GEOLOGICAL SURVEY OF CANADA
COMMISSION GEOLOGIQUE DU CANADA

Open File 662

THE MICROPALAEONTOLOGY, PALYNOLGY AND STRATIGRAPHY OF THE PANARCTIC ET AL. CHADS CREEK B-64 WELL

G. DOLBY, J.H. FORD, R.J. PRICE AND B.V.A. THORNE

Geological Survey of Canada (Calgary)
3303 - 33 Street N.W.
Calgary, Alberta T2L 2A7

March 1978

CONTENTS

ENCLOSURES: Biostratigraphical analysis charts, enclosures Nos. 1, 2 and 3.

I

INTRODUCTION

This report comprises a summary of the micropalaeontological, palynological and stratigraphical analyses carried out under Project No. RRNA/778/466, on material received from the Chads Creek B-64 well over the interval 80' - 16,523' (T.D.).

This well was drilled on the Sabine Peninsula, Melville Island, Northwest Territories at Latitude 76° 23' 8.2" N., and Longitude 109° 54' 21" W..

The stratigraphical interval covered by the well section commences in strata of Early Cretaceous (Albian and Aptian) age which are underlain by Neocomian beds. A possible unconformity occurs within the Neocomian. This interval is underlain by Late Jurassic (?Tithonian - Kimmeridgian) strata. The Late/Middle Jurassic contact is probably unconformable with beds of Oxfordian and ?Callovian age missing. A continuous sequence of Middle to Early Jurassic (Bathonian - Liassic) strata is underlain with possible unconformity by Late Triassic (Rhaetian) beds. The entire Triassic sequence is present. It rests with unconformity on undifferentiated Late Permian deposits. These in turn give way to Early Permian (Kungurian - Sakmarian) strata within which the well terminated.

A tentative interpretation of the environment of deposition is indicated on the analysis charts. The interpretation of a probable

environment is based on the use of a combination of factors, including the faunal and floral diversity and dominance, their stratigraphical distribution, the comparison of assemblages with analogous components in the Recent and fossil record and the lithological characteristics of the intervals studied.

It should be realised that as the information is mainly derived from cuttings samples, only a generalised interpretation of the environment is feasible throughout the well section.

A summary of the sequence penetrated in this well together with the age diagnostic microfossil assemblages may be seen overleaf in Table I.

II

SUCCESSION
TABLE I

INTERVAL	THICKNESS	STAGE	SYSTEM
80' - 2090'	2010'	Albian	
2090' - 2400'	310'	Aptian	Early Cretaceous
2400' - 3400'	1000'	Neocomian (undifferentiated)	
3400' - 3500'	100'	?Tithonian-Kimmeridgian	Late Jurassic
3500' - 3890'	390'	?Callovian-Bajocian	Middle Jurassic
3890' - 4424'	534'	Toarcian-Liassic (undifferentiated)	Early Jurassic
4424' - 4550'	126'	Rhaetian	
4550' - 4650'	100'	Norian	Late Triassic
4650' - 4750'	100'	Karnian	
4750' - 4850'	100'	Ladinian	
4850' - 5550'	700'	Anisian	Middle Triassic
5550' - 7850'	2300'	Spathian-Smithian	
7850' - 9808'	1958'	Dienerian-Griesbachian	Early Triassic
9808' - 10,350'	542'	-	Late Permian (undifferentiated
10,350' - 13,050'	2700'	Kungurian-Artinskian (Leonardian)	
13,050' - 16,523' T.D.	3473'	Sakmarian (late Wolfcampian)	Early Permian

N.B. The above figures are approximate only, since they are mainly based on

II

SUCCESSION
TABLE I

MICROFAUNAL ASSEMBLAGE ZONE		PALYNOMORPH ASSEMBLAGE ZONE
Quadrimorphina ruckerae & Valvulineria loetterlei		
Miliammina manitobensis & Psamminopelta cf. bowsheri		
Haplophragmoides goodenoughensis & Cribrostomoides canui		
Haplophragmoides kingakensis/barrowensis		
Ammodiscus orbis & Ammodiscus francisi		
–		Nannoceratopsis gracilis (pars.)
–		Ricciisporites tuberculatus
Astacolus connudatus	) Healdia sp. 1 &	Sverdrupiella
–	) Hungarella sp. 24	Camerosporites
–		Dictyotidium
	) ?Aclistochara sp. 1	Striatoabieites aytugii
	) ?Stellatochara sp. 1	Taeniaesporites & Protohaploxypinus
		Striatoabieites richterii
–		Weylandites spp. and Striatoabieites multistriatus
	) Thurammina cf. texana &) Hyperamminella cf. elegans (pars.)	Weylandites cincinnatus & Decussatisporites sp. A. Potonieisporites

information derived from cuttings samples.

III

MATERIALS AND METHODS

Under Project No. RRNA/778/466, cuttings samples were available from the interval 80' - 16,523' (T.D.). In addition 4 cored intervals between 9672' - 9732' (core 1), 11,150' - 11,154' (core 2), 15,046' - 15,100' (core 3), and 16,470' - 16,519' (core 4) were also examined. No samples were available for examination between 110' - 180'. The examination comprised both detailed micropalaeontological and palynological studies. For specific information, reference should be made to the biostratigraphical analysis charts, enclosures 1, 2 and 3.

The prepared samples and recorded information are now curated in the confidential files of the Calgary laboratory of Robertson Research (North America) Limited.

IV

CRETACEOUS

INTERVAL 80' - 2090': Early Cretaceous, Albian

Lithology and Stratigraphy

The interval between 80' - 1180' consists of a continuous sequence of medium, dark grey or black shales with minor pyrite. This lithology is equated with the Christopher Formation.

Between 1180' - 2090' increasing quantities of angular to sub-rounded, fine to coarse-grained white sandstone interfingers with the shale. These interbeds give way to more distinct sandstone horizons toward the base. The top of this unit probable represents interfingering of the Christopher and underlying Isachsen Formations. The latter occurs toward the base of the interval.

Micropalaeontology

The regular and common occurrence of the typical Albian calcareous foraminiferid assemblage within the Sverdrup Basin is found throughout this interval. Age diagnostic calcareous species present include Conorboides umiatensis, Quadrimorphina ruckerae and Valvulineria loetterlei, together with the agglutinating taxa Haplophragmoides topagorukensis and Verneuilinoides borealis.

These species occur throughout the Albian but are more commonly found in Middle and Late Albian strata, (Chamney, 1973 and 1976).

Palynology

This interval yielded generally rich and varied assemblages of both marine and terrestrial palynomorphs. Included in the rich pollen and spore assemblages of Early Cretaceous age are Alisporites bilateralis, Cedripites cretaceus, Lycopodiumsporites austroclavatidites, Cicatricosisporites spp., C. auritus, Aequitriradites spinulosus, Tigrisporites scurrandus, Trilobosporites apiverrucatus, Costatoperforosporites fistulosus and Distaltriangulisporites perplexus.

Marine forms present include Cribroperidinium spp., Odontochitina operculata, Paleoperidinium cretaceum, Aptea polymorpha, Gardodinium eisenackii, Tenua spp., and Batioladinium jaegeri. The occurrence of Luxadinium propatulum, Apteodinium maculatum, Leptodinium cancellatum, Cribroperidinium intricatum and Lecaniella foveatae in the dinoflagellate assemblage indicates an Albian age.

Depositional Environment

The common to abundant occurrence and large species diversity of the aforementioned foraminifera probably indicates a normal marine environment. This is supported by the rich microplankton assemblage.

INTERVAL 2090' - 2400': Early Cretaceous, Aptian

Lithology and Stratigraphy

The increasing amounts of angular to subrounded sandstones as found at the base of the overlying interval continue throughout the

major part of this interval. However dark grey and black shales still form thin interbeds within the sandstone sequence. This lithology is equated with the Isachsen Formation.

Toward the base of the interval the sandstone becomes more argillaceous and silty which may indicate the contact and transition of the Isachsen into the Mould Bay Formation.

Micropalaeontology

The top of this interval has been assigned on palynological evidence. However the sudden influx and abundance of agglutinating species including Psamminopelta cf. bowsheri, Miliammina manitobensis and M. awunensis in the 2160' - 2200' ditch cuttings sample indicates the presence of earliest Albian to Aptian strata within the Sverdrup Basin. These species dominate this interval. This assemblage is however known to be diachronous and environmentally controlled. It is characteristic of the Late Albian in northeastern British Columbia (Stelck, 1975). Nevertheless, the assemblage appears to be confined to the earliest Albian and Aptian stages in the Sverdrup Basin.

Palynology

The recovery of palynomorph assemblages from this interval is relatively rich and diverse, particularly the microplankton.

The terrestrial palynomorphs mentioned from the previous interval continue to be evident. In addition to these are the following taxa

which make their first appearance in this interval, Triporoletes radiatus, T. reticulatus, Appendicisporites bilateralis, Pilosisporites trichopapillosus and Rouseisporites reticulatus.

Included in the dinoflagellate assemblage are Lunatadinium dissolutum, Tenua? sp. B, Brideaux,1977 (Aptian - Albian), Tenua spp., Pseudoceratium retusum (Barremian - Aptian), Muderongia asymmetrica, M. tetracantha (Valangian - Aptian), Fromea complicata (Aptian - Middle Albian), Subtilisphaera perlucida (Hauterivian - Aptian), Batioladinium micropodium (Hauterivian - Aptian) and Gonyaulacysta spp.. The overall age indicated by the above assemblages can be interpreted as Barremian to Aptian.

Depositional Environment

The abundant occurrence of the above foraminiferid species below and throughout the interval 2160' - 2400' probably signifies a very shallow marine to brackish water environment as discussed by Chamney (1973) and Stelck (1975).

INTERVAL 2400' - 3400': Early Cretaceous, Neocomian undifferentiated

Lithology and Stratigraphy

The upper part of this interval between 2400' - 2750' comprises interbedded dark grey to black shale and argillaceous sandstones which probably represent the upper part of the Mould Bay Formation.

Between 2750' - 3400' distinct sandstone cycles can be seen on the BSGR logs which probably signify the more sandy facies of this Formation.

Micropalaeontology

The common to abundant occurrence, and highest appearance of Cribrostomoides canui and Haplophragmoides goodenoughensis are indicative of the Neocomian. The latter species was first described from the Barremian of the Mackenzie District by Chamney (1969). However both species are known to range from the late Jurassic and throughout the Neocomian, but not into younger strata.

The unconformably contact between the Isachsen and Mould Bay Formations as illustrated within the Neocomian on Melville Island by Henao-Londoño (1977, fig. 2), could not be determined biostratigraphically. However the change in abundance of palynomorphs at 2500' could mark a facies change and Formational contacts, and therefore a possible non-sequence within the Neocomian.

Palynology

At 2500' a definite change in the palynomorph assemblages is noted. There is an increase in the abundance of bisaccate pollen and conversely a decrease in the frequency and diversity of microplankton species.

Dinoflagellate species which have their highest appearance in the interval include, cf. Sirmiodinium grossi (Kimmeridgian - Early Cretaceous), Oligosphaeridium albertense (Barremian), ?Lanterna saturnalis, (Late Oxfordian - Kimmeridgian), Pareodinia dasyforma (Late Jurassic - Neocomian), P. capillosa (Late Oxfordian - Berriasian) and Endoscrinium sp. cf. luridum. The overall ranges tend to indicate a Late Jurassic to Neocomian age, however it must be noted that in most cases they represent single occurrences.

Depositional Environment

The abundance of agglutinating foraminifera throughout this interval probably signifies a shallow marine environment. This would be expected due to the position of the well on the Basin margin with resulting interfingering and development of non-sequences between Formations.

V

JURASSIC

INTERVAL 3400' - 3500': Late Jurassic, ?Tithonian - Kimmeridgian

Lithology and Stratigraphy

The interval consists of dark, argillaceous, silty sandstone with thin interbeds of shale. Toward the base of the interval a thicker shale horizon occurs. The interval is again equated with the Mould Bay Formation.

Micropalaeontology

A distinct faunal and preservational change occurs within the 3410' - 3500' ditch cutting samples. This contrasts markedly with the Neocomian faunal assemblage above. The foraminifera in this interval are probably of Late Jurassic, ?Tithonian - Kimmeridgian age. It should be noted however that a facies change from argillaceous sandstone to silty shale occurs across this boundary. Nevertheless, the foraminifera are distinct and the Cretaceous - Jurassic boundary is drawn around 3400'. The occurrence of an agglutinating assemblage containing Ammobaculites alaskensis, Haplophragmoides kingakensis/barrowensis and Ammodiscus cf. thomsi is indicative of the Late Jurassic.

Palynology

This interval is poorly represented by palynomorphs. No age

determination can be made on the basis of the material recovered from this interval.

Depositional Environment

As in the overlying interval, the dominance and diversity of agglutinating taxa suggests a shallow marine environment which appears to have existed throughout the Early Cretaceous and Late Jurassic within the western Basin margin.

INTERVAL 3500' - 3890': Middle Jurassic, ?Callovian - Bajocian

Lithology and Stratigraphy

The upper part of this interval consists of fine to medium-grained, argillaceous, silty sandstone probably representing the lower Mould Bay Formation. Toward the base of the interval below 3630', shale predominates with minor interfingerings of sandstone. This lower interval probably equated with a transition to the underlying Wilkie Point and Savik Formations.

Micropalaeontology

The very rare occurrence of Pseudonodosaria brandi, Lenticulina ?audax and Ammobaculites cobbani could indicate the presence of ?Callovian strata at the top of this interval. However the absence of a typical Callovian calcareous foraminiferid assemblage as listed by Souaya (1976), coupled with the complete absence of Oxfordian taxa would suggest that a non-sequence exists between the Late and Middle Jurassic. This interpretation, showing the absence of the Oxfordian

and most of the Callovian on Melville Island, is also illustrated by Henao-Londoño (1977, fig. 2).

The regular and diverse occurrence of an ammodiscid fauna including A. cf. rugosus, A. southeyensis, A. orbis and A. francisi are characteristic of Bathonian to Bajocian strata. The latter two species together with the presence of the ostracod Norcanolella parryi are indicative of the Bathonian (Wall, 1960).

Palynology

Samples from this section yielded poor assemblages dominated by cavings contamination from overlying Cretaceous strata.

The rare occurrence of Acanthaulax sp. 1, Johnson and Hills, 1973 (early Callovian - Oxfordian), and single occurrences of Scriniodinium dictyotum (Bajocian - Kimmeridgian) and Pareodinia sp. cf. ceratophora together support a Bajocian - Callovian age for the strata.

Depositional Environment

The continuing dominance and diversity of agglutinating foraminiferid taxa together with the rare occurrence of calcareous species suggests a shallow marine environment. The very slight increase in the numbers of calcareous species in this interval may indicate the more marine influence of the Savik Formation, although it must be noted that the microfauna is still of marginal marine aspect and not typical of this formation in the central part of the Basin.

INTERVAL 3890' - 4424': Early Jurassic, Toarcian to undifferentiated Liassic

Lithology and Stratigraphy

The interval between 3890' - 4310' consists predominantly of dark grey to black shale and siltstone. It is equated with the Savik and possibly interfingering Wilkie Point Formations. However a distinct sandstone with glauconite horizon occurs at the base of the interval which can clearly be seen on the BSGR logs between 4310' - 4360'. This sandstone probably represents the thinly developed Borden Island Formation.

Micropalaeontology

The highest appearance of ?Pseudobolivina sp. B. Souaya, 1976 in the 3860' - 3900' ditch cuttings sample has been taken to indicate the Toarcian. Its regular occurrence in the Toarcian of the Linckens Island P-46 well has been documented by the above author. This age determination is corroborated by the rare occurrence of Reophax homoagglutinans which is again indicative of Toarcian or older strata. All other taxa recorded were rare and of long-ranging Early to Middle Jurassic aspect.

The restricted occurrence of very rare Rhaetian species over the interval 4160' - 4250' could represent reworking near or within the Sinemurian Borden Island Formation, as suggested by Henao-Londoño (1977).

Palynology

The appearance of large numbers of Nannoceratopsis senex together with smaller numbers of N. gracilis and a poor specimen of Mancodinium semitabulatum in the 3900' - 3990' sample confirms the presence of Toarcian strata. Other forms present include Uvaesporites argentaeformis, Duplexisporites problematicus, Micrhystridium lymensis, M. semitabulatum, Maturodinium inornatum, significant numbers of indeterminate, primitive dinoflagellate cysts and abundant clumps of Spheripollenites spp.. The presence of Limbosporites lundbladii, a dominantly Rhaetian form, in the 4100' - 4190' sample is attributed to reworking and more or less coincides with a similarly reworked, micropalaeontological assemblage.

Cavings contamination is quite abundant throughout this interval and because of the sandy lithologies, the in situ microflora is relatively poor and a biostratigraphic subdivision of the Liassic is not possible.

Depositional Environment

The problem of caving within the Savik Formation makes the recognition of in situ species difficult.

The very rare occurrence of foraminifera does not permit an environmental interpretation based on the microfauna. However, the presence of abundant dinoflagellate cysts in the upper part of the interval together with acritarchs in the lower part indicates a marine environment for much of this unit.

VI

TRIASSIC

INTERVAL 4424' - 4550': Late Triassic, Rhaetian

Lithology and Stratigraphy

The interval is dominated by black shale which is equated with the Upper Blaa Mountain Formation. The distinct contact between the shales of this Formation and the overlying Borden Island sandstone can be seen clearly on the BSGR logs.

Micropalaeontology

This interval contained no age diagnostic microfauna.

Palynology

The presence in the 4400' - 4490' sample of Ricciisporites tuberculatus, Semiretisporis gothae, Limbosporites lundbladii, Brachysaccus sp., Ovalipollis sp. and Minutosaccus sp. indicates the presence of Rhaetian strata. There is very little evidence of cavings contamination from the overlying Jurassic strata.

For a discussion on the Rhaeto-Liassic boundary, please refer to the stratigraphic conclusions.

Depositional Environment

There is no evidence from the admittedly poor palynological assemblage for a marine environment of deposition.

INTERVAL 4550' - 4650': Late Triassic, Norian

Lithology and Stratigraphy

The interval is a lithological continuation of that above and again represents the shales of the Upper Blaa Mountain Formation. A sandstone horizon occurs at the base of this interval between 4600' - 4670' and extends into the uppermost part of the underlying interval. This horizon is possibly the interfingering "Pollux Sand" as described by Henao-Londoño (1977).

Micropalaeontology

The interval 4610' - 4650' contained single occurrences of Astacolus connudatus and Lingulina cf. borealis. The former species is of Norian to early Rhaetian age according to Souaya (1976), while the latter is of Late Triassic age (Tappan, 1951). In addition the regular appearance of the ostracoda Healdia sp. 1 and Hungarella sp. 24 also range into the Norian as defined by Sherrington (1977).

Palynology

The 4500' - 4590' sample yielded small numbers of the Sverdrupiella group of dinoflagellate cysts including S. usitata, S. spinosa and S. cf. septentrionalis. The spore-pollen assemblage is also relatively poor. Important forms to appear include Triadispora obscura, Platysaccus cf. queenslandi and Ovalipollis cf. ovalis. Riccisporites tuberculatus is also present in large numbers and is probably caved from the Rhaetian interval. Reworked Devonian spores are present.

The Rhaeto-Norian boundary is placed for convenience at the midpoint between samples.

Depositional Environment

The low ostracod and foraminiferid species diversity suggests a restricted marine environment which is to some extent born out by the poor dinoflagellate assemblage recovered from this interval.

INTERVAL 4650' - 4750': Late Triassic, Karnian

Lithology and Stratigraphy

The occurrence of dark shales between 4670' - 4720' are again equated with the Upper Blaa Mountain Formation. However toward the base of the interval a limestone horizon occurs which extends into the underlying interval and is equated with the Schei Point Formation.

Micropalaeontology

The regular and common occurrence of the ostracoda Healdia sp. 1 and Hungarella sp. 24 are indicative of the Late Karnian to Norian (Sherrington, 1977). The boundary of this stage has been defined on palynology.

Palynology

The presence of cf. Camerosporites sp., Dictyotidium sp. and Heibergella sp. in the 4600' - 4690' sample indicates the presence of Karnian strata. The sample yielded a poor assemblage including caved Rhaetian forms. Reworked Devonian spores are again a prominent

feature. The Norian - Karnian boundary is placed for convenience at the midpoint between samples.

Depositional Environment

The presence of Dictyotidium sp. and Heibergella sp. suggests a marine environment. However, the samples also yielded large amounts of sapropelised debris containing inertinite which suggests that sediments in this interval were deposited in a restricted, shallow marine to brackish water environment. The micropalaeontology tends to agree with this.

INTERVAL 4750' - 4850': Middle Triassic, Ladinian

Lithology and Stratigraphy

The interval consists of limestone underlain by siltstone, and is equated with the Schei Point Formation.

Micropalaeontology

The interval contained no age diagnostic microfauna. The extremely scarce microfauna recorded is in marked contrast to the overlying interval.

Palynology

The appearance in the 4700' - 4790' sample of Rimaesporites cf. aquilonalis, Fossapollenites sp., Triadispora cf. crassa and abundant specimens of Dictyotidium sp. indicates the presence of Middle Triassic strata. The presence in abundance of Dictyotidium sp. is often a

feature of Ladinian strata elsewhere in the Sverdrup Basin.

The Ladinian - Karnian boundary is placed for convenience at the midpoint between samples.

Depositional Environment

The palynological residues suggest a similar environment to the overlying Karnian strata.

INTERVAL 4850' - 5500': Middle Triassic, Anisian

Lithology and Stratigraphy

The uppermost part of this interval consists of alternating beds of limestone and siltstone together with minor, subrounded to angular sandstone horizons. It is again equated with the Schei Point Formation.

Between 4900' - 5020' beds of siltstone with glauconite occur. This glauconitic horizon often characterises the base of the Schei Point Formation and its contact with the underlying Bjorne Formation (Henao-Londoño, 1977).

White, fine subangular to subrounded sandstone and thin, minor grey-grey shales occur between 5200' - 5500'. This sequence is equated with the Bjorne Formation, although its typical brick-red to brown colouration is not developed in this section.

Micropalaeontology

This interval contained only rare, non age-diagnostic foraminifera. Ostracoda of Triassic aspect occur in the topmost sample between

4860' - 4900'. However the abundant occurrence of the charophytes ?Aclistochara sp. 1 and ?Stellatochara sp. 1 over the interval 4960' - 5200' are characteristic of Scythian to Anisian strata in the Sabine Peninsula. These algae although environmentally controlled have been regularly found at this level in several wells in this area. In addition the single occurrence of the ostracod Judahella sp. in the 5110' - 5150' ditch cuttings sample is also characteristic of the Anisian (Sherrington, 1977).

Palynology

Samples between 4900' and 5500' yielded rich, Middle Triassic assemblages showing strong Anisian affinities. The top of the Anisian is defined here by the first appearance of Striatoabieites aytugii, a species which frequently dominates Anisian assemblages in other wells in the Sverdrup Basin.

Important species to appear include Ovalipollis ovalis, O. minimus, O. breviformis, O. cf. breviformis, Infernopollenites sulcatus, I. sp., Triadispora vilis, T. crassa, Granosaccus ornatus, Parcisporites sp., Klausipollenites sp., Aratrisporites sp., cf. Guthoerlisporites sp., Minutosaccus cf. acutus, Striatoabieites balmei, Falcisporites stabilis and Nevesisporites spp.

A Scythian influence is indicated by the presence of a few specimens of Protohaploxypinus and Taeniaesporites and the presence of a specimen of Lueckisporites singhii indicates the presence of reworked Permian sediments.

Depositional Environment

The abundance of charophytes between 4960' - 5200' is indicative of a fresh to brackish water environment. Their disappearance below this depth probably indicates true continental conditions of the Bjorne Formation. The palynological residues also suggest a shallow water, restricted marine or brackish environment in the upper part of this interval. Below this, there is a gradual transition to the typically non-marine palynofloras typical of the Bjorne Formation. The transition is probably prolonged by caving.

INTERVAL 5500' - 9808': Early Triassic

(5550' - 7850': Spathian - Smithian)

(7850' - 9808': Dienerian - Griesbachian)

Lithology and Stratigraphy

The interval 5500' - 8640' consists predominantly of white to buff, subangular to subrounded sandstone with irregularly interbedded medium grey, green and rusty brown shale characteristic of the continental Bjorne Formation.

Below 8640' these shale beds increase in thickness and become regularly interbedded with sandstone. Siltstones also occur and the Basin margin facies of the Bjorne probably interfingers with the more basinal facies of the Blind Fiord Formation toward the base of the interval (Stuart Smith & Wennekers, 1977).

Micropalaeontology

The interval down to 6950' contained only an extremely rare

microfauna which was non-age diagnostic. However between 6960' - 7100' the reappearance of the charophytes ?Aclistochara sp. 1 and ?Stellatochara sp. 1 again indicate the presence of Scythian strata. Rare foraminifera including a single specimen of the Triassic species Nodosaria shublikensis/mitis was also recorded.

Below 7100' only rare charophytes were found which probably represent caving from immediately above.

Palynology

Samples from this interval frequently yielded rich assemblages of palynomorphs dominated by striate, bisaccate pollen. The upper boundary is placed at the top of the regular appearance, in abundance, of the Taeniaesporites and Protohaploxypinus groups. Around this point, Anisian species diminished in abundance and their presence below here is almost certainly the result of cavings contamination.

Important species to appear include Taeniaesporites hexagonalis, T. noviaulensis, Protohaploxypinus samoilovichii and P. jacobii. Other important taxa to appear in subsequent samples include Densoisporites complicatus, D. playfordii, D. lockerensis, Lundbladispora brevicula, L. cf. denmeadi, Cyclogranisporites arenosus, Aratrisporites strigosus, A. paenulatus, A. tenuispinosus, Nevesisporites limatulus, Aculeisporites variabilis, Cycadopites follicularis, C. magnus, Polypodiisporites mutabilis, Equisetosporites steevesii, E. scottii, E. multistriatus, Proprisporites pocockii, Platysaccus papilionis, Klausipollenites staplinii,

K. decipiens, T. pellucidus, T. transversundatus, T. albertae, T. novimundi, T. gracilis, Crustaesporites globosus, Equisetosporites steevesii, E. scottii and E. multistriatus.

Although the microfloras are frequently very rich and varied, there is little present that is of use in subdividing the Scythian. Elsewhere in the Sverdrup Basin the appearance of Striatoabieites richterii has been used in defining the Dienerian - Griesbachian. It first appears in the 7800' - 7890' sample and the Smithian - Dienerian boundary is tentatively drawn at this point.

Reworked Devonian spores occur sporadically throughout the Skythian but become extremely abundant towards the base of the interval. Reworked Carboniferous forms are rare and there are a few reworked Permian forms present, especially just above the Permian.

Depositional Environment

The occurrence of charophytes and rare foraminifera over the interval 6960' - 7100' possibly represents a brackish water environment that was probably short lived in an otherwise truly continental environment.

Throughout this unit, acritarchs appear sporadically and most are probably caved. They appear more frequently in the lowermost 400' of the Bjorne Formation and, if in situ, indicate a marine influence on the sedimentation. From 8100' - 8190' to 9700' - 9790', large leiospheres are present, occasionally in significant numbers. They are tentatively interpreted as being indicative of brackish to freshwater environment.

VII

PERMIAN

INTERVAL 9808' - 10,350': Late Permian (undifferentiated)

Lithology and Stratigraphy

The interval between 9808' - 10,050' consists of light to dark grey shale with thin irregularly occurring bioclasts containing brachiopod and echinoid fragments. The distinct colour contrast between the above and the grey-green to rusty brown shales and siltstones of the Blind Fiord, together with the BSGR log evidence at 9808', suggests a contact at this level between the Blind Fiord and the underlying Trold Fiord Formation. This break probably represents the major Melvillian disturbance whereby the latest Permian is missing, as illustrated by Stuart Smith & Wennekers (1977).

Below 10,050' the grey shale gives way to grey siltstone.

Micropalaeontology

The very rare and highest appearance of brachiopod spines between 9910' - 10,050' are taken as indicative of the Permian. Normally brachiopod spines are found in abundance at the Permian - Triassic contact. However in this well only very rare specimens were recovered, although the lithological description notes brachiopod remains throughout this interval.

Palynology

The appearance of Striatobicites multistriatus with Striatopodocarpites cancellatus in the 9800' - 9890' sample is used to mark the top of the Permian. In subsequent samples other Permian markers appear including Weylandites striatus, W. spp., Vittatina cf. minima, Protohaploxypinus cf. amplus and Lueckisporites spp..

Cavings contamination from the overlying Early Triassic is a prominent feature of all samples in this interval. The Permian acritarch, Micrhystridium piveteauii appears here and is abundant towards the base of the unit.

Reworked Devonian forms are abundant and reworked Carboniferous spores are also a noticeable feature.

Depositional Environment

Although a significant microfauna is absent over this interval, the presence of brachiopod and echinoid remains throughout the interval suggests a marine environment which is confirmed by the presence of acritarchs in the palynological residues.

INTERVAL 10,350' - 13,050': Early Permian, Kungurian - Artinskian (Leonardian)

Lithology and Stratigraphy

The uppermost part of this interval comprises light to dark grey shale. Beneath this, between 10,410' - 10,670', siltstone and minor limestone containing brachiopod and bryozoan remains are interbedded.

This unit is inturn underlain between 10,670' - 10,770' by a siltstone and sandstone horizon which may represent the interfingering Artinskian Sabine Bay or Assistance Formations as described by Nassichuk and Wilde (1977) on Melville Island.

The underlying interval consists of light grey-brown, sandy siltstone with thin glauconitic shales and limestones which persist to 11,130'. These give way to a thin limestone - chert horizion between 11,130' - 11,160' which is intruded by basic igneous rock between 11,160' - 11,330'.

The interval between 11,330' - 12,100' consists of a thick chert sequence which is underlain by grey shale extending to the base of the interval.

The entire interval is equated with the undifferentiated Hare Fiord and Van Hauen Formations.

Micropalaeontology

The interval 10,360' - 12,100' is barren of in situ microfauna. Only very rare, probably caved charophytes occur. However from 12,110' to the base of the interval, the highest occurrence of Nodosinella sp., Thurammina cf. texana, Hyperamminella cf. elegans and Hyperammina spinescens occur. These species are of Late Pennsylvanian to Early Permian age, as figured by Cushman & Waters (1928). Nevertheless, from other wells studied within the Sverdrup Basin the highest occurrence of these foraminifera often occurs within the Artinskian stage.

The stratigraphic break between the Early and Late Permian, namely the Van Hauen and Trold Fiord Formation, as illustrated by Stuart Smith & Wennekers (1977) could not be recognised on microfaunal evidence.

Palynology

The appearance together in the 10,300' - 10,390' sample of Weylandites cincinnatus and Decussatisporites sp. A is used to indicate the presence of Kungurian strata. These taxa were useful in defining this boundary in Robert Harbour K-07 (Dolby & Price, 1977). Other important forms to appear include Lophotriletes aff. tereteangulatus, Nevesisporites fossulatus, Vittatina saccata, V. cf. subsaccata, V. aff. saccata and Protohaploxypinus aff. diagonalis. The first three of the above species also made their first appearance in the Kungurian of Robert Harbour K-07. Acritarchs are present in most of the samples in the upper part of the interval.

The preservation of the palynomorphs deteriorates rapidly below 10,800' and this is probably due to the presence of an igneous intrusion between 11,160' and 11,330' because below this, towards the base of the unit, the assemblages improve somwhat, although their state of preservation is still poor. In the 12,000' - 12,090' sample, Striomonosaccites sp. appears. This species characterises the early Artinskian and Sakmarian of Robert Harbour K-07.

Because of the poor preservation, it is not possible to subdivide this interval.

Depositional Environment

The interval 10,350' - 11,160' is probably of shallow marine origin as scattered brachiopod and bryozoan remains together with acritarchs occur throughout. However, the presence of an underlying basic, igneous intrusion and a thick chert sequence down to 12,100' does not enable an environmental interpretation to be made over this interval. The presence of abundant foraminifera between 12,110' and the base of this interval signifies a marine environment.

INTERVAL 13,050' - 16,523' T.D.: Early Permian, Sakmarian; (late Wolfcampian)

Lithology and Stratigraphy

The shale from the basal part of the overlying interval continues down and dominates this interval to a depth of 15,110'. Thin limestone and sandstone horizons however occur between 14,550' - 14,630' and 14,670' - 14,700' respectively. The remainder of the interval from 14,700' to T.D. comprises beds of limestone of varying thicknesses interbedded with shale.

The entire interval is again equated with the undifferentiated Hare Fiord and Van Hauen Formation. However the limestone horizons which contain common bryozoan remains and vary in texture from biosparite to biomicrite, may represent interfingering of the Belcher Channel/ Tanquary limestone (≡ Upper Nansen limestone) into these shale Formations.

Micropalaeontology

The continued abundance of T. cf. texana, H. cf. elegans and

H. spinescens together with abundant ammodiscids between 13,050' - 15,300' again indicates probable Early Permian strata. Also the associated rare occurrence of metacopid ostracoda is often indicative of the Sakmarian in the Sverdrup Basin. The abundance of the foraminiferid species decreases at limestone horizons.

Thin section examination of cored material, in particular cores 3 and 4 over the intervals 15,046' - 15,100' and 16,470' - 16,519' revealed abundant bryozoan and other skeletal remains within the limestones. Fusulinids were however absent in all thin section with the exception of the interval 16,517' - 16,519' which yielded one excellent axial section of Schwagerina whartoni. This species according to Nassichuk and Wilde (1977) is characteristic of the late Asselian to early Sakmarian of the Belcher Channel Formation on southwestern Ellesmere Island.

Palynology

The appearance of Diatomozonotriletes aff. townrowii in the 13,000' - 13,090' sample is used to mark the top of the Sakmarian. Similar forms commonly occur in the Sakmarian elsewhere. The rest of the assemblage recovered from samples around this point is of Sakmarian - early Artinskian affinity and important forms to appear include Microbaculispora tentula, M. cf. pseudoreticulata, Vittatina sp. L (Jansonius 1962) and Florinites sp..

In the 13,200' - 13,290' sample, indeterminate monosaccate pollen grains are present together with aff. Potonieisporites sp. followed

in subsequent samples by Cycadopites cymbatus and a relatively well preserved specimen of Diatomozonotriletes cf. townrowii. This assemblage has a late Sakmarian aspect.

Monosaccates become more abundant below 13,900' and other species to appear include a questionable specimen of Complexisporites polymorphus, Neoraistrickia ramosa, cf. Potonieisporites sp., Vittatins sp. A (also present in the early Artinskian and Sakmarian of Robert Harbour K-07, Dolby & Price, 1977), Cordaitina crenulata, C. sp. and Lophotriletes cf. micronodosus. Acritarchs are present in small numbers in the upper part of this interval.

The preservation of the palynomorphs is generally poor and assemblages are generally rich in indeterminate spore and pollen grains. At T.D. (16,523') there is no evidence of anything older than Sakemarien/Asselian (Wolfcampian).

Depositional Environment

The limestones with bryozoan and skeletal remains are probably indicative of a near shore possibly reefal environment. However their interfingering with thicker shale sequences probably indicates periods of marine transgression and regression in an essentially near shore environment.

VIII

STRATIGRAPHICAL REMARKS

The Chads Creek B-64 well reached a total depth of 16,523' and terminated in a light grey, slightly argillaceous limestone which is tentatively equated with the Belcher Channel/Tanquary (= Upper Nansen) Formation of Early Permian, Sakmarian age. This Formation is developed between 16,523' - 14,550' as shallow marine limestone horizons interbedded with the more dominant, medium to dark grey shale facies of the undifferentiated Hare Fiord and Van Hauen Formation. The questionable unconformity between these formations as suggested by Stuart Smith & Wennekers (1977) could not be determined biostratigraphically. They extend from T.D. to 10,290' and are also of shallow marine origin throughout. The sediments are intruded by a basic igneous sill between 11,160' - 11,330'. The interval 16,519' - 16,517' contained a single specimen of the fusulinid Schwagerina whartoni which according to Nassichuk & Wilde (1977) characterises the late Asselian to early Sakmarian. This foraminifer therefore enabled an age determination near T.D..

The Sakmarian (late Wolfcampian) extends from from T.D. to 13,050' and is characterised in part by the foraminifera Thurammina cf. texana and Hyperamminella cf. elegans and rare metacopid ostracods, together with monosaccate pollen grains. The Sakmarian/Artinskian - Kungurian (Leonardian) boundary occurs at 13,050' and is defined on palynology.

The latter stratigraphical stages extend between 13,050' - 10,350' and are characterised again in part by the above foraminiferid taxa, together with the palynomorphs Decussatisporites sp. A and Weylandites cinncinnatus. These palynomorphs occurred in a similar position in Robert Harbour K-07 (Dolby & Price, 1977). The top of this interval more or less coincides with the uppermost beds of the Van Hauen Formation. A sandstone and siltstone horizon is developed between 10,910' - 10,670' which is very tentatively assigned to interfingering beds of the ?Sabine Bay/Assistance Formations within the Van Hauen Formation. The occurrence of these Formations at Sabine Peninsula has been recorded by Nassichuk & Wilde (1977).

The interval 10,350' - 9808' has been assigned an undifferentiated Late Permian age, and is characterised by the palynomorph Weylandites spp. and Striatoabieites multistriatus. It is coincident with the Trold Fiord Formation which is of probable shallow to marginal marine origin as indicated by the presence of brachiopod, echinoid and bryozoan remains.

A distinct colour change occurs at 9808' from light to dark grey shales and siltstones of the Trold Fiord Formation into the overlying rust-brown silty shales and sandstones of the interfingering Blind Fiord and Bjorne Formations. This contact is supported by log evidence which shows a break at this level probably representing the major Melvillian disturbance which removed the latest Permian.

The interfingering sequence of Blind Fiord silty shales and Bjorne sandstones extends from 9808' to approximately 8640' and was probably deposited in part in a marginal marine environment. The former is

thought to be of basinal facies while the latter is developed at the basin margins (Stuart Smith & Wennekers, 1977). The increasing and more characteristic sandstone content within the Bjorne Formation extends between 8640' - 5020'. This interval is predominantly of continental origin with a fresh to brackish water environment between 7100' - 6960' as shown by the common occurrence of charophytes.

The Early Triassic (Scythian) has been tentatively subdivided on palynological evidence into the Griesbachian - Dienerian (9808' - 7850') and Smithian - Spathian (7850' - 5550') stages. These intervals are characterised by the palynomorphs Striatoabieites richterii, and Taeniaesporites spp. with Protohaploxypinus spp. respectively.

The succeeding interval 5550' - 4850' is of Anisian age and contains the uppermost Bjorne and lower Schei Point Formation. Their mutual contact occurs at 5020'. The stage is characterised by the palynomorph Striatoabieites aytugii and the abundant charophytes ?Aclistochara sp. 1 and ?Stellatochara sp. 1. The latter occur consistently at this level in the Sabine Peninsula. The base of the interval, namely the upper Bjorne Formation, is of continental to brackish water origin while the top of the interval contains acritarchs and rare foraminifera which indicate a marine environment of deposition for the Schei Point. The glauconitic horizon at the base of the latter is a characteristic feature of its development, as discussed by Henao-Londoño (1977).

The overlying interval, 4850' - 4750', is of Ladinian age and contains the acritarch Dictyotidium sp.. It is probably of shallow marine origin typical of the Schei Point limestone.

The Karnian stage between 4750' - 4650' is characterised by the ostracoda Healdia sp. 1 and Hungarella sp. 24 together with the palynomorph Camerosporites sp.. The interval is almost coincident with the base of the Upper Blaa Mountain shale Formation which is probably of shallow marine origin throughout. The distinct contact between the Schei Point limestones and the overlying Upper Blaa Mountain shales can be seen clearly on the electric logs around 4700'.

The Karnian is in turn succeeded by the Norian between 4650' - 4550' and contains specimens of the dinoflagellate cyst group Sverdrupiella, the above ostracoda and the foraminifer Astacolus connudatus. An interbedded sandstone horizon within the Upper Blaa Mountain occurs between 4670' - 4600' which possibly represents the "Pollux Sand", as described by Henao-Londoño (1977).

The Rhaetian, which extends from 4550' to 4424', contains the palynomorph Ricciisporites tuberculatus. The top of the stage is coincident with the topmost Upper Blaa Mountain Formation.

The succeeding interval between 4424' - 3890' is of Liassic - Toarcian age and is characterised in part by the palynomorph Nannoceratopsis gracilis. The junction of the Borden Island and Upper Blaa Mountain Formations is clearly visible on the electrical logs at 4424'. The presence of glauconitic sandstone at this contact is also a feature of basal Borden Island (Henao - Londoño, 1977). The Formation is succeeded by dark shale and siltstone of the Savik and Wilkie Point Formations which extend between 4310' - 3630' and into the succeeding stratigraphic interval. The entire interval is of probable marginal to shallow marine origin.

There is often a zone containing abundant, reworked Rhaetian palynomorphs and microfossils at the base of the Jurassic in the Borden Island Formation (Henao-Londoño, 1977). This can lead to difficulties in determining the position of the Rhaeto-Liassic boundary. In this well, the zone of reworking is at the top of the Borden Island Formation and the "reappearance" of Rhaetian forms coinciding with the penetration of the Upper Blaa Mountain Formation is therefore chosen with some confidence as the top of the Triassic.

The interval 3890' - 3500' is of Bajocian - ?Callovian age and has a distinct ammodiscid assemblage with A. orbis and A. francisi. It contains the Savik/Wilkie Point Formations and overlying lower Mould Bay Formation. The latter extends from around 3630' - 2314'. The fauna suggests a shallow marine environment for the interval.

Between 3500' - 3400', Late Jurassic (Kimmeridgian - ?Tithonian) shales and succeeding sandstone of the Mould Bay Formation probably rest with unconformity on the underlying Savik/Wilkie Point as the ?Callovian and Oxfordian stages are absent. This unconformable contact is also illustrated by Henao-Londoño (1977, fig. 2) on Melville Island. The interval is characterised by the foraminifer Haplophragmoides kingakensis/barrowensis and is of probable shallow marine origin.

The Jurassic/Cretaceous boundary is placed at 3400' and is marked by a distinct change in foraminiferid species and their preservation. The interval 3400' - 2400' is of undifferentiated Neocomian age and contains Haplophragmoides goodenoughensis and Cribrostomoides canui. A change in palynomorph abundance at 2500' may indicate a non-sequence within the Neocomian and possibly the unconformable contact between

the Mould Bay and overlying Isachsen Formations. The absence of Late Neocomian strata has again been suggested by Henao-Londoño (1977, fig. 2) on Melville Island. The interval is of shallow marine origin.

The interval 2400' - 2090' has been equated with the Isachsen sandstone Formation of Aptian age. The abundant occurrence of the foraminifera Miliammina manitobensis and Psamminopelta cf. bowsheri signify a shallow marine to brackish water environment as discussed by Chamney (1973) and Stelck (1975). Between 2090' - 1180' the sandy facies of the Isachsen interfingers with shale of the Christopher Formation.

The interval 2090' - 80' is of Albian age and contains abundant marine palynomorphs and calcareous foraminiferids including Quadrimorphina ruckerae and Valvulineria loetterlei of shallow marine origin. The upper part of this interval between 1180' - 80' is of typical Christopher shale facies.

IX

REFERENCES

BRIDEAUX, W. W. (1977): Taxonomy of Upper Jurassic - Lower Cretaceous microplankton from the Richardson Mountains, District of Mackenzie, Canada. Geol. Surv. Can., Bull. 281.

CHAMNEY, T. P. (1969): Barremian textulariina, Foraminiferida from Lower Cretaceous beds, Mount Goodenough section, Aklavik Range, District of Mackenzie. Geol. Surv. Can., Bull. 185.

_____ (1973): Micropalaeontological correlelation of the Canadian boreal Lower Cretaceous. In The Boreal Lower Cretaceous (Ed. Casey, R. & Rawson, P.F.), Seel House Press.

_____ (1976): Foraminiferal morphogroup symbol for palaoenvironmental interpretation of drill cutting samples: Arctic America. In, First International Symposium on Benthonic Foraminifera of Continental Margins. (Ed. Schafer, C.T. & Pelletier, B.R.), Maritime Sediments Spec. Pub. 1, Pt. B, Paleoecology and Biostratigraphy, pp. 585-624.

CUSHMAN, J. A. & WATERS, J. A. (1928): Some foraminifera from the Pennsylvanian and Permian of Texas. Contr. Cush. Lab. For. Res. vol. 4(2).

DOLBY, G., & PRICE, R. J. (1977): The micropaleontology, palynology and stratigraphy of the Panarctic Tenn. Robert Harbour K-07 well. Robertson Research (N.A.) Ltd., Exploration Report No. 167.

HENAO-LONDOÑO, D. (1977): Correlation of producing formations in the Sverdrup Basin. Bull. Can. Pet. Geol. 25(5).

JANSONIUS, J. (1962): Palynology of Permian and Triassic sediments, Peace River Area, Western Canada. Palaeontographica B, v. 110.

JOHNSON, C. D. & HILLS, L. V. (1973): Microplankton zones of the Savik Formation (Jurassic), Axel Heiberg and Ellesmere Islands, District of Franklin. Bull. Can. Pet. Geol. 21(2).

NASSICHUK, W. W. & WILDE, G. L. (1977): Permian fusulinaceans and stratigraphy at Blind Fiord, southwestern Ellesmere Island. Geol. Surv. Can., Bull. 268.

SHERRINGTON, P. F. (1977): The use of ostracoda in biostratigraphical correlation in Arctic Canada. Bull. Can. Pet Geol., 25(6) - Abstract only.

SOUAYA, F. J. (1976): Foraminifera of Sun-Gulf-Global Linckens Island P-46, Arctic Archipelago, Canada. Micropaleontology 22(3).

STELCK, C. R. (1975): The Upper Albian Miliammina manitobensis Zone in northeastern British Columbia. In, The Cretaceous System in the Western Interior of North America (Ed. Caldwell, W.G.E.); Geol. Assoc. Can., Spec. Paper No. 13.

STUART SMITH, J. H. & WENNEKERS, J. H. N. (1977): Geology and Hydrocarbon discoveries of Canadian Arctic Islands. Am. Assoc. Pet. Geol., Bull. 61(1).

TAPPAN, H. (1951): Foraminifera from the Arctic Slope of Alaska. Part 1: Triassic Foraminifera. U.S. Geol. Surv., Prof. Pap. 236-A.

WALL, J. H. (1960): Jurassic microfaunas from Saskatchewan. Dept. Min. Res. Sask., Rpt. No. 53.

CHADS CREEK B-94

PLATES 1 - 6

All magnifications are X500 unless otherwise stated

PLATE 1

		Depth
1.	*Trilobosporites apiverrucatus*	1110' - 1190'
2.	*Pterodinium aliferum*	400' - 490'
3.	*Leptodinium cancellatum* (phase)	1000' - 1090'
4.	*Lunatadinium dissolutum* (phase)	2000' - 2090'
5.	*Subtilisphaera perlucida*	2100' - 2190'
6.	*Triporoletes reticulatus*	2200' - 2290'
7.	*Fromea complicata*	2100' - 2190'
8.	*Muderongia asymmetrica* (phase)	2200' - 2290'
9.	*Batioladinium micropodum*	2100' - 2190'
10.	*Pseudoceratium cf. retusum*	2200' - 2290'
11.	*Osmundacidites wellmanii*	1300' - 1390'
12.	*Cicatricosisporites australiensis*	2000' - 2090'

PLATE 1

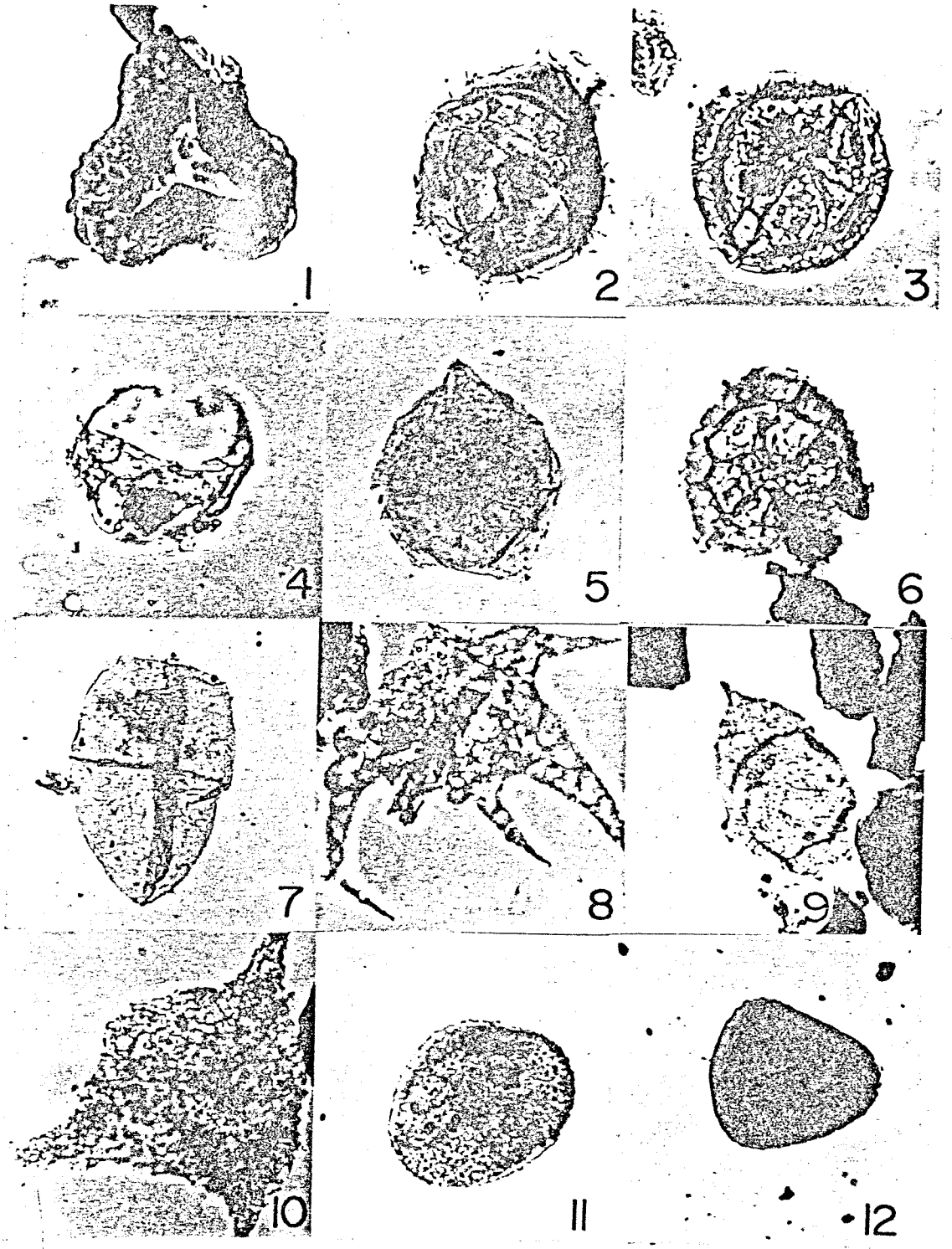

PLATE 2

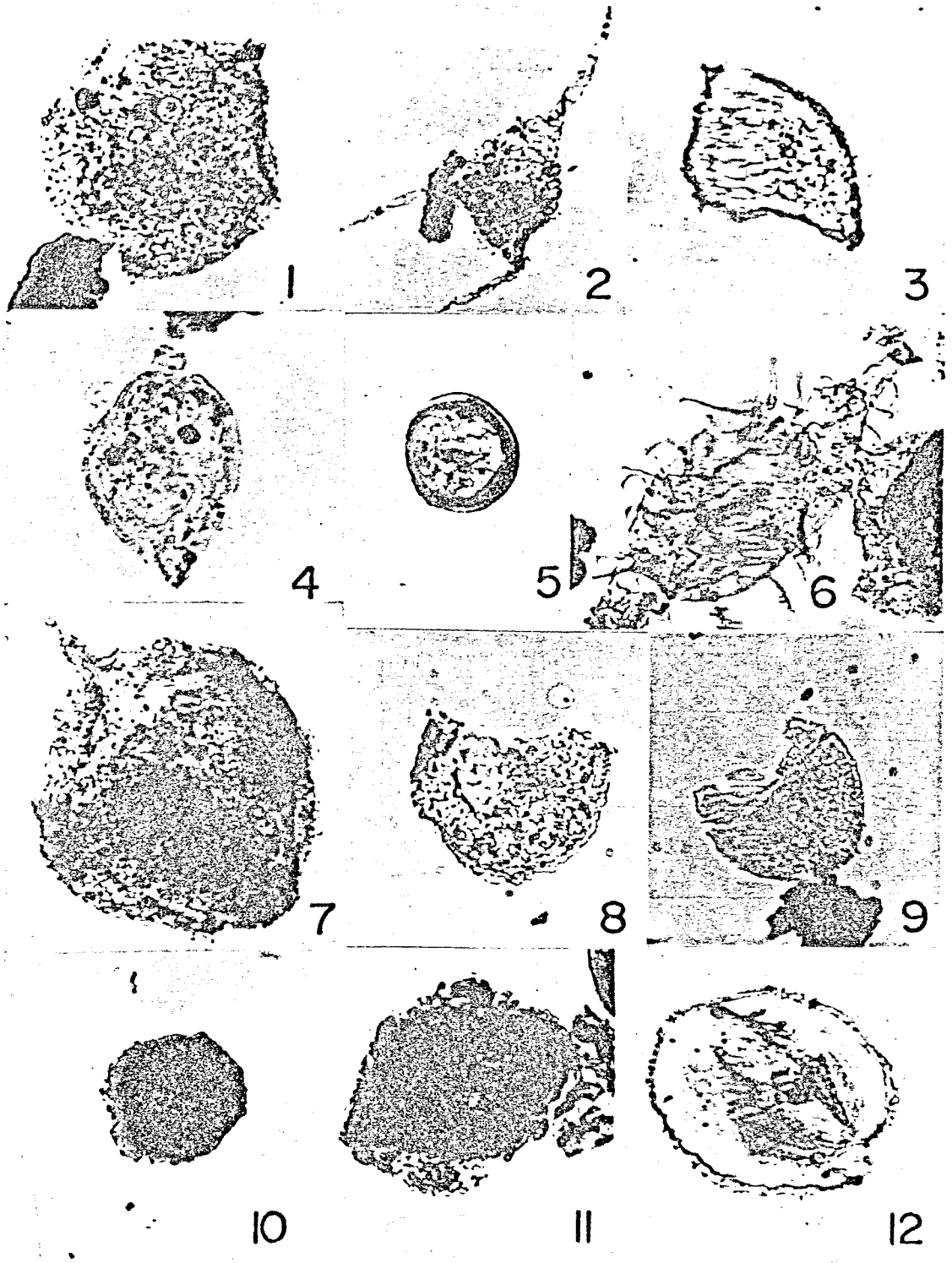

PLATE 3

		Depth
1.	*Duplexisporites problematicus*	4500' - 4590'
2.	*Platysaccus queenslandi*	4610' - 4690'
3.	*Ovalipollis breviformis*	4900' - 4990'
4.	*Ovalipollis minimus*	4900' - 4990'
5.	*Dictyotidium sp.*	4900' - 4990'
6.	*Infernopollenites cf. sulcatus*	5000' - 5090'
7.	*Triadispora crassa*	5200' - 5290'
8.	*Taeniaesporites noviaulensis*	5500' - 5590'
9.	*Taeniaesporites hexagonalis*	5500' - 5590'
10.	*Guttulapollenites sp.*	5600' - 5690'
11.	*Densoisporites complicatus*	5600' - 5690'
12.	*Taeniaesporites novimundi*	5600' - 5690'

PLATE 3

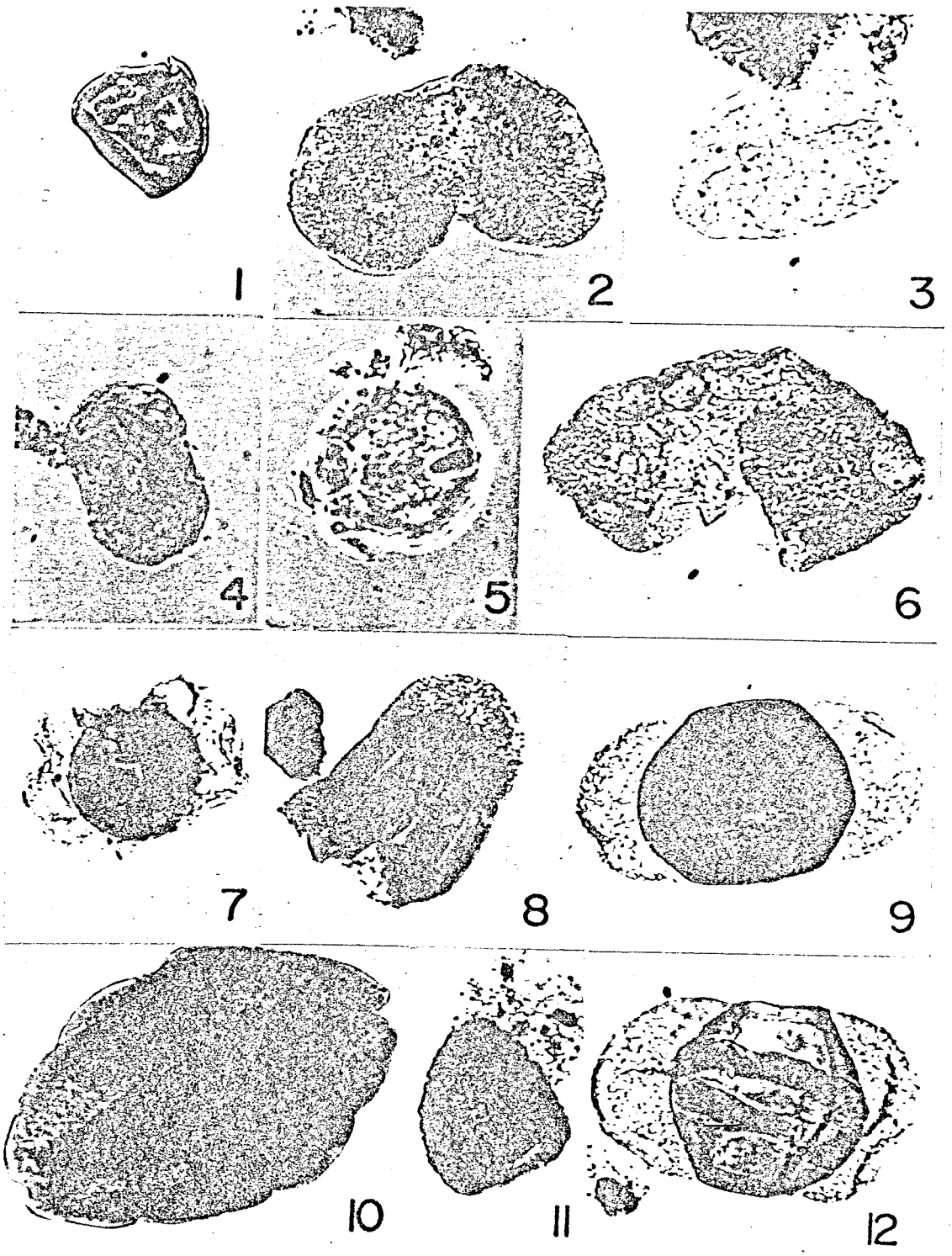

PLATE 4

		Depth
1.	*Aratrisporites strigosus*	5700' - 5790'
2.	*Densoisporites playfordii*	5700' - 5790'
3.	*Nevesisporites limatulus*	5800' - 5890'
4.	*Taeniaesporites gracilis*	5700' - 5790'
5.	*Cycadopites cf. follicularis*	6000' - 6090'
6.	*Striatoabieites aytugii*	6200' - 6290'
7.	*Equisetosporites steevesii*	9000' - 9090'
8.	*Equisetosporites scottii*	9200' - 9290'
9.	*Aculeisporites variabilis*	9200' - 9290'
10.	*Fungal body* (X250)	9600' - 9690'
11.	*Striatoabieites richterii* (Core 1) (X250)	9728' - 9732'
12.	*Fungal body* (Core 1) (X250)	9728' - 9732'

PLATE 4

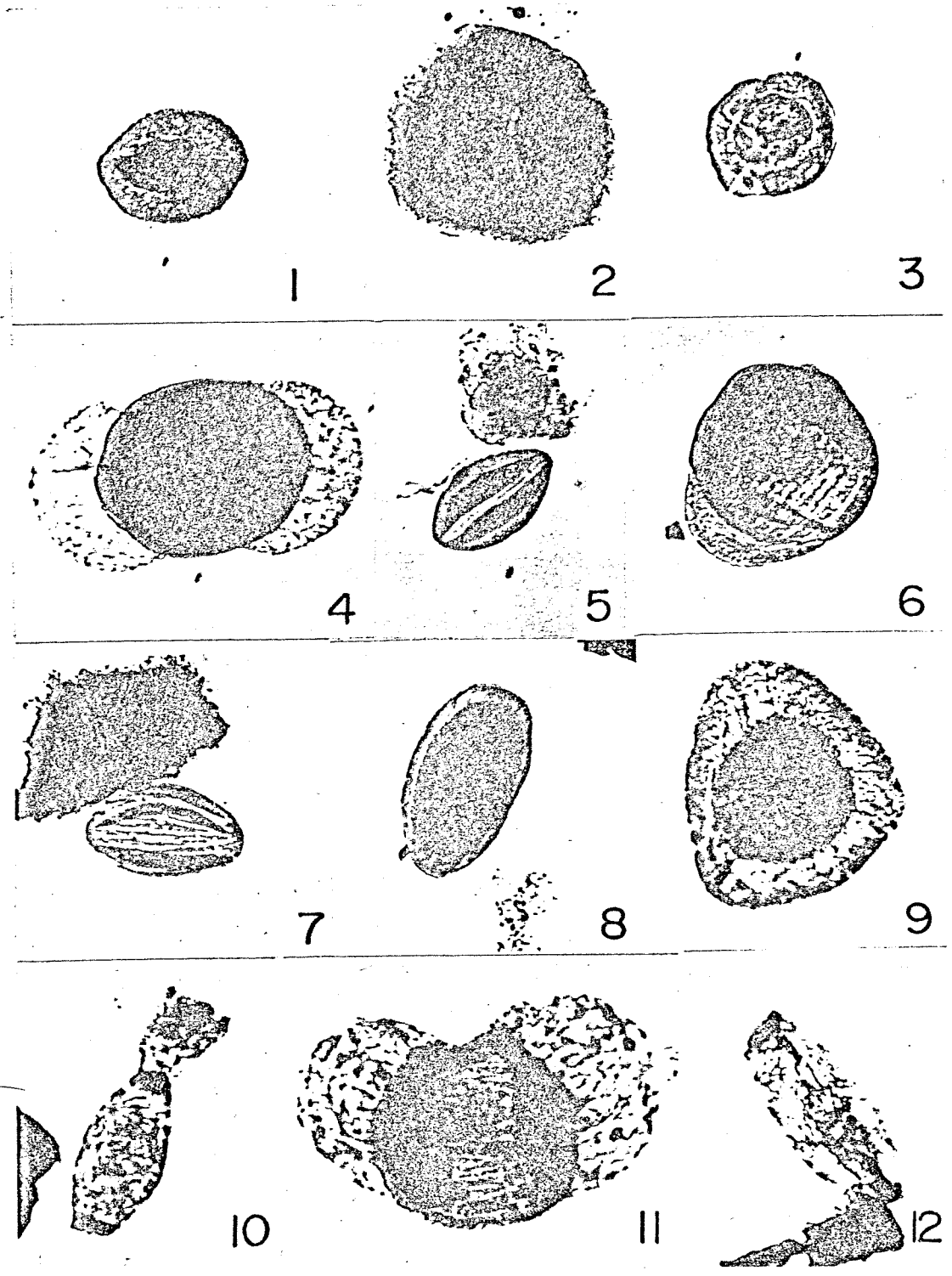

PLATE 5

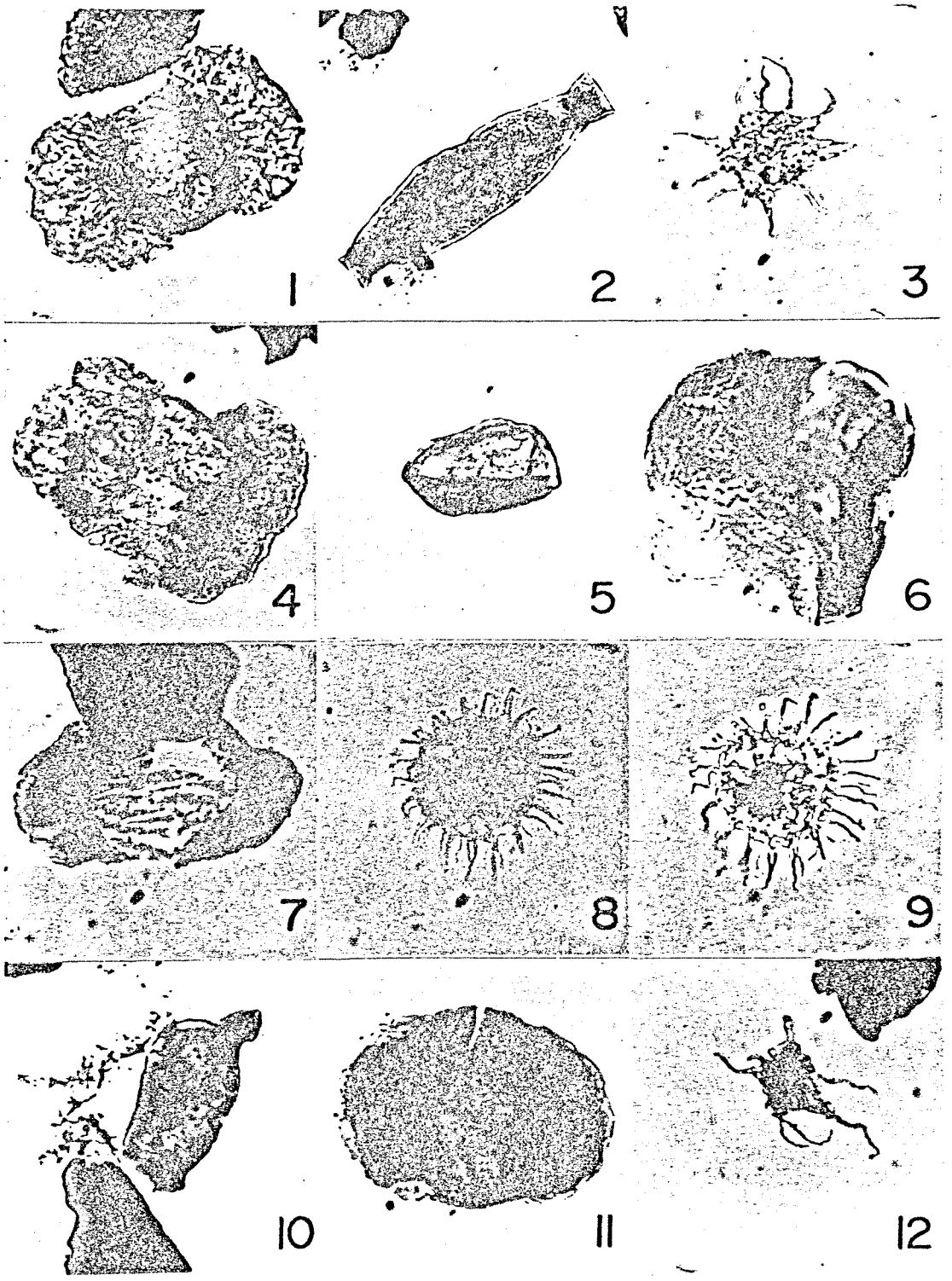

PLATE 6

		Depth
1.	*Vittatina saccata*	11800' - 11890'
2.	*Weylandites cincinnatus*	12100' - 12190'
3.	*Vittatina costabilis*	12900' - 12990'
4.	*Microbaculispora tentula*	13000' - 13090'
5.	*Microbaculispora cf. pseudoreticulata*	13100' - 13190'
6.	*Cycadopites cf. cymbatus*	13300' - 13390'
7.	*Diatomozonotriletes cf. townrowii*	13400' - 13490'
8.	*cf. Potonieisporites sp.*	14100' - 14190'
9.	*Lophotriletes tereteangulatus*	15400' - 15490'
10.	*Vittatina sp. A*	15400' - 15490'
11.	*cf. Mehlisphaeridium sp.*	15600' - 15690'
12.	*Schwagerina whartoni* Petocz (axial section) (X20 approx.)	16517' - 16519'

PLATE 6