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PRELIMINARY REPORT OF LOWER PALAEOZOIC FOSSILS OF SAMPHIRE MARSH No. 1 BORE, WESTERN AUSTRALIA

by

Joyce Gilbert-Tomlinson

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INTRODUCTION

Lower Palaeozoic fossils were determined in the following cores of Samphire Marsh No.1 Bore, Western Australia:

CORE 4 (4,090 - 4,100 feet) - Lower Ordovician - Arenigian

CORE 5 (4,438 - 4,448 feet) - Lower Ordovician - Arenigian

CORE 6 (4,946 - 4,948 feet) - Lower Ordovician - possibly Arenigian, but perhaps uppermost Tremadocian.

CORE 8 (5,535 - 5,547 feet) - Lower Ordovician - Tremadocian

CORE 9 (5,852 - 5,862 feet) - Lower Ordovician - lower Tremadocian OR late Upper Cambrian

CORE 10(6,185 - 6,187 feet) - Ditto.

There was no recovery from Core 7 (5,435 - 5,445 feet) and Core 11 (6,390 - 6,400 feet) contained no visible fossils.

In this report, the main emphasis is on faunas and correlation: a discussion of palaeogeography and palaeocology would be premature at present, although observations that may be relevant to a future discussion of these aspects have been recorded.

The Samphire Marsh sequence provides a number of new records of fossils, both for Western Australia and for Australia as a whole. Most important is the discovery of a determinable graptolite, _Tetragraptus_ cf. _similis_ (Hall), at the top of the sequence, which provides a ceiling, and excludes the possibility of a Middle Ordovician age (see pp.4, 6, 16).

As in other Ordovician sequences of northern Australia, the fossiliferous horizons can be dated within wide limits only. Moreover, the Samphire Marsh fossils are so unusual that none can be compared directly with the few described Ordovician fossils from northern Australia, and few are comparable with undescribed Upper Cambrian and Ordovician fossils known to me (see pp. 8, 9).

Correlation is complicated by the large proportion of undescribed genera: at least three can be detected from a preliminary study, and more may be revealed when the faunas are studied in detail. A further difficulty arises from the occurrence of three fossils outside the known stratigraphic ranges of these, or similar, fossils (see p.7).

The stratigraphic terminology used in this report is explained on page 8.

An approximate correlation with the Prices Creek area of Western Australia and the Larapintine region of central Australia is outlined (see p.10).

The "NOTES" at the end of this report contain some additional remarks on morphology, stratigraphic range, and palaeogeographic distribution of the fossils mentioned in this report, as well as a note on the use of the term "Larapintine".

Knowledge of the Ordovician of northern Australia is increasing so rapidly that some changes in the interpretations here presented are inevitable. Workers desiring to cite any part of this report in print are requested to communicate with the author, to ensure that out-of-date information is not published.

PALAEONTOLOGY

Fossil content and ages of cores

The accompanying table summarizes the fossil content and estimated ages of Cores 4, 5, 6, 8, 9 and 10, (no recovery from Core 7.) The results of palaeontological examination are set out in more detail below.

In the table, fossils arranged in the order of first appearance. Generic identification is not always possible, and therefore many of the fossils are referred to higher taxonomic categories. But it is not intended to imply that identical fossils occur in neighbouring cores: on the contrary, with few exceptions, the genera in every core are distinct, but no more exact identification of these fossils is possible at present.

CORES 9 & 10.

Cores 9 and 10: Core 10 contains only one fossil (apart from the ubiquitous "worm" castings) -- the inarticulate brachiopod Lingulella. Core 9 contains a more varied fauna: Lingulella (probably a different species from that in Core 10) is supplemented by an orthoid brachiopod (Orusia?), a ribeirioid (cf. Genus B), and trilobites.

Age: None of the fossils permits exact dating. They indicate an age within the limits of late Upper Cambrian and early Tremadocian (lowermost Ordovician). Lingulella is a long-ranging genus and by itself is not diagnostic; Orusia, if confirmed, would indicate a Cambrian age, although superficially similar brachiopods are known in the early Ordovician; the ribeirioid (cf.Genus B), if judged by Australian standards would favour a Cambrian age, but, once again, similar forms are known in the early Ordovician of North America and southern Manchuria; finally, the trilobites, ordinarily the most reliable index fossils, are too fragmentary to identify. Palaeontological evidence for age, therefore, is inconclusive, but Core 9 cannot be younger than early Tremadocian, and may be older. The stratigraphic relationship of Core 10 to Core 9 - about 320 feet lower in well compacted sediments - strongly suggests that Core 10, at least, is of Cambrian age. (See also pp. 11-17).

CORE 8.

Core 8: Two species only can be detected in Core 8 - the ribeirioid Technophorus? and the solenopleurid trilobite Hystricurus. This is the only core in which brachiopods are absent. Ostracods are also missing (an important difference from the younger cores).

Age: Core 8 is dated as "Ordovician - Tremadocian". The presence of Hystricurus establishes the lower Ordovician age and excludes the possibility of a Cambrian age. Hystricurus is known to range into the Arenigian, although most of the described species are Tremadocian.

Hystricurus is a genus of world-wide distribution. In Australia it is known to occur in Victoria (Singleton in Lindner, 1953) and in the Northern Territory (unpublished); both are considered to be Tremadocian in age. As the species are not described, no comparison with the Samphire Marsh forms is possible at present.

Within the Samphire Marsh sequence, Hystricurus occurs at two levels; the upper level (Core 5, q.v.) is reliably dated as Arenigian, and the occurrence of Hystricurus at this level probably corresponds to the upper limit of the known range of the genus. Core 8 is 1,109 feet below Core 6, and this relationship strongly suggests a Tremadocian age for Core 8.

TABLE - Lower Palaeozoic fossils in Samphire Marsh No.1 Bore.

10 6185-6187 ft.	9 5852-5862 ft.	8 5535-5547 ft.	6 4946-4948 ft.	5 4438-4448 ft.	4 4090-4100 ft.	Cores / Fossils
———	———	———	———	———	———	annelid? castings
———	———	· · · · ·	· · · · ·	· · · · ·	· · · · ·	*Lingulella* (brach.)
	———	· · · · ·	· · · · ·	· · · · ·	· · · · ·	*Orusia?* (brach.)
	———	· · · · ·	· · · · ·	· · · · ·	· · · · ·	ribeirioid cf.genus B
	———	· · · · ·	· · · · ·	· · · · ·	———	trilobites indet.
		———	· · · · ·	· · · · ·	· · · · ·	*Technophorus?* (rib.)
		———	· · · · ·	———	· · · · ·	*Hystricurus* (tril.)
			———	· · · · ·	· · · · ·	possible graptolite fragments
			———	· · · · ·	· · · · ·	aff. *Ptychopyge* (tril.)
			———	· · · · ·	· · · · ·	aff. *Kayseraspis* (tril.)
			———	———	· · · · ·	inarticulate brachiopods indet.
			———	———	· · · · ·	orthoid brachiopods indet.
			———	———	· · · · ·	pliomerid trilobites indet.
			———	———	———	asaphid trilobites indet.
			———	———	———	ostracods indet.
			———	———	———	beyrichioid ostracods indet.
				———	· · · · ·	*Pseudotechnophorus?* (tril.)
				———	· · · · ·	cf. *Tropidodiscus* (gast.)
				———	· · · · ·	pliomerid trilobite, n. gen.
				———	· · · · ·	aff. *Asaphus raniceps* (Dalman) (tril.)
				———	· · · · ·	*Lachnostoma?* (tril.)
				———	· · · · ·	*Scolopodus* (con.)
				———	· · · · ·	cheirurid? trilobite (immature)
				- - ? - - -	———	aff. *Goniophora* (pel.)
				- - ? - - -	———	*Temnograptus?* (grapt.)
					———	oboloid brachiopod indet.
					———	*Ctenodonta?* (pel).
					———	pelecypods indet.
					———	gastropods indet.
					———	*Plumulites* (mach.)
					———	illaenid trilobite indet.
					———	*Dionide?* (tril.)
					———	*Tetragraptus* cf. *similis* (Hall) (grapt.)
					———	conodonts indet.
Upper Cambrian or early Tremadocian	(Ordovician)	Ordovician (Tremadocian)	Ordovician (late Tremadociam or early Arenigian)	Ordovician	(Arenigian)	Fossils / Age

The ribeirioid _Technophorus?_ is close to a form occurring in the Alice Springs area and dated by Öpik (1956, p.47) as "possibly Tremadocian or Upper Cambrian".

The absence of ostracods, which are common in all the higher cores (4, 5, and 6), may have stratigraphic significance, as ostracods are not known to occur in rocks older than late Tremadocian.

Finally, the stratigraphic interval of 587 feet between Core 8 and Core 6, which is not younger than early Arenigian, also strongly suggests a Tremadocian age for Core 8. (See also pp.11-17).

A Tremadocian (as distinct from anArenigian) age for the Samphire Marsh specimens thus seems probable.

CORE 6

Core 6: The fossils of Core 6 present a striking change from Core 8. _Hystricurus_ and _Technophorus?_ are absent and are replaced by a varied fauna of asaphid and pliomerid trilobites, ostracods, and possible graptolites. All these groups make their first appearance in this core, Fragmentary brachiopods are also present. Unlike Cores 4 and 5, Core 6 contains no molluscs.

At least three genera of asaphids are present (indicated by pygidia): one of these cannot be determined at present; another (aff._Ptychopyge_) is almost certainly new; and the third (with a barbed terminal spine), though provisionally assigned to _Kayseraspis_, may prove to belong to a different genus when studied in detail. Asaphid cranidia and free cheeks are also present but cannot yet be assigned to the pygidia mentioned above. Another cranidium (not listed) seems to have some of the characters of an asaphid combined with the glabellar furrows characteristic of another family - the Remopleurididae. The pliomerid trilobites are too fragmentary for generic identification. The ostracods are extremely small (probably immature instars), and even the family is in doubt. The graptolites are too fragmentary for determination.

Age: Because of the lack of firm identifications, the exact age of Core 6 is in doubt. The presence of ostracods, however, gives a lower limit: ostracods are not known to occur in rocks older than late Tremadocian.

The trilobites do not permit an exact age determination Asaphids are, of course, zone fossils in Europe, where the species are well known. In the present sample, however, even the genera are uncertain, and thus these trilobites cannot yet be used for exact dating. The presence of a _Ptychopyge_-like trilobite may suggest an Arenigian age, and _Kayseraspis_, if confirmed, would indicate an early Arenigian age (Harrington, 1938). But caution is needed in dating rocks by undescribed asaphids: _Kayseraspis_, for example, is one of a number of superficially similar genera whose combined ranges cover the whole of lower Ordovician time.

The other fossils in the core are useless in dating.

Core 6 is 498 feet below Core 5 (q.v.), which is not younger than middle Arenigian. Core 6 is thus unlikely to be younger than early Arenigian.

It is concluded that Core 6 should be placed near the Tremadocian - Arenigian boundary, and no more precise dating is possible at present. (See also pp.11-17).

CORE 5. Core 5: In general aspect, the fauna of Core 5 bears some resemblance to that of Core 6; both cores contain asaphid and pliomerid trilobites, for example. On the other hand, the asaphids in Core 5 are almost certainly generically distinct from those in Core 6, and Core 5 contains, in addition, a pelecypod (aff. Goniophora), a bellerophontacean gastropod (cf. Tropidodiscus), and a probable ribeirioid (Pseudotechnophorus?); it also contains a probable cheirurid trilobite (the only member of the family in the Samphire Marsh collection) and a Hystricurus (present in Core 8, but absent in Core 6). A beyrichioid ostracod, the earliest undoubted graptolite (Temnograptus?), and a very large conodont (Scolopodus), are also present. Orthoid brachiopods, as usual in the Samphire Marsh cores, are too fragmentary for determination.

The pliomerid trilobites are more numerous and better preserved than in Core 6, and all the cranidia indicate the presence of a new genus.

Age: The trilobites give a reasonably reliable date - within the Arenigian but not younger than middle Arenigian. One of the asaphids is a cranidium close to Asaphus s.s. and is somewhat reminiscent of A. raniceps (Dalman), an Arenigian species of the Baltic region. An asaphid pygidium (immature) in this sample recalls Lachnostoma Ross from the late Canadian (Arenigian) of Utah, U.S.A. (Ross, 1952). In this sample, the presence of Hystricurus excludes the upper levels of the Arenigian.

With one exception, the other fossils support the Arenigian age but do not provide evidence for any narrower age-determination - the beyrichioid ostracod, the cheirurid trilobite, and the multiramous dichograptid Temnograptus?. The exception is the probable ribeirioid Pseudotechnophorus?, whose only other known occurrence is in the Tremadocian of southern Manchuria (Kobayashi, 1933).

Core 5 is 338 feet below Core 4, which cannot be younger than late Arenigian, and therefore Core 5 must be placed below the top of the Arenigian. This confirms the conclusion indicated by the presence of the trilobite Hystricurus.

The original tentative age determination of this core was "late Tremadocian to early Arenigian". More detailed study indicates a later date, as explained above. (See also pp.11-17).

CORE 4. Core 4: A few fossils of Core 4 are similar to forms in Core 5: the pelecypod aff. Goniophora, a beyrichioid ostracod, and the graptolite Temnograptus?. Most of the fossils, however, are different. Asaphid trilobites are rare; pliomerid trilobites are absent; and illaenid and dionidid trilobites make their first (and only) appearance. The pelecypods show more variety (Ctenodonta and perhaps two other genera); orthoid brachiopods are apparently absent; and the core contains the only machaeridian (Plumulites) noted in the bore.

The most notable feature of the fauna is the presence of a graptolite well enough preserved to permit a tentative specific identification (Tetragraptus cf. similis (Hall)). This identification is based on a single fragment.

Age: T. similis (Hall) is a long-ranging species of middle and late Arenigian age (Zones of Didymograptus extensus and D. hirundo of the British scale), and the core may be dated within the limits of these zones. The graptolite also provides an upper limit for the age of the core and of the known Ordovician sequence of Samphire Marsh sediments: Middle Ordovician is excluded.

With one exception, the shelly fauna does not dispute the age determination given by the graptolite, although it does not permit any more precise dating. The exception is the trilobite Dionide?, which is unknown below the Middle Ordovician in the Northern Hemisphere (Whittington, 1952). Its presence suggests that Core 4 should be placed high in the Arenigian, and, moreover, that Dionide appears in Australia somewhat earlier than elsewhere. (See also pp.11-17).

Faunal Summary

Stratigraphic distribution of animal groups. At least thirty species of shelly fossils can be distinguished in the lower Palaeozoic sequence of the Samphire Marsh No.1 Bore (4,090 - 6,187 feet). Most of the species occur in the upper part of this sequence - 4,948 feet (Core 6) and above. Below this depth, fossils are rare and are not nearly so varied as in the upper levels.

Brachiopods are present in every core except Core 8. The inarticulate Lingulella is the first fossil to appear (in Core 10), and is the only fossil in that core, apart from "worm" castings. The first articulate brachiopod (Orusia?) occurs in Core 9. Thereafter, both classes are represented in almost every core. They are nowhere common and are mostly too badly preserved for generic identification to be attempted. As far as can be judged from the fragmentary fossils, the articulate brachiopods are all orthoids; no plectambonitids have been noted. The orthoids of Cores 5 and 6 appear to be generically distinct.

Gastropods and pelecypods are confined to the two uppermost cores (4 and 5). Gastropods are rather rare, and only one genus can be identified - cf. Tropidodiscus in Core 5. The best development of pelecypods occurs in Core 4, which may contain four different forms; one of these is a new genus externally resembling Goniophora.

The only observed machaeridian (Plumulites) occurs in Core 4.

Ribeirioids occur in Cores 5, 8, and 9. The genera in the three cores are distinct. Core 5 contains several specimens of a shell that is provisionally determined as Pseudotechnophorus, a new record for Australia. The ribeirioids in Cores 8 and 9 are both comparable with forms from central Australia: the genus in Core 8 resembles a form (Technophorus?) of probable Tremadocian age, and that in Core 9 resembles an undescribed Upper Cambrian genus (Genus B; see "NOTES" : ribeirioids).

Trilobites are the commonest and best-preserved fossils. Of these, the asaphids are the most numerous and most varied; several different forms occur in Core 6 and Core 5, and the genera in the two samples seem to be distinct. At least one new genus of asaphids is present (aff.Ptychopyge in Core 6). Another asaphid in the same sample shows some resemblance to the South American Kayseraspis. Core 5 contains a cranidium close to Asaphus s.s (aff. A.raniceps (Dalman)), as well as a pygidium that recalls the North American Lachnostoma Ross. Asaphids are not represented below Core 6, and are not well represented in Core 4.

Other trilobites include a solenopleurid (Hystricurus in Cores 5 and 8, a new record for Western Australia), a possible cheirurid (Core 5); and pliomerids (Core 5, new genus and Core 6). Core 4 contains the only illaenid and the only dionidid, as well as another trilobite that cannot at present be assigned to a family. The earliest trilobites (in Core 9) are too fragmentary for determination.

Ostracods make their first appearance in Core 6, and are thereafter common. Most of the specimens are very small and probably represent immature instars. Beyrichioid ostracods are identified in Cores 4 and 5.

Apart from the regular shelly fauna, two other kinds of animals are represented - castings of mud-eating animals (annelids?) and graptolites. Castings occur in every core. Undoubted graptolites first appear in Core 5 and are common (though fragmentary) in Core 4. Some carbonaceous fragments that might be interpreted as graptolites occur in Core 6. The only specifically determinable graptolite (Tetragraptus cf. similis) occurs in Core 4; it is associated with a multiramous dichograptid, provisionally determined as Temnograptus?. The graptolite fragments in Core 5 are also provisionally referred to Temnograptus.

Faunal changes. In general, each of the six cores has a distinctive fauna. The long intervals between the cores make it impossible to decide whether the changes are gradual or abrupt.

Two important changes in the faunas are evident: the first occurs between Core 10 and Core 9, and the second between Core 8 and Core 6. The first change is indicated by the appearance in Core 9 of orthoid brachiopods, ribeirioids, and trilobites - a marked contrast to the monotonous Lingulella fauna of Core 10. The second change is marked by the incoming in Core 6 of asaphid and pliomerid trilobites, ostracods, and, perhaps, graptolites, all of which are absent in the lower levels. The occurrence of an illaenid and a dionidid trilobite in Core 4 is unique and may indicate a third change.

New records. Stratigraphically the most interesting find is the graptolite Tetragraptus cf. similis (Hall) in Core 4. This is the first recorded occurrence of the genus in northern Australia and the first specifically identified graptolite in Western Australia. Graptolites are always welcome in a shelly fauna. In the present case, the shelly faunas are so unusual that the presence of an identifiable graptolite at the top of the sequence is of inestimable value in dating: without it the present age - determination - tentative as it is- would be even less certain, and a Middle Ordovician age could not be positively excluded for this core.

The trilobites Dionide (Core 4) and Hystricurus (Cores 5 and 8), known in other parts of Australia, are recorded in Western Australia for the first time, and Core 5 contains a probable cheirurid, not previously recorded in northern Australia. The bellerophontacean gastropod Tropidodiscus (Core 5) has not previously been noted in northern Australia, and the machaeridian Plumulites (Core 4) is the first record of an Ordovician machaeridian in Australia. Ribeirioids are recorded in Western Australia for the first time: two of the forms are closely allied to forms previously known from central Australia (Genus B in Core 9; Technophorus? in Core 8); the third, Pseudotechnophorus, is a new record for Australia.

The number of new records is a good illustration of the present imperfect knowledge of the Ordovician succession of northern Australia.

Novelty of the faunas. Of the thirty odd species of shelly fossils in the Samphire Marsh sequence, none can be assigned to the "Larapintine" species of central Australia. (Apart from the Prices Creek nautiloids, and the brachiopod *Spanodonta*, the Larapintine fossils are the only described Ordovician fossils from northern Australia). On the generic level, only three fossils can be assigned with confidence to described genera - the inarticulate brachiopod *Lingulella* (Cores 9 and 10), the machaeridian *Plumulites* (Core 4), and the solenopleurid trilobite *Hystricurus* (Cores 6 and 8). All are long-ranging genera and unsuitable for exact stratigraphy. Two other doubtful generic determinations - the bellerophontacean gastropod *Tropidodiscus* (Core 5) and the trilobite *Dionide* (Core 4) - might be confirmed if better material were available.

Even a preliminary study is enough to establish that at least three new genera are present - the pelecypod aff. *Goniophora* (Core 4), the *Ptychopyge* - like trilobite (Core 6), and the pliomerid (Core 5). The trilobite in Core 6 that seems to combine the characters of a remopleuridid and an asaphid is also probably new. The beyrichioid ostracods in Cores 4 and 5 do not fit well into described genera, and may also be new. These ostracods were originally identified as "cf. *Bollia*", but a further study reveals a structure of the border that excludes that genus.

Extension of known stratigraphic range. Three of the fossils of the Samphire Marsh sequence occur at levels outside the known stratigraphic range of these, or similar, fossils, and, taken alone, could give misleading age determinations. They are: the trilobite *Dionide?* and the pelecypod aff. *Goniophora* (both in Core 4), and the ribeirioid *Pseudotechnophorus?* (Core 5).

Dionide is not known to occur in rocks older than Llanvirnian (early Middle Ordovician) in the Northern Hemisphere (Whittington, 1952), and its present occurrence in the late Arenigian is somewhat earlier than elsewhere. In New South Wales it occurs in the early Upper Ordovician (Kalimnah formation) (Öpik, 1951).

Goniophora-like pelecypods range from Upper Ordovician to Devonian (Isberg, 1934). The Samphire Marsh specimens have well-developed teeth, and the fossil, if occurring alone, would most probably be taken to indicate a Devonian age.

Pseudotechnophorus is described from the Wanwanian (basal Ordovician) of southern Manchuria (Kobayashi, 1933), and the occurrence of a very similar form in the Arenigian of Western Australia provides a marked upward extension of its known range.

In dealing with these anomalies, I have disregarded the evidence of these fossils in favour of other groups which are more reliable index fossils.

The pelecypod aff. *Goniophora* and the trilobite *Dionide?* are associated with the graptolite *Tetragraptus* cf. *similis*. Graptolite species provide the standard correlation scale, and the ranges of other fossils are adjusted to agree with that scale. The present occurrence of a *Dionide*-like trilobite thus appears to be the earliest record of the genus and of the family Dionididae. The occurrence of the pelecypod aff. *Goniophora* is best regarded as throwing new light on the imperfectly known history of Ordovician pelecypods.

A final judgement on the apparently anomalous occurrence of *Pseudotechnophorus* cannot be given at present.

Absentees. The present study reveals the absence of a number of fossil groups known to occur in the Ordovician of other parts of northern Australia. Corals and bryozoans are absent. Among brachiopods, the absence of tritoechiines and the plectambonitid Spanodonta is noteworthy. The characteristic gastropods of the "Larapintine" Orthis dichotomalis fauna of central Australia are missing, and no nautiloids can be positively identified. Agnostid, komaspid, raphiophorid, and telephid trilobites are also missing. If cores 9 and 10 are indeed Upper Cambrian in age, their faunas present a striking contrast to other Upper Cambrian faunas of northern Australia, which are noted for the size and abundance of their trilobites.

The absence of some fossils may be explained stratigraphically: corals and bryozoans are not recorded from the lower Ordovician of Australia. The brachiopod Spanodonta seems to be substantially Middle Ordovician in age, and its absence in the lower Ordovician sequence at Samphire Marsh is not surprising.

No explanation can be put forward for the absence of the other groups. Each of the main regions of Ordovician sediments in northern Australia seems to have its own characteristic fauna (or sequence of faunas) that does not extend into other regions. This distinction may, of course, be merely the reflexion of the present imperfect knowledge of the formations and faunas. In the Samphire Marsh sequence, moreover, the samples are too widely spaced to give a complete picture of the faunas, and the differences between this area and other areas may be more apparent than real.

CORRELATION

Terminology

Discussion of Ordovician faunas and correlation is complicated by the current use of two different time-scales - (1) the North American scale, used by Öpik (in Guppy & Öpik, 1950) and Teichert & Glenister (1954); and (2) the European scale, used by Öpik (in Traves, 1955) and in the present report. In the present report it is understood that Tremadocian and Arenigian together correspond to Canadian (Lower Ordovician), but no exact coincidence of boundaries is implied, and the position of the Tremadocian-Arenigian boundary in relation to the Canadian sequence is not known. Arenigian is used in the restricted sense - Zone 6 of the British scale (Didymograptus bifidus), included in Arenigian by some authors, is here excluded. Zone 6 (Lower Llanvirnian) is here regarded as the base of Middle Ordovician.

Dating and thickness of sequence

The Samphire Marsh sequence consists of at least 2,097 feet of fossiliferous lower Palaeozoic sediments, represented in Cores 4, 5, 6, 8, 9 and 10. The sequence covers probably the whole of lower Ordovician time (both Tremadocian and Arenigian), and, in addition, some Upper Cambrian may be present at the base.

The estimated ages for the six cores are shown in the Table (above). In the two uppermost cores, palaeontological evidence alone gives a reasonably accurate date. In the lower cores, where no described species can be detected, precise dating is not possible, and the palaeontological evidence is supplemented by observations on the sttatigraphic distance between the cores. No firm dating for Cores 6, 9, and 10, can yet be deduced.

The presence of a specifically identifiable graptolite (Tetragraptus cf. similis (Hall)) in the highest core of the sequence (Core 4) provides a ceiling: the latest possible date is Arenigian, and Middle Ordovician is excluded.

The Arenigian part of the sequence is at least 358 feet thick and (if Core 6 should in future prove to be Arenigian in age) may be at least 859 feet thick. Insufficient samples are available to estimate the thicknesses of the Tremadocian and possible Upper Cambrian, but the minimum thickness of Tremadociam plus possible Upper Cambrian is 652 feet. If Core 6 should in future be included in the Tremadocian part of the sequence, this minimum would be correspondingly increased to 1,241 feet.

Comparison with other areas.

Faunal. As remarked above (p. 7) the only Ordovician fossils described from northern Australia are the brachiopod Spanodonta (Prendergast, 1935) and the nautiloids (Teichert & Glenister, 1954) - all from Price's Creek, and the faunas of the "Larapintine" region of central Australia, west and south-west of Alice Springs (summarized by Tate, 1896; Teichert & Glenister 1952). The "Larapintine" faunas are now being studied in the Bureau, as are the other Ordovician faunas of central Australia and western Queensland. No late Upper Cambrian fossils are described from northern Australia; Öpik (1956) and I (in Casey & Tomlinson, 1956) have published preliminary identifications of some of the Upper Cambrian fossils of the Northern Territory. These undescribed faunas have been taken into consideration in the following discussion.

When compared with the Larapintine faunas, the Samphire Marsh trilobites and gastropods show no resemblance whatever. The pelecypods are probably also distinct. The Orthis dichotomalis fauna of the Larapintine sequence contains an undescribed beyrichioid ostracod superficially similar to the ostracods in Cores 4 and 5, but no firm conclusions can be drawn regarding their identity without a detailed systematic study. It is unfortunate that the brachiopods of the Samphire Marsh sequence are too poorly preserved to permit comparison with Orthis dichotomalis itself.

Some of the genera of the Samphire Marsh sequence have been noted in other parts of central Australia, but in each case in a different faunal association. The trilobite Hystricurus (Cores 5 and 8) has been provisionally identified in the Toko Range on the Queensland/Northern Territory border; it is associated with a gastropod (cf. Raphistomina), a different ribeirioid (cf. Euchasma), and other trilobites (unpublished). The ribeirioid Technophorus? (Core 8) occurs in the Alice Springs area (Öpik, 1956, p.47) associated with molluscs and trilobites, but Hystricurus has not been noted there. Ribeirioid Genus B (Core 9) in the Huckitta area, N.T., is associated with a large fauna of brachiopods, trilobites, and other ribeirioids, some of which are provisionally identified by me (in Casey & Tomlinson, 1956, p.65).

No comparison is possible at present with the Prices Creek area, W.A., although it is not impossible that some correspondence will emerge when the Prices Creek faunas are described. In a brief fossil list, Öpik (in Guppy & Opik, 1950) mentions the presence of the trilobite Xenostegium in Stage II and dichograptids, ostracods, conodonts, and bellerophontacean gastropods in Stage III. Core 6 contains a Xenostegium-like trilobite (here provisionally referred to Kayseraspis), and the fossil groups mentioned above as occurring in Stage III are all present in Cores 4 and 5. Nevertheless, the absence of nautiloids from the Samphire Marsh sequence is noteworthy. According to present estimates, the pliomerid and illaenid trilobites of the Prices Creek sequence (Stages IV and V) are younger (Middle Ordovician) than those of the Samphire Marsh sequence (Cores 4, 5, and 6).

The Ordovician faunas of the Pander Greensand, Ord-Victoria region, W.A., cannot be compared at present, as the Bureau collection was destroyed by fire. Öpik (in Traves, 1955) mentions the occurrence of trilobites at several levels within the 400 feet of the formation.

Stratigraphic. The upper part of the Samphire Marsh sequence (Cores 4 to 6) is probably the time-equivalent of Stages II and III of the Prices Creek sequence. According to Öpik (in Guppy & Öpik, 1950), Stage IV is Chazyan (Middle Ordovician) in age and is thus younger than the youngest part of the Samphire Marsh sequence. Teichert & Glenister (1954) have suggested an earlier date for this Stage - late Canadian. In any case, Stage V (Gap Creek Dolomite) is younger than any known horizon in the Samphire Marsh sequence.

The Samphire Marsh sequence probably corresponds to the lower part of the Larapintine sequence of central Australia - the Pacoota Quartzite (Upper Cambrian plus Tremadocian) and the *Orthis dichotomalis* beds (provisionally dated as Arenigian). It is interesting to note that the inarticulate brachiopod *Lingulella*, the only fossil at the base of the Samphire Marsh sequence (Core 10), is also the first animal fossil to appear in the Larapintine sequence at Ellery's Creek, Western MacDonnell Range. It occurs low in the Pacoota Quartzite (Upper Cambrian), above the algal (*Girvanella*) limestone. The significance of this occurrence is just as likely to be ecological as stratigraphic.

At present, comparison with other areas, - less well known and geographically more remote - would be purely speculative.

NOTES

(Names are arranged in alphabetical order; fossils noted in the Samphire Marsh sequence are marked with an asterisk ☆)

AGNOSTID TRILOBITES - The only published record of agnostids in the Ordovician of northern Australia is at Prices Creek, where Öpik (in Guppy & Öpik, 1950) has noted their presence in Stage IV. The only other occurrence of an Ordovician agnostid in northern Australia known to me is in the Dulcie Range, Northern Territory, in a fauna that is possibly Tremadocian in age (unpublished). Agnostids have also been recorded in the Mandurama area, New South Wales (Pittman, 1900) and at Wilsons Promontory, Victoria (Singleton in Lindner, 1953).

☆ ANNELIDS - Castings of mud-eating animals occur in every core of the sequence. They are here referred to annelid worms.

☆ ASAPHID TRILOBITES - Asaphids occur in Cores 4, 5, and 6. None are comparable with the described asaphids of central Australia (Tate, 1896). For convenience, some of the Samphire Marsh asaphids are provisionally referred to described (extra-Australian) genera, though these determinations will probably be modified when the faunas are systematically studied (see: *Asaphus raniceps* (Dalman), *Kayseraspis*, *Lachnostoma*, *Ptychopyge*). The undetermined asaphids in Cores 5 and 6 may be determinable when the faunas are better known: those in Core 4 are too fragmentary for determination.

☆ ASAPHUS RANICEPS (Dalman) - A cranidium in Core 5 is close to *Asaphus* ss. and is reminiscent of the Baltic Arenigian species *A. raniceps* (Dalman) (Schmidt, 1901). The present determination is put forward for orientation only; it is unlikely that a Baltic species would also occur in Australia.

☆ BEYRICHIOID OSTRACODS - See ; ostracods

☆ BRACHIOPODS - See : inarticulate brachiopods; *Lingulella*; oboloid brachiopods; orthoid brachiopods; *Orusia*; *Spanodonta*; tritoechiine brachiopods.

☆ CHEIRURID TRILOBITES - A single fragmentary immature cranidium occurs in Core 5. The presence of a cheirurid, if confirmed, would indicate an Arenigian, rather than a Tremadocian age. Cheirurids have not previously been noted in northern Australia.

☆ CONODONTS - A large grooved *Scolopodus* was noted in Core 5 and an unidentified genus in Core 4.

☆ CTENODONTA Salter (pelecypod) - A single shell with the characteristic outline of *Ctenodonta* occurs in Core 4; the identification is in doubt because the dentition has not been observed. The genus is common in the *Orthis dichotomalis* beds of the Larapintine region of central Australia (unpublished). Itis a long-ranging genus (Ordovician to Silurian) of world-wide occurrence and of little stratigraphic significance.

☆ DIONIDE Barrande (dionidid trilobite) - Core 4 contains a single fragmentary head-shield and, in the same bedding-plane, an immature pygidium, which are provisionally referred to this genus. Both flanks of the head-shield are damaged, and therefore the generic identification is in doubt (*Dionide* has a marginal facial suture), but the other observed characters agree well with those of the genus, although the surface sculpture cannot be made out in all details. Whittington (1952), in the most recent revision of the family Dionididae, mentions that the earliest occurence (in the Northern Hemisphere) is Llanvirnian (early Middle Ordovician), and therefore the present occurrence (Arenigian) indicates that the genus appears earlier in Western Australia than elsewhere. The only other known occurrence of the genus in Australia - in the Mandurama area of New South Wales (Öpik, 1951) - is dated by graptolites as early as Upper Ordovician.

☆ GASTROPODS - Fragments of an undetermined genus of gastropods occur in Core 4 (See also : Tropidodiscus).

☆ GONIOPHORA Phillips (pelecypod) - Core 4 contains several well preserved specimens of a pelecypod with an oblique umbonal ridge and simple arcoid teeth behind the umbo; a shell of similar shape occurs in Core 5. Goniophora is the nearest described genus, but the arcoid dentition excludes that genus, as well as Goniophorina Isberg. A North American Devonian species attributed to Palaeoneilo (P. emarginata (Conrad)) also has a strong umbonal ridge, but, as a nuculid, would be expected to have teeth in front of, as well as behind, the umbo.

Goniophora ranges from Upper Ordovician to Devonian, Goniophorina (Isberg, 1934) is Upper Ordovician, and Palaeoneilo ranges from Devonian to Triassic. The Samphire Marsh pelecypod is thus considerably older than all known shells of similar shape, and, indeed, if it has been the only fossil found, a Devonian age for the core would have been the strongest possibility.

Shells with an oblique umbonal ridge are known from the Ordovician of the Larapintine region (q.v.) of central Australia. At least one of these is a ribeirioid (Technophorus?) (q.v.). Of the true pelecypods, Isoarca opiformis Tate, 1896, is somewhat similar in outline, but its dentition is nuculoid.

☆ GRAPTOLITES - Indeterminable fragments that might be interpreted as graptolites occur in Core 6. Undoubted graptolites occur in Cores 4 and 5 (See : Temnograptus; Tetragraptus similis).

☆ HYSTRICURUS Raymond (solenopleurid trilobite) - A single cranidium is present in Core 5, and several cranidia, a free cheek, and a damaged pygidium are present in Core 8. The specific relationship between the specimens from the two cores has not been studied. Hystricurus is a genus of world-wide distribution in the lower Ordovician. Most of the described species occur in the Tremadocian (or its equivalents), but in Utah, U.S.A., where a succession of species is known (Ross, 1951), the genus ranges through Tremadocian into Arenigian equivalents, but is not present in the uppermost Arenigian. This is the first recorded occurrence in Western Australia. The only other known occurrence in northern Australia is in the Toko Range, N.T.ø It is also recorded (as "Hystricunus") by Singleton (in Lindner, 1953) from the Wilsons Promontory area, Victoria. Both these Australian occurrences are believed to be Tremadocian in age. No Australian Hystricurus is described, and no attempt has been made to compare the Samphire Marsh specimens with the numerous extra-Australiam species. For the present, it is convenient to date them by the associated faunas.

(ø unpublished)

☆ ILLAENID TRILOBITES (genus not determined) - Core 4 contains several pygidia and damaged thoracic segments of a trilobite referable to the family Illaenidae. The posterior edge of the pygidium is vertical (characteristic of the family); the pygidial axis is better defined than is usual in the family, but this is, perhaps, to be expected in such an early form. Cranidia and free cheeks are not present, and no generic identification has been attempted. The only other record of illaenids in northern Australia is in Stage V (Gap Creek Dolomite) of the Prices Creek sequence, W.A. (Öpik, in Guppy & Öpik, 1950). Öpik dates this formation as Lower Trenton (i.e., late Middle Ordovician), and it is thus considerably younger than the Samphire Marsh species.

☆ INARTICULATE BRACHIOPODS - Inarticulate (phosphatic) brachiopods occur in all cores except Core 8. Lingulella is present in Cores 9 and 10, and an oboloid occurs in Core 4. The inarticulate brachiopods of Cores 5 and 6 are too fragmentary for determination.

☆ KAYSERASPIS Harrington (asaphid trilobite) - Core 6 contains a single pygidium that is provisionally referred to Kayseraspis. It has a long terminal spine, which, in turn, is furnished with small, backwardly-directed barbs. The border is discontinuous in the mid-line, and in this respect the trilobite recalls Xenostegium Walcott, or even Trigonocerca Ross. It has not been possible to assign a cranidium to this pygidium. Kayseraspis occurs in the early Arenigian of Argentina (Harrington, 1938), Trigonocerca in the late Canadian (late Arenigian) of North America (Ross, 1951), and Xenostegium in the early Canadian (Tremadocian) of North America (Ross, loc. cit.). Öpik (in Guppy & Öpik, 1950) records a trilobite tentatively identified as Xenostegium as a characteristic fossil of Stage II of the Emanuel Limestone of the Prices Creek sequence.

KOMASPID TRILOBITES - The only known occurrence of Ordovician komaspids in northern Australia is Carolinites Kobayashi in the Orthis dichotomalis fauna of the Larapintine region of central Australia.

☆ LACHNOSTOMA Ross (asaphid trilobite) - Core 5 contains an immature asaphid pygidium with a wide and well-marked axis that recalls Lachnostoma, a genus of the late Canadian (late Arenigian) of Utah, U.S.A. (Ross, 1951; Hintze, 1952).

LARAPINTINE - The name is sometimes loosely applied to all the Ordovician formations and faunas of central Australia. Properly speaking, it belongs to the country of the upper and middle reaches of the Finke River and to the characteristic sequence of Ordovician faunas of that region (Tate, 1896). The main development is in the quadrant south-west of Alice Springs. The brachiopod Orthis dichotomalis Tate (q.v.) is characteristic of one of the faunas of the Larapintine region. The name is used in this restricted sense in this report, and is not intended to apply to the second major area of Ordovician sediments in central Australia - the Huckitta-Marqua region.

☆ LINGULELLA Salter (inarticulate brachiopod) - Linguella is present in Cores 9 and 10, and the two occurrences probably represent distinct species. The brachiopod is extremely common in Cambrian and early Ordovician sediments of northern Australia, and is of little stratigraphic significance.

☆ MACHAERIDIANS - See: Plumulites.

NAUTILOIDS - Nautiloids (Teichert & Glenister, 1952 ; 1954) are common both in the Emanuel Limestone of the Prices Creek area and the Orthis dichotomalis beds of the Larapintine region of central Australia. No nautiloids can be positively identified in the Samphire Marsh sequence.

☆ OBOLOID BRACHIOPODS - Core 4 contains an oboloid brachiopod, which has not been determined generically. It may be possible to identify it after detailed study.

☆ ORTHID BRACHIOPODS - In addition to Orusia (q.v.), provisionally identified in Core 9, two other genera occur in Cores 5 and 6. They are too fragmentary for determination.

ORTHIS DICHOTOMALIS Tate - In this report, the name of this characteristic brachiopod is used to designate one of the formations (and its contained fauna) of the Ordovician (Larapintine) sequence (q.v.). It occurs in the older of the two limestone-shale formations, which is provisionally dated as late Arenigian, although a more detailed study of the fauna may require a revision of this estimate. Well-known fossils include the gastropods Ophileta gilesi and Raphistoma brownii and the trilobites Ampyx, Asaphus howchini, and Carolinites. The formation contains the main nautiloid horizon. An undescribed beyrichioid ostracod (unpublished) is also present. The described fossils are summarized by Tate (1896).

☆ ORUSIA Walcott (orthoid brachiopod) - Core 9 contains several specimens of a small ribbed orthoid. The shells are flattened in the bedding-plane, and the internal characters are not well enough preserved for positive generic identification. They are close to the Upper Cambrian Orusia, but orthoids of this general appearance are also common in the early Ordovician, and therefore this brachiopod cannot be regarded as a reliable index-fossil.

☆ OSTRACODS - Beyrichioid ostracods occur in Cores 4 and 5; these cores also contain small specimens (immature instars) that may belong to other groups of ostracods. Very small specimens of uncertain affinities are present in Core 6. The beyrichioids are unisulcate forms with a flat flange. They do not fit well into any described genera and may be new. No Ordovician ostracods are described from Australia, but ostracods are recorded by Öpik in Stage III of the Emanuel Limestone (Guppy & Öpik, 1950), and an undescribed beyrichioid is present in the Orthis dichotomalis beds (q.v.) of central Australia (unpublished). A detailed systematic study is needed to compare the species of these three areas.

☆ PELECYPODS - Unidentified pelecypods (perhaps two genera) occur in Core 4 (see also : Ctenodonta; Goniophora).

☆ PLIOMERID TRILOBITES - Core 5 contains three cranidia of a new genus of pliomerid trilobites. The anterior part of the glabella is completely divided into lobes by long glabellar furrows which meet a long median furrow that extends from the front of the glabella to the first (posterior) glabellar furrows. This arrangement of the furrows is unknown: it most nearly resembles the Middle Ordovician cheirurid Heliomeroides Evitt, which, however, has a pair of longitudinal furrows, not a single furrow. Pygidia and discrete thoracic segments in the same core may belong to this genus. Fragments of pliomerids are also present in Core 6, but at present no attempt can be made to identify the genus.

☆ PLUMULITES Barrande (machaeridian) - Core 4 contains a single (detached) plate, referable to Plumulites. It is small but well preserved, and is a kite-shaped plate of the outer row. Machaeridians have not previously been noted in the Australian Ordovician.

Plumulites is known by several species in the Ordovician of the Northern Hemisphere, as well as in younger rocks; it is also known in the Silurian of New South Wales and Victoria (Withers, 1926).

☆ PSEUDOTECHNOPHORUS Kobayashi - See : ribeirioids.

☆ PTYCHOPYGE Angelin (asaphid trilobite) - Core 6 contains a trilobite referred for convenience to *Ptychopyge* but almost certainly representing an undescribed genus. Three pygidia, a thoracic segment, and a free cheek (all damaged) are present; they have an unusual ornament and apparently belong to the same species. The pygidia and free cheek show a very wide doublure, of the kind generally associated with *Ptychopyge*, and, in addition, the pygidial doublure shows a deep median notch, also characteristic of that genus. However, the pygidial doublure also shows a most unusual structure: a series of paired notches on the inner edges of the doublure, corresponding to the pleural furrows. Such a structure is not known to occur in any asaphid, and the only other trilobite in which it has been noted is the lower Middle Cambrian "paradoxidid" *Xystridura* Whitehouse (A.A. Öpik, verbal communication). Cranidia that can be assigned to this form have not been noted.

Material from Core 5 contains a piece of fissile shale, lithologically similar to the shale of Core 6; it contains a pygidium that seems to be specifically identical with the trilobite mentioned above. I am inclined to regard it as a stray from Core 6, rather than a legitimate constituent of Core 5.

RAPHIOPHORID TRILOBITES - Raphiophorids have not been noted in the Samphire Marsh sequence. The only known occurrence in northern Australia is *Ampyx* s.l. in the *Orthis dichotomalis* beds (*q.v.*) of central Australia.

☆ REMOPLEURIDID TRILOBITES - Core 6 contains a single cranidium (immature) with the glabellar furrows characteristic of the family Remopleurididae. The trilobite is doubtfully assigned to this family, however, because of the presence of a tubercle that is characteristic of the Asaphidae but not known to occur in the Remopleurididae. It probably represents a new genus. Better material is need to solve the mystery of its taxonomic position.

☆ RIBEIRIOIDS - Ribeirioids are lower Palaeozoic invertebrates of uncertain zoological affinities. They are usually classified as Crustacea. Externally the shell resembles that of a pelecypod, and ribeirioids are sometimes incorrectly identified as pelecypods. When well preserved, however, the ribeirioid shell - unlike the bivalved pelecypod shell - is seen to be a single unit; the single shell is folded in the mid-line, which then forms the dorsal margin. Internally the ribeirioid shell is buttressed by one or two transverse plates - the clavicles. No Australian ribeirioids are described, but Öpik (1956) and I (in Casey & Tomlinson, 1956) have recorded their presence in central Australia, and Kobayashi (1936) has drawn attention to the possible presence of ribeirioids in Tasmania. Outside Australia, most of the described species are Ordovician, but Kobayashi (1933) records the presence of Upper Cambrian species in southern Manchuria. In northern Australia, three genera are present in the late Upper Cambrian and about seven genera in the Tremadocian. The Cambrian genera of central Australia are temporarily distinguished by letters until they are described (Tomlinson, *loc.cit.*). Genus B (see below), provisionally identified in Core 9 of Samphire Marsh, is one of these genera.

☆ GENUS B. - Core 9 contains a single specimen of a ribeirioid resembling Genus B from the Upper Cambrian of central Australia. The clavicles are not preserved (probably obliterated by compression), and thus the generic identification is not absolutely certain. Nevertheless, shells of this form are very common in the Australian Upper Cambrian and very rare inthe Australian Tremadocian, so that, by Australian standards at least, a Cambrian age is preferred for this sample; but no positive age-determination can be made on the present material.

☆ PSEUDOTECHNOPHORUS Kobayashi.- Core 5 contains several specimens (mostly fragmentary) of inequilateral shells with undivided ribs radiating from an indistinct umbo. The shape of the shell and the ornament agree with Pseudotechnophorus; but I can detect no trace of the stout clavicles characteristic of the genus. In this preservation, of course, the cavities left by the clavicles could easily be obliterated by pressure; but, on the other hand, the shell may be that of a true pelecypod homeomorphus with Pseudotechnophorus. In this case it is a new genus. I have not seen any comparable shells in the Australian Ordovician. Pseudotechnophorus occurs in the Wanwanian (Tremadocian) of southern Manchuria, and the present occurrence, if confirmed, would indicate an upward extension of its known stratigraphic range. (Kobayashi, 1933). It would also be the first record of a ribeirioid in the Australian Arenigian; all other proved occurrences are either Upper Cambrian or Tremadocian in age.

☆ TECHNOPHORUS Miller - Core 8 contains several specimens, including one complete shell with the two lobes spread apart and flattened in the bedding-plane. The characteristic oblique ridge is preserved. Shells of very similar appearance occur in the "No.4 Quartzite" of the Alice Springs area; they are associated with gastropods, nautiloids, and trilobites, and are dated by Öpik (1956, p.47) as "possibly Tremadocian or upper Upper Cambrian". The present occurrence, associated with the trilobite Hystricurus, is clearly Ordovician and not Cambrian. In North America, the genus is recorded at all levels of the Ordovician (Kobayashi, 1933).

☆ SCOLOPODUS Pander - See: conodonts.

SPANODONTA Prendergast (plectambonitid brachiopod) p The genus was originally described from the Prices Creek sequence, W.A., (Prendergast, 1935). Öpik (in Guppy & Öpik, 1950) has noted it in the upper part of the Emanuel Limestone (Stage IV) of that sequence, and throughout Stage V (Gap Creek Dolomite). It has not been noted elsewhere in northern Australia (including the Samphire Marsh sequence), but Öpik (1951a; 1951b) records the presence of Spanodonta-like brachiopods in the Mandurama area, N.S.W., and the Florentine Valley, Tasmania. The stratigraphic range of the brachiopod is not known, but it seems to be substantially Middle Ordovician in age.

☆ TECHNOPHORUS - See: ribeirioids

TELEPHID TRILOBITES - Öpik (in Guppy & Öpik, 1950) records the presence of undetermined genera of telephids in the Prices Creek sequence. They have not been noted elsewhere in northern Australia (including the Samphire Marsh sequence). In Europe, they are not recorded before the Middle Ordovician.

☆ TEMNOGRAPTUS Nicholson (multiramous dichograptid) - Core 4 contains several specimens of a multiramous dichograptid, superimposed one upon another. The present determination is provisional, and a detailed study may indicate a different genus. Such a study would not be warranted at present, because the ranges of the multiramous dichograptids are not well known, and the assocuated Tetragraptus is, in any case, a much more reliable indicator of age. Core 5 contains fragmentary graptolites that may belong to the same genus.

☆ TETRAGRAPTUS SIMILIS (Hall) - Core 4 contains a graptolite provisionally referred to this species. The identification is based on a single fragmentary specimen, with a small fragment of the counterpart. One stipe only is reasonably well preserved, but the proximal end, including the sicula, is badly distorted. The measurements, as far as they can be taken, agree with those of T.similis; the ventral outline of the stipe has the appearance of being rather straighter than is typical in that species, however, and recalls T. phyllograptoides Linnarsson; but I think this may be an accident of preservation.

T. similis is a species of world-wide distribution. In Britain it is recorded as occurring in the Zones of Didymograptus extensus and D. hirundo (Zones 4 and 5). The Zone of D. hirundo is therefore the extreme upper limit of the Samphire Marsh Ordovician faunas.

N TRILOBITES (See also: agnostid trilobites; asaphid trilobites; Asaphus raniceps; cheirurid trilobites; Dionide; Hystricurus; illaenid trilobites; Kayseraspis; komaspid trilobites; Lachnostoma; pliomerid trilobites; Ptychopyge; raphiophorid trilobites; remopleuridid trilobites; telephid trilobites).

Indeterminable fragments of trilobites occur in Core 9. Core 4 contains several specimens of an opistoparian free cheek that cannot be assigned to any cranidium in the sample. It is an indication of the incompleteness of the fauna, as preserved in the core.

TRITOECHIINE BRACHIOPODS (Clitambonacea) - No brachiopods that can be interpreted as tritoechiines have been noted in the Samphire Marsh sequence. This is surprising, as they are typical lower Ordovician brachiopods and, moreover, are present in the Dampier Downs sequence, W.A. (Glenister & Glenister, 1958; identified as Pomatotrema Ulrich & Cooper by Dr. B.F. Glenister). They have not been identified elsewhere in northern Australia.

☆ TROPIDODISCUS Meek & Worthen (bellerophontacean gastropod) - Core 5 contains a single specimen tentatively referred to this genus. It has not previously been noted in northern Australia, although Öpik (in Guppy & Öpik, 1950) has not noted the presence of undetermined bellerophontacean gastropods in Stage III of the Emanuel Limestone. Tropidodiscus is a long-ranging genus (Ordovician to Devonian), and the present occurrence is of little stratigraphic value unless the species can be determined.

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