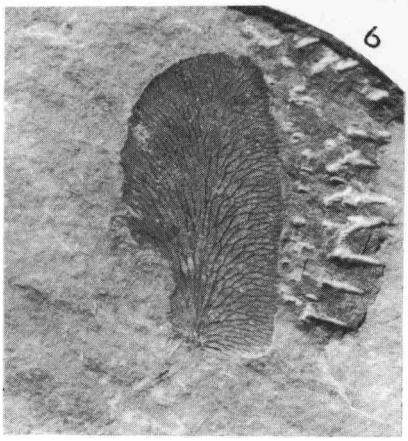

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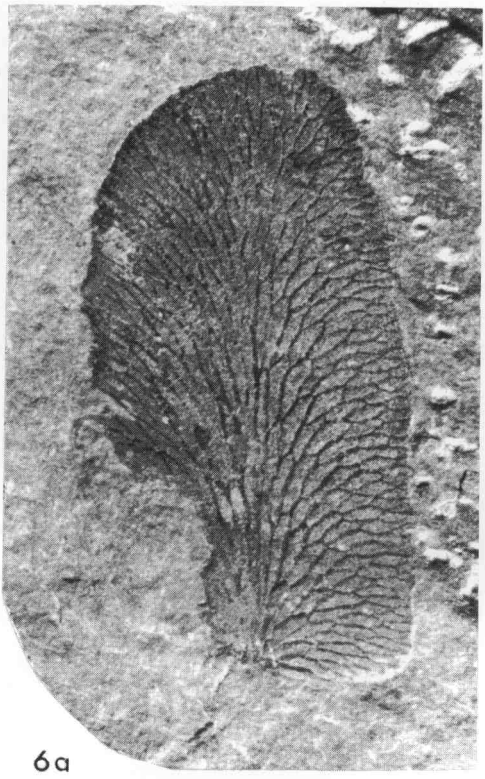


6a

PLATE 8

PLANTS OF THE PRIORO REGION

Fig. 1.—*Sphenopteris polyphylla* LINDLEY & HUTTON. × 3. Pando Formation, Mesao Limestone Member (? m above the base; isolated exposure). Loc. 611. G. B. Heerlen 50423.

Fig. 2.—*Reticulopteris munsterifolia* (NĚMEJC). × 3. Prioro Formation (160 m above the base). Loc. 301. G. B. Heerlen 50454.

Fig. 3.—*Mariopteris muricata sensu* ZEILLER *(non* v. SCHLOTHEIM). × 3. Prioro Formation (? m below the base of the reference section, along the road in the village of Prioro). Loc. 591. G. B. Heerlen 50455.

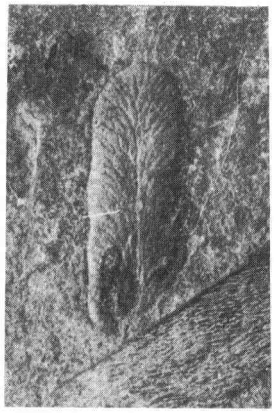
Fig. 4.—*Lobatopteris (Pecopteris) waltoni* (CORSIN) WAGNER. × 3. Pando Formation, Mesao Limestone Member (27 m above the base). Loc 672. G. B. Heerlen 50413.

Fig. 5.—*Palmatopteris furcata* (BRONGNIART) POTONIÉ. × 3. Pando Formation, Mesao Limestone Member (50 m above the base). Loc. 742. G. B. Heerlen 50425.

Fig. 6.—*Taeniopteris?* sp. × 3. Prioro Formation (12 m above the base). Loc. 696. G. B. Heerlen 50456. *Note*: This specimen is specifically different from the earliest recorded species in the Upper Carboniferous, *Taeniopteris jejunata*, and probably represents an undescribed species.

Fig. 7.—*?Pterophyllum* sp. × 3. Pando Formation, Mesao Limestone Member (50 m above the base). Loc. 742. G. B. Heerlen 50424.


1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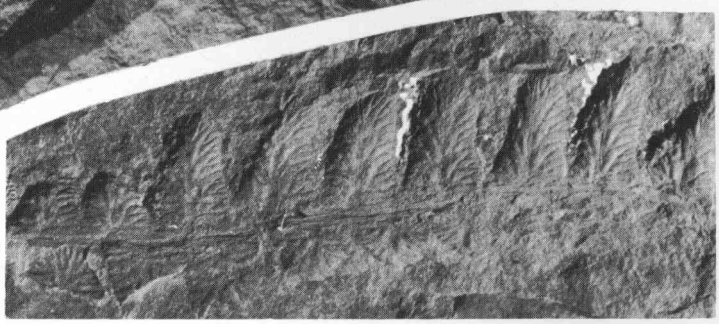
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