COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

BULLETIN No. 59.

MARINE FOSSILS FROM THE UPPER JURASSIC AND THE LOWER CRETACEOUS OF DAMPIER PENINSULA, WESTERN AUSTRALIA

BY

R. O. BRUNNSCHWEILER.

Issued under the Authority of Senator the Hon. W. H. Spooner,
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Minister: SENATOR THE HON. W. H. SPOONER, M.M.
Secretary: H. G. RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

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INTRODUCTION.

In several publications which have appeared during the last few years mention was made of Upper Jurassic (Kimmeridgian and Tithonian) and Lower Cretaceous (Neocomian and Aptian) marine fossils from Dampier Land, a peninsula which lies between the townships of Derby and Broome in the north of Western Australia. The fossils were listed in detail or otherwise mentioned in more or less preliminary stratigraphical descriptions of the area in papers by Brunnschweiler (1951a, 1951b, 1954, 1957), Guppy (1953), Guppy, Lindner, Rattigan, & Casey (1958), and Fairbridge (1953). A great deal of geological work has been carried out since those preliminary exploration activities, chiefly by the staff of the West Australian Petroleum Pty Ltd (WAPET). The currently accepted stratigraphical picture has recently been presented by McWhae, Playford, Lindner, Glenister, & Balme (1958), and the reader is referred to this paper for the overall situation and the relationships of the formations mentioned in the present descriptions of the fossils.

The occurrence of Upper Jurassic and Lower Cretaceous formations in this region has been known for many years, but only in recent years have the nature and extent of the sequences become known in reasonable detail. The only description of Upper Jurassic fossils of this area is found in a short paper by Teichert (1940a).

Unfortunately several of the fossil specimens described hereafter were lost in the fire in the Canberra offices of the Bureau of Mineral Resources in April, 1953. The illustrations on plates I and II had to be made up from discoloured and singed photographs, the negatives of which did not survive the fire. Mostly, " open " nomenclature is applied even where an obviously new form is in evidence; for new species can only be established where satisfactory type material is still available. The main purpose of this paper is to substantiate earlier statements by showing what fossils have been found, even though this can only be done with the help of photographs which luckily escaped destruction by the fire.

Much of the work for this paper was done before mid-1954, when the writer was still a member of the staff of the Bureau of Mineral Resources, and engaged in work on the stratigraphy and palaeontology of the Australian Mesozoic.

SYSTEMATIC PALAEONTOLOGY.

FOSSILS FROM THE LANGEY BEDS* (late Upper Jurassic).

CEPHALOPODA.

Genus BELEMNOPSIS Bayle 1878 emend. Stolley 1919.

Belemnites of the *gerardi* group are probably the most abundant fossils in the glauconitic siltstone of Langey Crossing on the lower Fitzroy River (= " Langey Crossing Marl " in Guppy et al., 1952). The fossil material consists mostly of either steinkern fragments or incomplete external moulds. This state of preservation is due to decalcification of the rock either during diagenesis or through the present exposure to semi-arid weathering processes. Specific identification of such fragmentary material is very difficult—the species of *Belemnopsis* are difficult to determine even where well preserved complete specimens are available. Like Teichert (1940a), one cannot do more than point out the most likely affinities with better known species of this genus.

BELEMNOPSIS cf. B. AUCKLANDICA (Hochstetter).

(Pl. 1, fig. 9, text fig. 1.)

Belemnopsis alfurica (Boehm)—Teichert, 1940a, pl. 1, figs. 17, 18.
Belemnopsis cf. *tanganensis* (Futterer)—Brunnschweiler, 1951a, p. 8.
Belemnopsis cf. *gerardi* (Oppel)—Guppy, 1953, p. 112.
Belemnopsis cf. *B. aucklandica* (Hochstetter)—Brunnschweiler, 1957, p. 6.
Belemnopsis—Guppy et al., 1958, p. 62 (part).
Belemnopsis cf. *B. tanganensis*—McWhae et al., 1958, p. 90.

About a dozen steinkern fragments and external moulds are referred to this species. They are similar to the specimen, fig. 9 on pl. 1, which is of average size; the rostra in the Canberra collection range from about five-eighths to one and one-third of the size of the figured specimen. All these rostrum fragments, like the one figured, are fairly slender and almost cylindrical. They are neither club-shaped with rapidly tapering point, like some hibolitids, nor elongate lance-shaped with slowly tapering and drawn-out sharply pointed end, like *B. tanganensis* (Futterer). The sides of the rostrum are slightly flattened; lateral lines are absent. The ventral groove is fairly deep in the middle and upper part of the rostrum and becomes gradually shallower and narrower towards the point. How far from the point the groove ends is not known, but that it does end before reaching the point is evident from the fact that grooved apical fragments have never been found. Bottom and shoulders of the groove are evenly, yet sharply, rounded: the bottom more sharply than the shoulders.

The cross section of the rostrum is subcircular, the dorso-ventral diameter exceeding the lateral by about 13 per cent. near the alveolus, and by about 9 per cent. towards the point. Details of the phragmocone and the alveolus are not known.

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* The informal " Langey Beds " is preferred to " Langey Siltstone " because the field relationships of this formation are uncertain. It is only known from a single small outcrop.

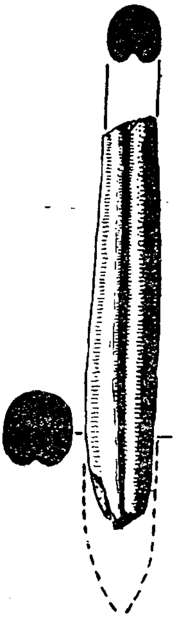

Figure 1.—*Belemnopsis* cf. *B. aucklandica* (Hochstetter), X 1. Ventral view with cross sections of specimen shown in Pl. 1, fig. 9. Suspected outline of apical part of rostrum shown in broken line.*

The form certainly belongs to the *gerardi*-group of the genus *Belemnopsis,* but specific identification cannot safely be undertaken. There are similarities to *B. gerardi* (Oppel), to *B. alfurica* (Boehm), to *B. aucklandica* (Hochstetter), and to *B. tanganensis* (Futterer), yet none of these species is really like the form from Langey Crossing.

B. gerardi has neither the fairly deep ventral groove nor the neatly flattened sides of the Australian form. *B. alfurica* has the same type of ventral groove yet lacks the flattened sides. In *B. tanganensis* the ventral groove is distinctly wider adapically and the rostrum as a whole is more slender. Moreover, all these species are said to have lateral lines. They are absent on the Australian form. Especially on account of the latter feature *B. aucklandica* (Hochstetter 1863) appears to be the most closely related species, all the more as it is known to occur in the Upper Jurassic of the Lesser Sunda Islands (Stolley, 1929). *B. aucklandica* has recently been refigured in Marwick (1953). The form of its rostrum, the characters of the ventral groove, the increase in the flattening of the sides towards the alveolus, and the absence of lateral lines (Hauer, in Zittel, 1864) are all features which are also characteristic of the Australian material. The only apparent difference appears to be in size. *B. aucklandica* is a rather big form, whereas the material from Langey Crossing rarely reaches two-thirds of the size of the New Zealand species, and specimens as large as the one figured in Marwick (1953) are quite unknown. On the other hand, some representatives of *B. aucklandica* in the Lesser Sundas (Stolley, 1929) also do not reach the size of the New Zealand individuals.

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* Because of the damaged or badly discoloured state of the photographs on Pl. 1 and Pl. 2 I have made interpretative line drawings of these photographs and present them as text figures.

One of the specimens figured in Teichert (1940a, pl. 1, figs. 17, 18) under the name of *B. alfurica* (Boehm), because Teichert believed the absence of lateral lines to be due to wear, is conspecific with the *aucklandica*-like species from the Langey Beds.

The specimen Pl. 1, fig. 9 (also text-fig. 1) was lost in the 1953 fire. Other material is kept under No. F.21670 and No. R.7887 in the B.M.R. Museum, Canberra.

BELEMNOPSIS cf. B. ALFURICA (Boehm).

(Pl. 1, fig. 5; text-fig. 2.)

cf. *Belemnopsis* cf. *B. alfurica* (Boehm)—Teichert, 1940a, figs. 14-16.
Belemnopsis cf. *gerardi* (Oppel)—Brunnschweiler, 1951a, p. 8.
Belemnopsis cf. *B. alfurica* (Boehm)—Brunnschweiler, 1957, p. 6.
Belemnopsis—Guppy et al., 1958, p. 62 (part).
Belemnopsis cf. *B. gerardi*—McWhae et al., 1958, p. 90.

Among material from Langey Crossing are several fragments which have a shallower and wider ventral groove than the *aucklandica*-like form. In size and general shape of the rostrum the two forms are, however, very much the same. Faint lateral lines seem to be present, but the material before me is not quite good enough to be absolutely certain about it.

As the general shape of the rostrum is the same in both species from the Langey Beds an apical fragment is chosen to illustrate the shallowly grooved form. At the same time the rate of tapering common to both species can be shown (text fig. 2).

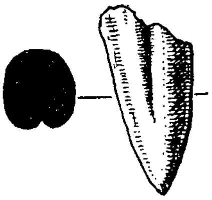

Figure 2.—*Belemnopsis* cf. *B. alfurica* (Boehm), X 1. Ventral view and cross section of same specimen as Pl. 1, fig. 5.

The absence of a sharp point is a feature of all apical fragments. All have a little hole at the apex, usually about 1 mm. in diameter and up to 1.5 mm. deep.

The wide but sharp-bottomed groove removes this species from both *Belemnopsis gerardi* and *B. tanganensis*. As there seems to be a trace of lateral lines the form's affinities are closest to *B. alfurica,* all the more as Teichert (1940a) identified this species in material from water bores in Broome. Teichert's specimen is evidently conspecific with the Langey Crossing form.

The specimen pl. 1, fig. 5 was lost in the 1953 fire. Topotypic material is kept under No. R.7887 in the B.M.R. Museum, Canberra.

Genus KOSSMATIA Uhlig 1907.

Ammonites are probably not scarce in the Langey Beds, but the very small and so far only known outcrop (about 50 sq. yards) severely limits the chances for the collector. Half a dozen fragments were found during the field seasons of 1949 and

1950, and the best two of them are described here. Unfortunately, the whole collection was lost in the 1953 fire and the only proofs of their existence are the photographs on Pl. 1, from which also the text figures were drawn.

KOSSMATIA cf. K. TENUISTRIATA (Gray).

(Pl. 1, figs. 3 and 45; text-fig. 3.)

Kossmatia cf. *K. tenuistriata* Uhlig—Brunnschweiler, 1951a, p. 8.
Kossmatia Uhlig—Guppy, 1953, p. 112.
Kossmatia—Fairbridge, 1953, p. IX/2.
Kossmatia cf. *K. tenuistriata* Uhlig—Brunnschweiler, 1957, p. 6.
Kossmatia—Guppy et al., 1958, p. 62.
Kossmatia cf. *K. tenuistriata*—McWhae et al., 1958, p. 90.

The collection contained five fully septate fragments of this form. Although none of these fragments could be accurately measured they evidently all belong to a species in which the whorl height is about twice maximum width, which is about two-thirds of the whorl height up from the umbilical shoulder. The flanks are flattened. The umbilical shoulder is evenly, but sharply, rounded and the umbilical wall low and steep. The venter is evenly rounded, with a tendency to become slightly flattened, and it merges smoothly with the flanks (text-fig. 3).

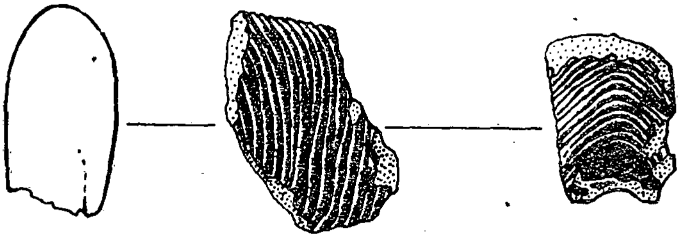

Figure 3.—*Kossmatia* cf. *K. tenuistriata* (Gray) X 2. Cross section, lateral, and ventral view of same specimen as shown on pl. 1, figs. 3 and 4.

The ribs are low, very closely spaced, and rounded. Interspaces are rather sharp furrows, i.e., they are noticeably narrower than the ribs. Over the umbilical shoulder the ribs curve backward, then turn into a radial direction at the bottom of the flanks. They remain radial until, about two-thirds way up the flanks, they turn into a conspicuous forward swerve. On the venter the ribs are not interrupted. There are single, bifurcate, and trifurcate ribs, the forking taking place at a distance varying from half to two-thirds of the whorl height up on the flanks. On the venter the ribs are all of equal size and shape (text-fig. 3).

Parts of the septal suture have been observed on most fragments but the sutural elements could not be identified, nor the entire suture reconstructed, because of poor preservation.

There is little doubt that all these fragments from Langey Crossing belong to the Upper Jurassic genus *Kossmatia* Uhlig. The dense ribbing and the compressed whorl shape suggest close affinity to the species *K. tenuistriata* (Gray) as shown in Uhlig (1910), i.e., to the type of the genus *Kossmatia.*

The specimen shown in the text-figure and on Pl. 1 was destroyed in the 1953 fire, the only record now being the photographs.

KOSSMATIA sp. aff. K. TENUISTRIATA (Gray).

(Pl. 1, figs. 1 & 2; text-fig. 4.)

Kossmatia n. sp. ind. aff. *K. tenuistriata* Uhlig—Brunnschweiler 1957, p. 6.

Besides the five fragments described above there is one somewhat larger fragment of the septate portion of a conch, which is characterized by less regular and slightly coarser ribbing and by the occasional appearance of quadrifurcate ribs. Moreover, the points where the ribs fork seem to be lower on the flanks than on the previously described form (text-fig. 4).

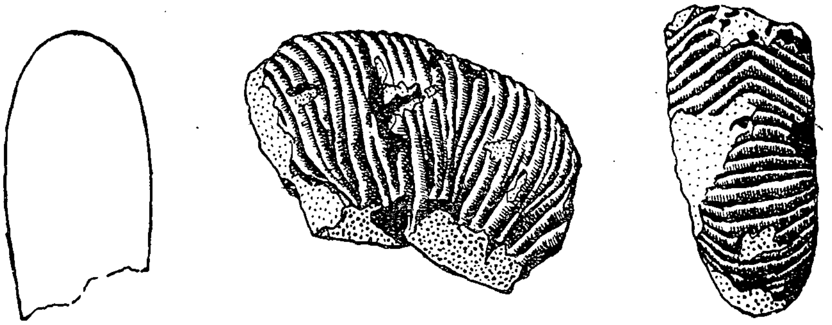

Figure 4.—*Kossmatia* sp. aff. *K. tenuistriata* (Gray), X 2. Cross section, lateral, and ventral view of same specimen as shown in Pl. 1, figs. 1 and 2.

Because the whorl height of this specimen is greater than that of all other fragments of *Kossmatia* in the collection it may be that the distinguishing features are simply those of the later growth stages of the species *tenuistriata,* and not those of another species. However, the differences appear conspicuous enough to deal with this form separately.

The lower forking points of the ribs on the flanks suggest that the form might easily be identified with a species of the genus *Substeueroceras* Spath 1923, all the more as even on this rather large fragment there is no indication of the ribs being interrupted on the venter, or the venter being grooved or concave as it is in most species of the genus *Kossmatia* (though not in *tenuistriata*). The tendency to a flattened venter also points to *Substeueroceras* to some extent.

PELECYPODA.

Genus BUCHIA Rouillier (= AUCELLA Keyserling).

Next to *Belemnopsis* the most common fossil in the Langey Beds is *Buchia*: most rock specimens show a number of cavities which are external moulds of *Buchia.* Frequently one also finds internal casts in the form of " steinkerns " which partly fill cavities. This mode of preservation makes the study of the material rather difficult because complete and well preserved specimens are wanting. Before the 1953 fire there were in the collection about half a dozen internal and a few external casts of more or less damaged left valves as well as four internal and one external casts (all damaged) of right valves of *Buchia* available for study. The best of these specimens are figured in this paper. The originals were lost in the fire, but topotypic material is kept under R.7887.

Buchia malayomaorica (Krumbeck).

(Pl. 1, figs. 6-8 and 10-13; text-figs. 5 and 6.)

Buchia cf. *malayomaorica* (Krumbeck)—Brunnschweiler, 1951a, p. 8.
Buchia malayomaorica—Fairbridge, 1953, p. IX/2.
Buchia malayomaorica (Krumbeck)—Brunnschweiler, 1957, p. 6.
Buchia cf. *B. subspitiensis* (Krumbeck)—Brunnschweiler, 1957, p. 6.
Buchia malayo-maorica—McWhae et al., 1958, p. 90.

The Langey Crossing species is small, obliquely oval, with anterior and posterior margins of outline subparallel. The left valve (Pl. 1, figs. 6, 7, 8, 12, 13, text-fig. 5) is rather broad and inflated in most individuals, but a few, such as Pl. 1, fig. 12 (text-fig. 5a), are rather narrowly elongate. The other extreme is represented by the specimens pl. 1, figs. 6 and 13 (text-figs. 5b, 5c). The umbo is short and blunt, not noticeably twisted, and lies directly on the margins of the hinge-line. Anterior and posterior ears are usually present, typically of about equal size and broadly rounded. The ventral margin merges in a broad curve with the anterior margin, but posteriorly the outline is characterized by a sharp, often almost angled, curve.

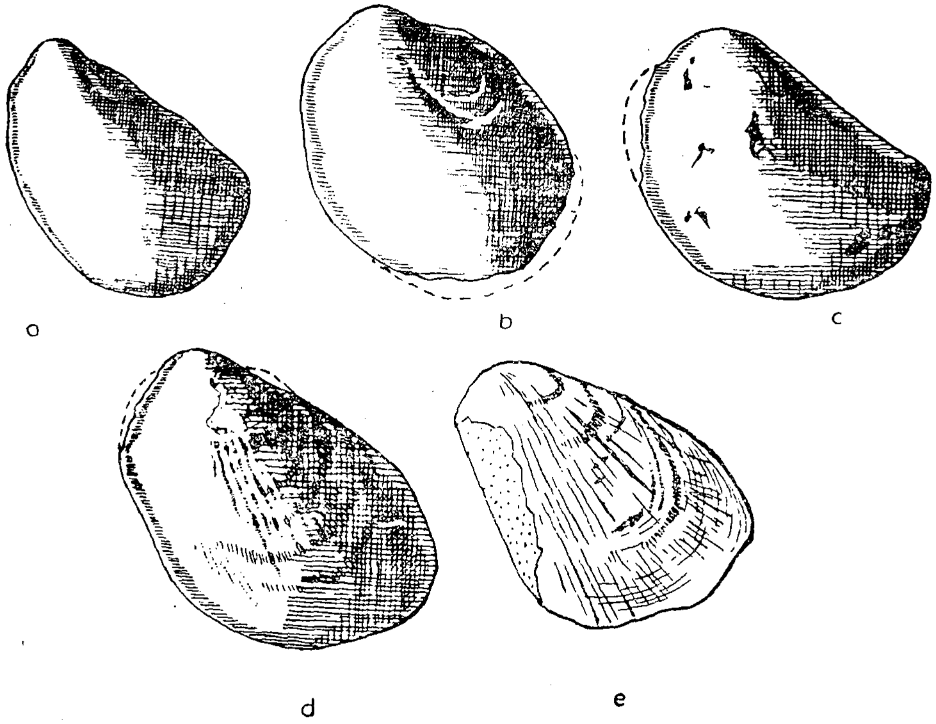

Figure 5.—*Buchia malayomaorica* (Krumbeck). Left valves (ink drawings of specimens shown on Pl. 1), X 2.

5a, 5b, 5c—Steinkerns showing variation in outline of the Langey Crossing species. Note characteristic steep posterior and gentle anterior sloping of shell, its little detached ears, and muscular scars.

5d, 5e—Steinkern (5d) and external mould (5e—Plasticine cast) of the same individual (Pl. 1, figs. 7 and 8), showing the typical ornament of the species.

The right valve (Pl. 1, figs. 10, 11, and text-fig. 6) is almost flat and, on steinkerns, its umbo is so little elevated that it is contiguous with the prominent byssal ear. The form of the byssal notch itself cannot be observed on our damaged specimens, but it appears to have been rather large and about as indicated by the broken lines on text-fig. 6. In outline the right valve is more circular than the left, in size it is noticeably, but not very much, smaller.

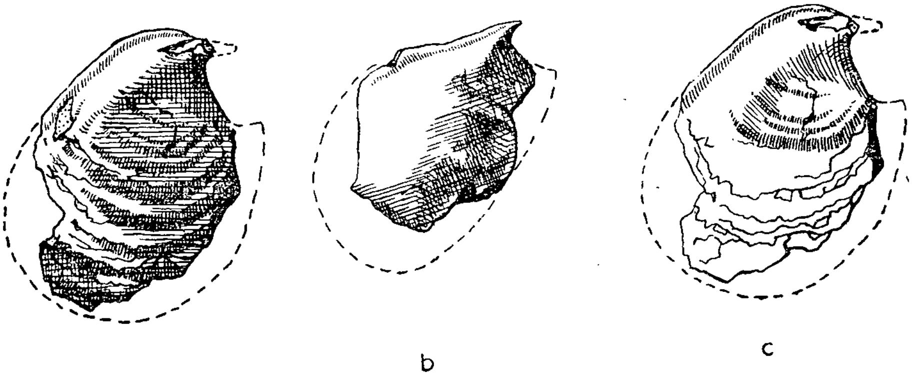

Figure 6.—*Buchia malayomaorica* (Krumbeck). Right valves (ink drawings of specimens shown on Pl. 1), X 2.

6a. Damaged steinkern with partly preserved outer shell layer.

6b. Damaged steinkern, a more elongate oval right valve.

6c. Same specimen as 6a with ornament omitted to show the typically lamellar structure of outer shell layer.

Shell ornament is seldom preserved on internal casts. The only steinkern fragment showing traces of the typical fine and dense radial, and broad-folded concentric, ribbing of *Buchia malayomaorica* is shown on Pl. 1, fig. 8. Pl. 1, fig. 7, however, shows that the external aspect of the ornament of the same individual (the steinkern was found locally in place in the mould) is in all respects quite as shown in Wandel (1936, pl. 17). As on East Indian specimens the radial ornament is very weak on many right valves, and invariably weaker than on left valves. The concentric ornament on both valves consists of broad, rather irregular, folds which seem also to mark growth stages of the individuals. The outer layers of the test are built of paper-thin lamellae (Pl. 1, fig. 11, and text-fig. 6c). This is a very characteristic feature of members of the *Buchia* family.

The *Buchia* species from the Langey Beds is undoubtedly *B. malayomaorica;* no other species occurs in the single small outcrop. Until the evolutionary sequence of the Buchiidae is better known it will be difficult to determine what the formation's stratigraphical relationship is to (a) the beds with *B. subspitiensis* (Krumbeck), *B. subpallasi* (Krumbeck), *Belemnopsis* cf. *B. alfurica,* and *B.* cf. *B. incisa* (Stolley) at 1,184 to 1,390 feet in the Broome town waterbores, some 90 miles to the west, (b) the equivalent beds with the same faunule at around 200 feet in the Yeeda Homestead bore, about 12 miles to the north-east (Teichert 1942), or (c) the Jarlemai Formation with *Buchia* cf. *B. extensa* (Holdhaus) and *B.* cf. *B. spitiensis* (Holdhaus), 70 miles to the south (Brunnschweiler, 1954, p. 49). This question is discussed below on p. 37.

INFUSORIA—TINTINNINA.

Genus CALPIONELLA Lorenz 1901.

CALPIONELLA SCHNEEBERGERI sp. nov.

(Text figures 7, 8.)

Calpionella Lorenz—Brunnschweiler, 1951b, and 1954, p. 52.
Calpionella n. sp. (similar to *C. alpina* Lorenz)—Brunnschweiler, 1957, p. 6.
Calpionella schneebergeri—McWhae et al., 1958, p. 90 (*nom. nud.*).

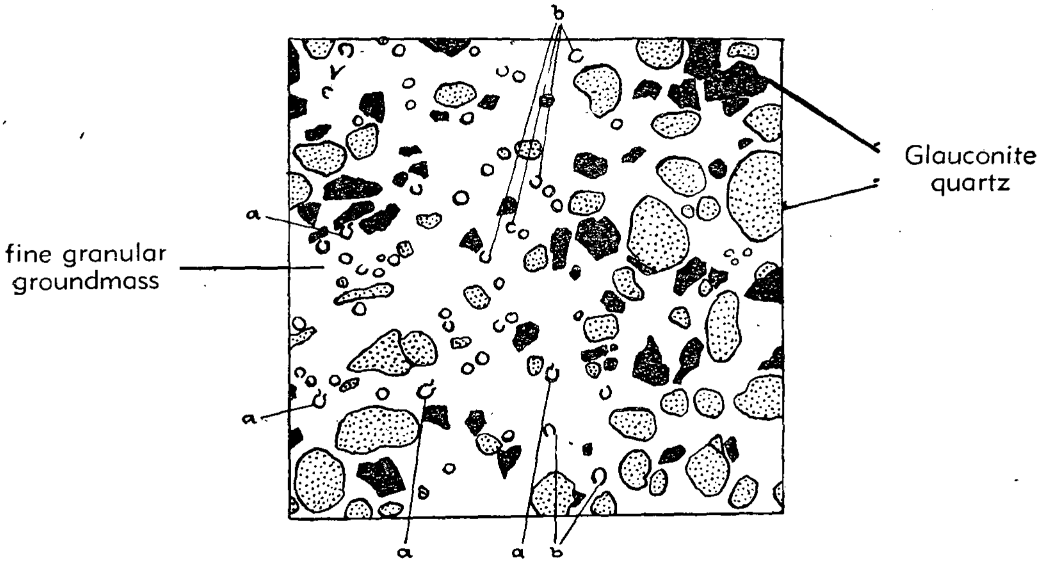

Fig. 7.—Type thin section, x 60. Ink drawing from photomicrograph. (*a*) *Calpionella schneebergeri* **sp. nov., longitudinal section** (*b*) *Calpionella* **cf.** *C. undelloides* **Colom.**

Diagnosis: Lorica globular or subglobular, slightly contracted toward the apex. Collar high, inverted conical. Walls of lorica thick but without agglutinated foreign particles. Base of collar not thickened. For schematic cross-section see text-fig. 8.

Remarks: The new species belongs with the smaller forms of the genus. The width is not more than 50 microns and the height not more than 70 microns. Most individuals in the type section (text-fig. 7) show dimensions of only 40/55 microns. An unusual feature is the absence of calcite in the material of the lorica. This must be due to diagenetic leaching which has decalcified the rock, as is also demonstrated by the fact that macrofossils are only preserved as moulds and casts. The Tintinnina loricas appear dark in transmitted light: the material is most likely an iron oxide.

Comparisons: Calpionella schneebergeri is probably closest to *C. alpina* Lorenz, but the latter has a nearly cylindrical collar and its apical region is characteristically pointed. Other species of the genus have much more elongate oval, or pointed, loricas, or they lack the collar (Campbell, 1954).

Type material: The original thin section of which the ink drawing (text-fig. 7) was made was lost in the fire, but the relevant specimen from the type locality is available in the B.M.R. Museum, Canberra, under No. R.7886, and another thin section has been made and registered as C.P.C. 573.

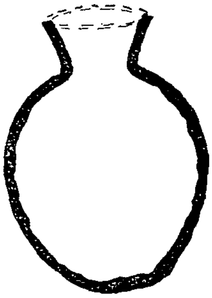

Fig. 8.—*Calpionella schneebergeri* sp. nov. Schematic cross-section, greatly magnified, of an individual whose width is 40 microns and the height just over 60 microns including the collar.

The new species is named after Dr. Werner F. Schneeberger (now of Denver, Colorado, U.S.A.), former Supervising Geologist with the Bureau.

CALPIONELLA cf. C. UNDELLOIDES Colom.

(Text-figure 9).

Calpionella Lorenz—Brunnschweiler, 1951b, and 1954, p. 52.

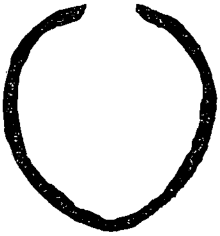

Fig. 9.—*Calpionella* cf. *C. undelloides* Colom. Cross-section, greatly magnified, of an individual whose width is about 40 microns and height 50 microns.

In addition to *C. schneebergeri*, the Langey Beds contain numerous examples of a collarless *Calpionella* with a thickened lorica wall at the aperture. Colom (1939, 1948) has described almost identical forms with oval loricas under the name of *C. undelloides*, and compared them with Recent species of the genus *Undella*. They are commonly associated with *C. alpina* and *C. elliptica* Cadish, i.e. a faunal composition similar to that seen in north-western Australia, where *C. alpina* is represented by *C. schneebergeri*.

Specimens of *C. undelloides* can be seen on the type thin section (text-fig. 7) for *C. schneebergeri*.

OTHER FOSSILS.

The Langey Beds are richly fossiliferous, but decalcification left only fragmentary casts and moulds and thus has made specific identification of the material extremely difficult, and partly impossible. On the generic level the following forms have been noticed:

Pelecypoda: Species of *Nucula, Cucullea, Modiolus, Exogyra, Opis,* and *Astarte*.
Brachiopoda: Two unidentifiable rhynchonellids.
Radiolaria: Chiefly spumelline and nasseline genera.

It is hoped that sooner or later better material will become available to allow of accurate identification of the many elements of this interesting and stratigraphically important fauna. Among other things there seems to be a good chance here to solve the problems of the apparently aberrant evolutionary sequence (Brunnschweiler, 1951a) of the Southern Hemisphere Buchiidae and of the stratigraphical position and distribution of some of the species of the ammonoid genus *Kossmatia* Uhlig. Recently this genus has been transferred from the Tithon-Neocomian family Berriasellidae to the Kimmeridgian Ataxioceratinae (Arkell, 1957). This change affects previous age concepts of the Langey Beds (Brunnschweiler 1951a, 1951b, 1954, 1957) and will be discussed later on in this Bulletin (p. 36).

FOSSILS FROM THE JOWLAENGA FORMATION (EARLY NEOCOMIAN).

In places the Jowlaenga Formation is fairly rich in marine fossils, but original fragmentation of the material in shallow near-shore environments as well as subsequent decalcification and other weathering damage has mostly left only rough casts and moulds on which the more delicate morphological details are usually lost. In addition, moulds from material near the surface are commonly lined with a thickish coating of iron oxides. Many of the moulds, especially of belemnites, are completely filled with a hard deep-red hematitic mass which shows no internal texture that would reflect the structure of the test of the original fossil. In other words, the mould cavity left behind after the calcite of the belemnite rostrum had been dissolved was at some later stage filled in with the precipitate of iron solutions. Such hematitic " steinkerns " therefore display at best some features of the original external moulds; they are not steinkerns in the proper sense, such as occur in the Langey Beds, whose surfaces would show features of the internal casts of the fossils.

CEPHALOPODA.

Genus HIBOLITES de Montfort 1808 emend. Stolley 1919.

Although belemnites are not uncommon in the Jowlaenga Formation the deeply and broadly grooved belemnopsoid forms are absent. In this, and even more in the composition of its other faunal elements, this formation differs decisively from the Langey Beds. In fact, after a careful study of the literature on the subject I am now convinced that even the forms which I had previously regarded as belemnopsoids are in fact hibolitoids, and that the formation is very likely in a " post-belemnopsoid age ", as is indicated also by other faunal elements.

HIBOLITES cf. H. SUBFUSIFORMIS (Raspail).

(Pl. 1, figs. 14, 15; text-figs. 10, 11.)

Hibolites subfusiformis (Raspail)—Brunnschweiler, 1951a, p. 8.
Belemnopsis sp. aff. *tanganensis* (Futterer)—Brunnschweiler, Ibid.
Hibolites—Fairbridge, 1953, p.X/8.
Belemnopsis—Fairbridge, Ibid.
Belemnopsis cf. *B. tanganensis* (Futterer)—Brunnschweiler, 1957, p. 7.
Hibolites cf. *H. subfusiformis* (Raspail)—Brunnschweiler, Ibid.
Belemnopsis—Guppy et al., 1958, p. 62.
Belemnopsis cf. *B. tanganensis*—McWhae et al., 1958, p. 106.
Hibolites cf. *H. subfusiformis*—McWhae et. al., Ibid.

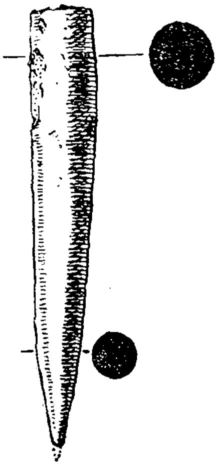

Figure 10.—*Hibolites* **cf.** *H. subfusiformis* **(Raspail) Hematitic filling of a mould of lower half of a rostrum. X1. C.P.C..574.**

The features of the genus *Hibolites* have recently again been summarized by Swinnerton (1955). It is a very distinct genus, but some confusion remains on the specific level. *H. subfusiformis*, for example, is still not clearly defined (Stolley, 1935) and comprises a group of similar forms rather than what is usually taken as a species. It is therefore with this group rather than with any particular representative of it that the specimens here figured have to be compared.

The ironstone internal cast (of an external mould) shown in text-fig. 10 (= Pl. 1, fig. 14) represents a third or perhaps half of a rostrum of the species. The cross-section is circular or very nearly so at all levels of the specimen: flattening of the sides is scarcely noticeable. Even from such an adapical fragment it is evident that the complete rostrum must have been elegantly slim and elongate with little inflation of the stem, which converges slowly and steadily towards a drawn-out acute apex. Neither a ventral groove nor lateral lines are present. The latter may have been obliterated by the particular mode of preservation of the specimen or because, on larger individuals, they have been rubbed off even before petrifaction. The very slight tendency to have flattened sides does perhaps indicate that this form possessed lateral lines. The absence of a ventral groove on an adapical fragment of a rostrum is, of course, typical of a *Hibolites* species.

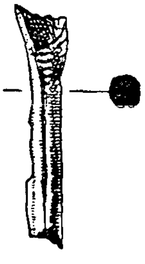

Figure 11.—Partly exfoliated fragment of the alveolar region of *Hibolites* **cf.** *H. subfusiformis* **(Raspail) X 1.**

As shown by the specimen illustrated in text-fig. 11 (= Pl. 1, fig. 15), which is taken to be conspecific with that in text fig. 10, the sides of the alveolar region converge rapidly backwards towards the stem and, about the level of the protoconch, the cross-section shows some lateral flattening. The ventral groove is narrow and shallow. It does probably not extend very much farther than the broken adapical end of the specimen, where it is already about to run out and disappear.

This specimen and another similar fragment have been responsible for the records in previous papers of *Belemnopsis* cf. *B. tanganensis* (Futterer). I had failed to realize the significance of the gradual fading-out of the ventral groove on the forward portion of the stem and—despite the fact that on *B. tanganensis* this groove is very much wider—I ventured to place these fragments with the genus *Belemnopsis,* the only good Neocomian species of which is *B. tanganensis.* But the specimens certainly belong with *Hibolites,* and probably represent alveolar fragments of the forms whose adapical, non-grooved and circular, stem parts look like the specimen shown in text-fig. 10.

Proper specific identification of fragmentary material of *Hibolites* is, as mentioned above, not possible. There is a general likeness to what is loosely called *Hibolites subfusiformis* (Raspail), but also to younger (Barremian—lower Aptian) species such as *H. jaculoides* Swinnerton, especially its variety *stylirostris* Swinnerton, from the Speeton Clay (chiefly its zone C.). The material is here tentatively compared with *H. subfusiformis* because that species occurs in the Neocomian beds of the Lesser Sunda Islands, and other similar species are known to occur on both shores of an ancient Timor Sea.

Material identified as *Hibolites subfusiformis* is kept under No. F.21671 in the B.M.R. Museum, Canberra. It was collected by the author from the basal beds at Mt. Clarkson (see map in Brunnschweiler, 1957).

ANCYLOCERATOID genus indet.

(Pl. 1, fig. 27; text-fig. 12.)

Hoplites sp. indet.—Brunnschweiler, 1951a, p. 8.
?Crioceras—Fairbridge, 1953, p. X/8.
Crioceras sp. indet.—Brunnschweiler, 1957, p. 7.
Crioceras—McWhae et al., 1958, p. 106.

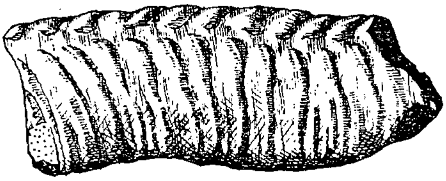

Figure 12.—Fragment of an ancyloceratoid genus. X 1. C.P.C. 575.

An enigmatic fragment of what I take to be an uncoiled ammonoid genus of the early Cretaceous, probably *Protancyloceras* Spath 1924, is figured in Pl. 1, fig. 27, and text-fig. 12. The type of uncoiling appears to be very irregular, the fragment evidently being from the living chamber, whose cross-section appears to have been subquadrate with a slightly fastigate venter. In other words, the specimen is taken to turn its broad flank and half of the venter against the viewer, the adoral direction being to the left. Small and low bullate ventro-lateral nodes are developed just below the rather angular ventral shoulder. The nodes sit at the upper end of the single ribs, which are interrupted on the ventral shoulder itself. The interruption of the ribs produces a feature similar to a narrow and shallow "spiral" furrow which runs along the ventral shoulder. The ribs are low and rounded, rather irregularly and closely spaced (about seven ribs on a length equal to estimated whorl height), and prorsiradiate. Especially on the lower part of the whorl side growth striae are visible. In places they are so strong as to simulate finer, intercalate, ribs.

The interpretation of this unique fragment as an ancyloceratoid genus is perhaps rather venturesome. Originally I regarded the spiral furrow as being ventral, not ventro-lateral as I do now. The nodes together with the furrow then recalled ornaments that are characteristic of hoplitoid (in the widest sense, i.e., including some Neocomitinid) genera, and the uncoiled appearance was interpreted as due to distortion during fossilization. This is now believed to be unlikely and ancyloceratoid affinities are regarded as a better interpretation for this fragment. Even so, however, it cannot be placed with any of the known genera of early Cretaceous Ancyloceratacеae, mainly on account of the unusual ornament and the ventro-lateral spiral furrow. The question must remain open until further examples of this form are found.

PELECYPODA.

Genus MELEAGRINELLA Whitfield 1885.

(= *Echinotis* Marwick 1935 = ?*Clathrolima* Cossman 1908.)

Cox (1941), after having examined topotype material of "*Avicula*" *curta* Hall, claimed that *Echinotis* Marwick must be taken as a subjective synonym of *Meleagrinella* Whitfield. This interpretation seems now generally accepted, although one cannot help but feel that Marwick (1935) did not create *Echinotis* for forms such as "*Avicula*" *curta* (Whitfield's genotype) and "*Eumicrotis*" *orbiculata* Whitfield. According to figures in the relevant literature Whitfield's genotype has typically a short hinge-line which, together with its small and subequal ears, places it rather close to *Pseudomonotis* Beyrich 1862, i.e. as Whitfield (1880) originally thought. Yet this is evidently not the type of form for which Marwick meant to create *Echinotis* (Genotype = "*Avicula*" *echinata* W. Smith). The salient point is, of course, that Cox (1941) makes a categorical statement to the effect that the figures in the literature are misleading and that, in his opinion, the species *curta* Hall and *echinata* Smith cannot be taken as types of different genera.

Whitfield (1885) unfortunately introduced *Meleagrinella* in conjunction with a re-description of the species *abrupta* Conrad. This form, because of its large posterior ear and very long hinge-line, is quite unlike *curta* Hall (Hall & Whitfield 1880), the genotype of *Melagrinella.* In fact, it is typical of those forms for which Marwick established *Echinotis. Echinotis* undoubtedly would be a synonym of *Melagrinella* if Whitfield (1885) had declared *abrupta* Conrad as the genotype. Thus, and in spite of the fact that Whitfield's type forms are Mesozoic (Upper Jurassic) and that Cox (1941) regards *curta* Hall and *echinata* Smith as congeneric, one cannot help entertaining slight doubts whether *Meleagrinella* might not remain a junior synonym of *Pseudomonotis* Beyrich (= *Eumicrotis* Meek), in which case *Echinotis* Marwick would have to be retained. Considering the varied new material found in Western Australia *Echinotis* may turn out to be a sound and useful genus.

Pseudomonotis Beyrich 1862 is at present believed to be restricted to the Upper Carboniferous and the Permian (Ichikawa, 1958). It includes those inequivalve aviculopectinids which are of small to moderate size, have a rather short hinge-line (by comparison with *Oxytoma* Meek, *Meleagrinella* Whitfield, etc.) and small ears, the anterior slightly smaller than the posterior. The ornament commonly differs on left and right valves, but in most species both radial—often predominant—and concentric elements occur. Stoliczka (1870) designated the Permian "*Gryphites*" *speluncaria* Schlotheim as genotype of *Pseudomonotis.* Ever since there have been discussions on the rights and wrongs of this action. Bittner (1901) as well as Diener (1902) made it clear that Beyrich really had the Triassic *ochotica*-group in mind when he introduced *Pseudo-Monotis* as a subgenus of *Monotis* Bronn 1830. Accordingly Diener revived and applied *Eumicrotis* Meek 1864 for the distinctive species of the *speluncaria*-group. However, this procedure is not acceptable, by the Rules. A more acceptable revival of *Eumicrotis* has been suggested by Newell (1955, p. 20), who would apply it to the sessile (cicatriced) pseudomonotids of the Permian, e.g. "*Monotis*" *hawni* Meek & Hayden, the genotype of *Eumicrotis.*

For the purposes of the present paper the concepts of Cox (1941) and Ichikawa (1958) are accepted and *Echinotis* is taken as a synonym of *Meleagrinella.*

MELEAGRINELLA sp. nov. aff. M. CURTA (Hall).

(Pl. 1, figs. 18, 19, 21, 23, 24; text-figs. 13, 14.)

Meleagrinella n. sp. *b.*—Brunnschweiler, 1957, p. 8.

Description: Left valve (Pl. 1, fig. 21 and text-fig. 13a) with sub-circular outline, slightly higher than wide, little oblique, with subcentral prominent sharply curved and pointed umbo. Anterior and posterior ears subequal and obtusely angled. Hinge-line straight, its length about half the width of the shell. Ornament consists of straight radial riblets—primary, secondary, and a few short tertiaries in the central, marginal, area of the disc. Interspaces are wider than riblets. The riblets carry distinct and discrete little nodes which are due to the intersection of the radial with the concentric ornament. The latter consists of fine striae which meet the dorso-posterior margin at an acute angle (text-fig. 13a) and are therefore not truly concentric in relation to the umbo. The radial ornament is strongest on the axial region of the valve and becomes very attenuated anteriorly as well as posteriorly. The concentric striae are quite distinct on the posterior third of the disc. In the axial area they disappear as striae but create the little nodes on the radial riblets. These nodes weaken gradually and finally disappear near the anterior margin.

The right valve of this species is believed to be represented by the specimens figured in Pl. 1, figs. 23, 24 (text-fig. 14). Unfortunately no specimens have been found with both valves in position. The right valve is near-circular, almost flat and, except for the cardinal margin, evenly rounded, with very little obliquity. Height and width are about equal. The anterior ear is a prominent linear process which is parallel to the hinge-line or just slightly turned toward the left valve. The subauricular notch beneath it is rather wide and deep because the antero-cardinal margin falls away at an appreciable angle. The posterior ear is small but neatly individualized by a slight re-entrant in the valve margin immediately below it. The ornament is weak or absent. It consists of closely set and very low radial riblets which are crossed, near the valve margin, by barely noticeable, somewhat irregular, concentric folds.

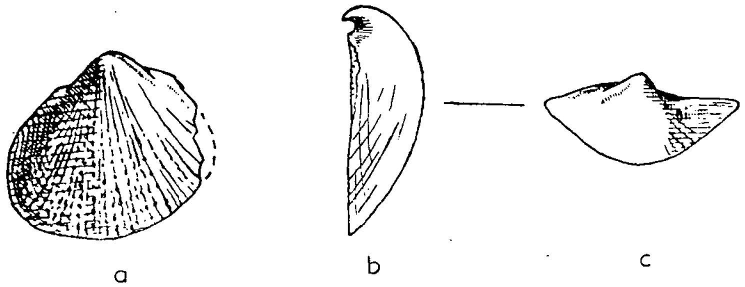

Figure 13.—*Meleagrinella* **sp. nov. aff.** *M. curta* **(Hall), X 2.**

a = **Left valve showing typical ornament, C.P.C. 576.**

b = **Left valve of another specimen, anterior aspect showing inflation and pointed curved umbo, C.P.C. 577.**

c = **Same valve as (*b*), dorsal aspect.**

Figures 18 and 19 on Pl. 1 and text-figs. 13b and c demonstrate the posterior and the dorsal aspects of the largest of the left valves in the collection. Pl. 1, fig. 24, and text-fig. 14b show the outline of the right valve of a young individual. This small specimen is not very much larger than the " prodissoconch " shown in text-fig. 29b and one notices that the marked differences between *Meleagrinella* sp. nov. aff. *M. curta* and the Oxfordian *Meleagrinella maccoyelloides* sp. nov. (see Appendix 1, p. 39) appear rather early in the ontogeny.

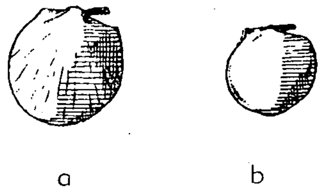

Figure 14.—*Meleagrinella* **sp. nov. aff.** *M. curta* **(Hall) X 2.**

a = **Right valve of an adult individual, side view. C.P.C. 578.**

b = **Right valve of a young individual, side view.**

Both internal casts.

Although details of the hinge are not observable on the available material it is obvious that the Australian form with its broadly subcircular outline and distinctive ornament (of the left valve) stands well enough apart from other forms to be regarded as a new species. The American *Meleagrinella curta* is the most similar, but it is more elongately oblique and the nodes on its ribs are quite inconspicuous by comparison with the Jowlaenga species. *M. orbiculata* Whitfield does not have the " beaded " ribs. The mid-Jurassic European forms *M. laevis* (Blake & Hudleston), *M. maltonensis* (Arkell), *M. clathrata* (Lycett), and *M. ovalis* (Phillips) are markedly different both in ornament and outline. The species of what may be called the *echinata*-group, which includes also *M. abrupta* (Conrad) and *M. superstes* (Spitz), show much greater inequality of the ears and they have a much longer hinge-line.

Topotype material is kept under No. F.21672 and R.7888 in the B.M.R. Museum.

MELEAGRINELLA cf. M. SUPERSTES (Spitz).

(Pl. 1, figs. 20, 22, 25, 26; text-fig. 15.)

Meleagrinella sp.—Teichert, 1950, p. 1792.
Meleagrinella n. sp. aff. *M. superstes* (Spitz)—Brunnschweiler 1951a, p. 8.
Meleagrinella—Guppy et al., 1958, p. 62.
Meleagrinella—McWhae et al., 1958, p. 106.

Meleagrinella cf. *M. superstes* is gregarious and is found in great numbers in parts of the formation, mostly as internal casts. Since the most typical material was lost in the 1953 fire a new species cannot now be established on the basis of the rather poor specimens that have been saved.

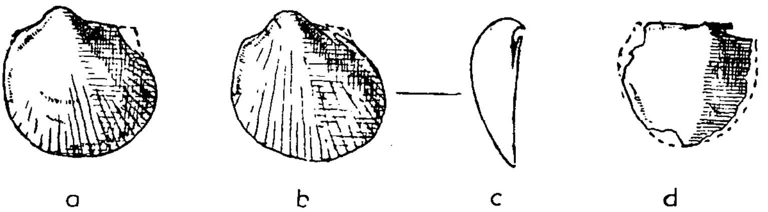

Figure 15.—*Meleagrinella* cf. *M. superstes* (Spitz), X 2.

***a* = Left valve, internal cast, showing large posterior ear and radial ornament. Also weak concentric folds. C.P.C. 579.**

***b* = Left valve of another specimen, internal cast, with posterior wing broken away.. Ornament as in (*a*). C.P.C. 580.**

***c* = Left valve, internal cast, anterior aspect showing inflation and sharply curved, pointed, umbo. C.P.C. 580.**

***d* = Right valve, internal cast, margins damaged but showing the typically long hinge-line and the distinct, relatively thin and small anterior ear.**

The left valve (Pl. 1, figs. 20, 25, 26, and text-figs. 15a-c) has an oblique subcircular outline, higher than wide. The umbo is sharply curved and pointed, rather prominent and slightly forward of the centre. The anterior ear is small and rounded, whereas the posterior is conspicuously extended and forms an obtuse angle with the posterior margin. The straight hinge-line is longer than half the width of the valve. Ornament consists of straight radial riblets which are much thinner than the interspaces. Primary and secondary riblets only seem to be present. The concentric ornament is very weak and consists (only on a few specimens) of very low, irregular, folds.

The right valve (Pl. 1, fig. 22, and text-fig. 15d) is broadly subcircular, noticeably wider than high, almost flat, with very low, non-projecting umbo. The hinge-line is very long and straight. The anterior ear forms a thin, rather small, linear process below which is a narrow, fairly deep, byssal sinus. The posterior ear is very much extended, its junction with the posterior margin angular. The antero-dorsal margin is also angular. Except for one or two indistinct concentric folds near the ventral margin no ornament is noticeable.

Species of *Meleagrinella* are rather common in Middle and Upper Jurassic and Cretaceous beds the world over. They are identified by differences in outline, form and size of ears, and ornament. The mid-Jurassic group of forms similar to *M. echinata* is distinguished by denser and coarser ornament and more complicated outline—especially affecting the posterior margin of left valves—from late Jurassic and early Cretaceous species, which are characterized by simple, more or less subcircular outline, and delicate or even obsolete ornament.

This evolutionary trend is also demonstrated by the Australian representatives of the genus. The Oxfordian/Kimmeridgian formations of the Canning Basin (Brunnschweiler, 1954) contain a series of species of *Meleagrinella.* One of them, the oldest of the series, is described in Appendix 1 (p. 39) under the name of *M. maccoyelloides* sp. nov. Its outline, size, and prominent ornament show that it is not far removed from the mid-Jurassic *echinata* group. All later (Kimmeridgian and after) species have the simpler outline and the delicate ornament.

The nearest occurrences of *Meleagrinella* are in Western Australia itself (Carnarvon Basin and farther south), in Queensland, in India, and in New Zealand. The forms with the closest affinity to the species from the Jowlaenga Formation are *M. superstes* (Spitz) from the Himalayan Giumal Sandstone (Spitz, 1914) and the "*Pseudomonotis* sp." from the marine beds in the Stanwell Coal Measures in Queensland (Whitehouse, 1946). *M. superstes* is more elongate (higher than wide) than the Jowlaenga form, but otherwise, especially in its ornament, it is very similar indeed. The *Meleagrinella* from Stanwell is not quite well enough preserved to make certain of its affinities. What can be seen of it, however, suggests that it is conspecific with the Jowlaenga species. The latter shows some variation in its obliquity too, and the almost acline form (Newell's 1938 terminology) of Stanwell falls within that variation. Since it could not be completely cleaned from the rock matrix (Dr. Whitehouse kindly showed me the specimens) it is, incidentally, quite possible that its obliquity is a little more pronounced than is suggested by the figures in Whitehouse (1946).

Some of the material was destroyed in the 1953 fire. Topotypic material, F21672 and R7888, is housed in the B.M.R. Museum.

Genus APIOTRIGONIA Cox 1952, em. Nakano, 1957.

Apiotrigonia Cox is a genus closely related to *Iotrigonia* van Hoepen, to which I have previously referred the Jowlaenga form. *Apiotrigonia* differs from *Iotrigonia* by having transverse costellae on the escutcheon and L-costae, not V-ribbing, on the disc. Cox (1952) lists about a dozen species. This list suggests that the genus ranges from the latest Jurassic to the top of the Cretaceous. Nakano (1957) distinguishes three major groups within the genus. Among these, one is characterized by incomplete L-costation (group of *A. turcmenensis* Archangelski).

The Australian form belongs to one of the two other groups, i.e. either to the group of *A. sulcataria* (Lamarck) or to that of *A. minor* (Yabe & Nagao). In both of these the later species are characterized by nodular or tubercular costae. These are absent from the Australian form and it may be concluded that it is a representative of the early stages in the lineages of these groups.

APIOTRIGONIA cf. A. MINOR (Yabe & Nagao).

(Pl. 1, figs. 16, 17, and text-fig. 16.)

Iotrigonia sp. aff. *limatula* Whitehouse—Brunnschweiler, 1951a, p. 8.
Iotrigonia—Fairbridge, 1953, p. X/8.
Iotrigonia n. sp. aff. *I. limatula* Whitehouse—Brunnschweiler 1957, p. 7.
Iotrigonia—Guppy et al., 1958, p. 62.
Iotrigonia—McWhae et al., 1958, p. 106.

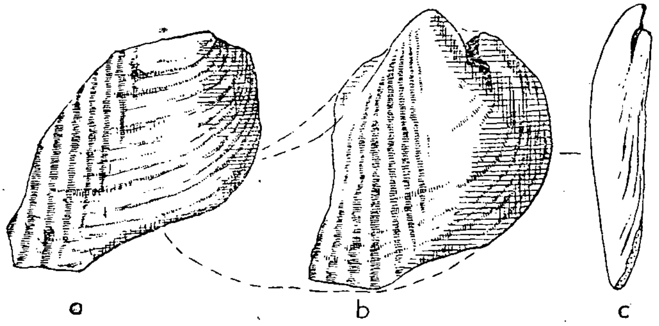

Figure 16.—*Apiotrigonia* cf. *A. minor* (Yabe & Nagao), X 1. C.P.C. 581.
a = External mould of same specimen as (*b*)—Plasticine cast.
b = Fragment of right valve, an internal cast (Steinkern).
c = Anterior view of steinkern shown in (*b*).

Although the posterior portion of the only available specimen is broken away, it is obvious that the outline is elongately triangular, considerably longer than high. The anterior end is broadly rounded, while—as far as can be conjectured—posteriorly the shell must have been nasute and probably had a rather acute postero-ventral corner. The umbo is well defined, although, because of the very slight inflation of the shell, it is little incurved. Its position is well forward. Posterior carinas seem very poorly defined.

The ribbing on the disc is clearly developed in an L-pattern. The vertical and horizontal elements do not terminate where they meet, i.e. there is no proper V-ribbing. The horizontal (concentric) costation on the anterior portion of the disc, having intersected some vertical costae, disappears nevertheless once the median sector of the disc is reached. Both costation elements are rather weak, whether on internal cast or on external mould. The vertical limbs of the L are more conspicuous than the horizontal. The former consist of broad and shallow folds, whereas the latter are composed of close, rather thin and low, folds and of striae which, except dorsally (where they meet the margin at an acute angle), are parallel to the anterior margin. The axis of the L-points is subvertical and comes fairly straight down from the umbo to the ventral margin, near which it gently curves backward. By how much abrasion has weakened the ornament cannot be determined; but the appearance of the external mould does suggest that weak costation is typical of the species.

In the type of ribbing, in the slight inflation, and in the absence of any posterior sulcus on the disc, the Jowlaenga form is quite close to *Apiotrigonia minor* from the early Upper Cretaceous of Japan. However, the Japanese species has stronger ribbing which shows a tendency to tuberculation. It is smaller too and less elongate posteriorly. Weakish ornament of the L-type occurs also on the American *Trigonia quadrangularis* (Hall & Whitfield) from the Upper Jurassic of the Black Hills of Dakota, but its very simple costation (small number of ribs) is different from the Jowlaenga form. Unfortunately, the fragmentary state of our specimen prevents comparisons of escutcheon, area, and hinge features.

For the late Jurassic and the early Cretaceous, Cox (1952) lists the species *A. calderoni* (Cragin) from the Tithonian of Texas, *A. heterosculpta* (Stanton, 1901), and *A. progonos* (Paulcke) from the Neocomian of Chile. Nakano (1957) refers Cragin's and Paulcke's forms to the Jurassic genus *Vaugonia* Crickmay. From his paper it is evident that he regards the range of *Apiotrigonia* as restricted to the Middle and Upper Cretaceous. Yet there can be little doubt that the Jowlaenga species is an *Apiotrigonia* and the Jowlaenga Formation is older than Aptian, although the American species are not closely related to the Australian form. But Cox (1952) seems to be right when claiming a rather long range for this genus. We have to conclude that the Australian form is a forerunner of the Japanese *A. minor.*

Cast and mould of the discussed form are kept under C.P.C. 581 in Canberra, further material under F21673.

Genus QUENSTEDTIA Morris & Lycett 1853.

The characters of *Quenstedtia*—the only representative of the family Quenstedtiidae Cox—have been discussed at length by Arkell (1934a, 1934b). It appears to be restricted to the Middle and Upper Jurassic in the main, but a few species range into the early Cretaceous.

The Jowlaenga form, like *Meleagrinella,* is very common, notably at Mt. Clarkson. The calcareous shell matter is not preserved; material in the Canberra collection consists exclusively of internal casts in silty ferruginous sandstone. Good external moulds are also lacking.

QUENSTEDTIA sp. nov. aff. Q. RODBORENSIS (Lycett).

(Pl. 21, figs. 1, 2; text-figs. 17, 18).

Pleuromya (?) n. sp.—Brunnschweiler, 1951a, p. 8.
Pleuromya (?)—Fairbridge, 1953, p. X/8.
Pleuromya n. sp.—Brunnschweiler, 1957, p. 7.

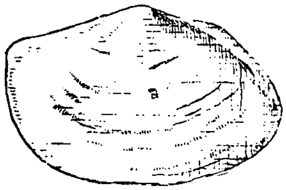

Figure 17.—*Quenstedtia* sp. nov. aff. *Q. rodborensis* (Lycett), X 1. An internal cast right valve aspect, C.P.C. 582.

The shell is equivalent, almost equilateral, subrectangularly oblong, flattened towards the ventral margin. The only ornament consists of faint concentric growth lines. The umbones are small, compressed, and close together. The anterior end is rather acutely rounded and a little shorter than the posterior end, which is truncate. The ventral margin is evenly and broadly rounded. The posterior truncation results in an angle of about 90° between dorsal and posterior margin. The cardinal margin in front of the umbones is compressed to form a distinct rim, which gradually decreases in height and disappears just before reaching the narrowly curved anterior end.

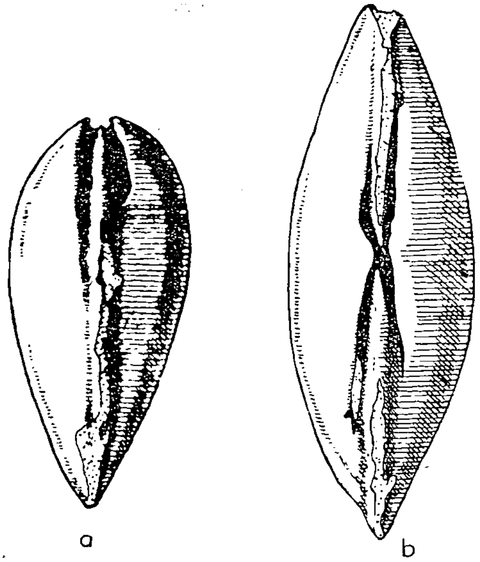

Figure 18.—*Quenstedtia* **sp. nov. aff.** *Q. rodborensis* **(Lycett), C.P.C. 583.**
a = **Posterior aspect, internal cast of another specimen. X 2.**
b = **Dorsal aspect of (*a*) showing cardinal tooth and countersunk grooves representing the typically long, deep, and narrow external ligament pits. X 2.**

The left valve possesses a single, transversely elongate and flattened cardinal tooth which fits into a broad, shallow cardinal socket in the right valve. A posterior lateral tooth is absent. Pallial lines and muscle impressions are not preserved on our material.

In outline this species strongly recalls *Q. rodborensis,* which is the genotype of *Quenstedtia,* especially as regards the posterior truncation and the angled postero-dorsal margin. The main difference lies in the form of the cardinal tooth, which, on *Q. rodborensis,* is blunt, knob-like, not extended plate-like. Other species differ in outline or in the height-length ratio from the Australian form, or they have a more or less clearly defined posterior lateral tooth.

This Jowlaenga species has previously been listed as a *Pleuromya* (Brunnschweiler, 1951a, 1957) chiefly on account of what I considered evidence of slight posterior gaping of the shell and because of a too adventurous interpretation of the hinge characters. In fact, good specimens do not show gaping valves (the left was mistaken for the right valve) and the hinge is of a simple tooth (left) and socket (right) type. Moreover, *Pleuromya* is commonly much more tumid and more inequilateral and scarcely ever truncate posteriorly, but tapering.

Topotypic material of this form is kept under F.21674 and R.7888 in Canberra.

OTHER FOSSILS.

Few fossils besides those described above have been found in the Jowlaenga Formation. Two or three additional forms were noticed but they are scarcely identifiable, even generically. In previous papers *Venus* sp. and *Pseudavicula* sp. were listed. Since the specimens have been destroyed in the fire there is no evidence left and one may as well forget them.

FOSSILS FROM THE BROOME SANDSTONE.

(NEOCOMIAN).

The Broome Sandstone has as yet not yielded marine fossils, except for numerous small worm-tracks. Plant fragments are rather common in some beds of the type area just west of Broome. There are in particular two thin beds, one to two feet thick, of fine-grained sandstone at Gantheaume Point. One of these beds is at the top of the cliff (Bed B) and the other just above high-water level at the bottom of the cliff in the undercut zone at the back of the high-water wave-cut platform (Bed A). These beds are full of fragmentary plant remains (impressions only). Still lower in this section and only exposed at low spring tide are some iguanodont footprints (on another, lower, wave-cut platform).

Among the plant remains the following forms are recognizable:

Bed B (top of cliff)
  Ptilophyllum pecten (Lindley & Hutton)
  Cladophlebis australis (Morris)
  Otozamites cf. *O. bengalensis* (Oldham & Morris)
  Pseudocycas sp.
  Hausmannia sp.
  ? *Cordaites* (stem fragment)

Bed A (bottom of cliff)
  Pterophyllum (*Anomozamites*) sp.
  ? *Microphyllopteris* sp.
  Sphenopteris cf. *S. superba* Walkom
  ? *Dictyophyllum* sp.
  Cladophlebis cf. *C. albertsi* (Dunkel)
  Taeniopteris cf. *T. howardensis* Walkom.
  Nilssonia sp.

The difference in the composition of the two floral assemblages does not, I think, have any stratigraphical significance; it might be due to ecological factors. There are in both beds innumerable other and indeterminate plant fragments. Among them may easily be those species which are common to both beds. Moreover, no exhaustive search for good specimens from these beds has ever been carried out.

The above list of fossil plants was inadvertently omitted from a previous paper on the geology of Dampier Land (Brunnschweiler, 1957), and it is here published in order to complete the record.

This collection was not damaged by the 1953 fire and is kept in Canberra under No. F.21503-21514.

FOSSILS FROM THE LEVEQUE SANDSTONE.

(NEOCOMIAN).

The Leveque Sandstone is an isolated erosional remnant of a formation of marine sandstone which seems to have once overlain the Broome Sandstone in northern areas of the Peninsula. It differs petrographically from the Broome Sandstone, which grades into it, only in the increased grain size and the thinnish bedding. However, the Leveque Sandstone contains marine lamellibranchs whereas the Broome Sandstone has not yielded marine fossils as yet.

The Leveque Sandstone contains at least one bed which, although it is lithologically indistinguishable from the others, is full of *Inoceramus*. This bed lies on the north-east side of the Cape Leveque headland just below the base of the big sand dune on which the lighthouse stands, i.e., in the top 20 feet of the sandstone cliffs, which are appreciably lower there than at the tip of the Cape opposite the little Leveque Island. How far the fossil horizon extends around the Cape and on its west side is not known; the high western cliff face of the Cape could be investigated only by mountaineering. Tracks of the marine worm *Rhizocorallium* have also been found in the Leveque Sandstone; they are described by Veevers (1960).

PELECYPODA.

Genus INOCERAMUS W. Smith 1816.

INOCERAMUS sp. nov. *a*. cf. I. ANGLICUS Woods.

(Pl. 2, figs. 3, 6, text-fig. 19.)

Inoceramus cf. *naumanni* Yokoyama—Brunnschweiler, 1951a, p. 8.
Inoceramus—Fairbridge, 1953, p. X/8.
Inoceramus n. sp. *a* aff. *I. naumanni* Yokoyama—Brunnschweiler, 1957, p. 9.
Inoceramus—McWhae et al., 1958, p. 107.

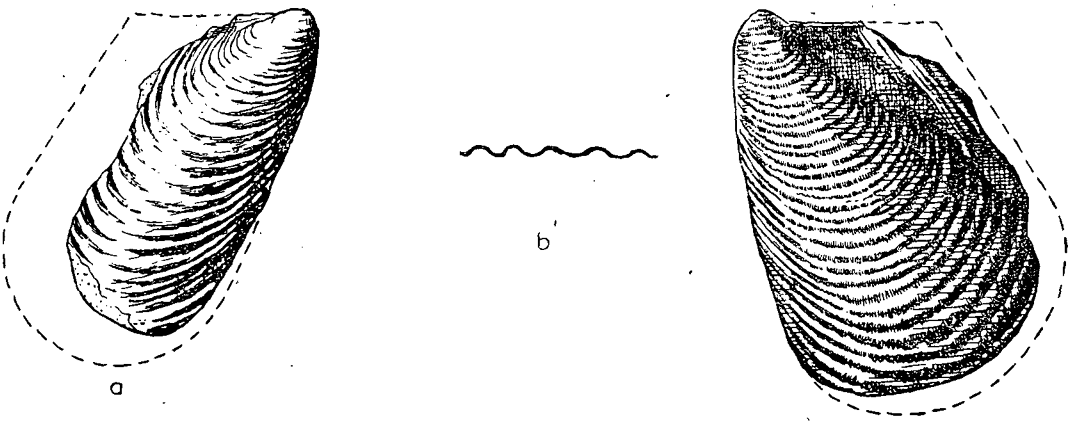

Figure 19.—*Inoceramus* sp. nov. *a* cf. *I. anglicus* Woods, X 1.
***a* = External cast (plasticine) of right valve fragment, C.P.C. 584.**
***b* = Schema of ribbing.**
***c* = External cast (plasticine) of left valve of another specimen, C.P.C. 585.**

This is a medium-sized, moderately oblique, equivalve and strongly inequilateral *Inoceramus* with terminal, not very acute, non-prosogyrate umbones. Even in the umbonal region neither valve is much inflated. The hinge-line is straight, its length equal to about half of the height of the shell. The angle between hinge-line and crest-line of umbo is about 70°, between hinge-line and anterior margin 80°-90°, between hinge-line and the long, straight, posterior margin about 120°. The ventral margin is evenly and broadly rounded. The outline of this shell is thus sub-rhomboidal, with the length equal to about three-quarters of the height. The ornament consists of regular strong concentric ribs with rounded crests. They are curved symmetrically, convex with regard to the crest-line of the shell's inflation. The interspaces are rounded grooves as wide as the ribs. Along the anterior margin the ribs are crowded, but every one of them remains distinct. On the flat dorso-posterior area, between cardinal and posterior margin, the ornament changes into indistinct and rather irregular riblets and striae which run parallel with the posterior margin. Close to the cardinal margin even this weaker ornament almost disappears. About the middle of the shell there are two or three ribs which show bifurcation on the posterior umbonal slope.

The two specimens in text-figure 19 demonstrate a slight variation in the density of the ribbing, and this is borne out by other collected material; it is not a difference between left and right valve because from other material in the collection it is evident that such variation exists with respect to both left and right valves alone too.

Very few species of *Inoceramus* resemble this compressed, simply ribbed, form closely enough for worthwhile comparison. Its place in the lineages of the genus is somewhere between Upper Jurassic broadly and widely ribbed species such as *I. everesti* Oppel, or *I. subhaasti* Wandel, and more densely ribbed Middle Cretaceous forms like *I. concentricus* Parkinson and *I. naumanni* Yokoyama. In late Jurassic and early Cretaceous times the *Inocerami* are still little diversified and remain almost as primitive in outline, degree of inflation, and ornamental style as their Middle and Upper Jurassic ancestors. It is only in Aptian time that the evolutionary burst of the family begins to take shape.

The form from the Leveque Sandstone evidently predates this burst, although the tendency to dense and elegant concentric ribbing—a feature of the *concentricus*-group of the Middle Cretaceous—is just beginning to show. Less closely ribbed forms of the *concentricus*-group, e.g. *I. naumanni* (especially figs. 4ab and 5 on pl. 18 in Yokoyama, 1890), come fairly close to the more densely ribbed Leveque specimens. One significant, presumably advanced, feature of the Japanese species, namely the fine groove along the crest of the ribs, is however absent on our material both on external moulds and on internal casts. Thus, while *I. naumanni* remains a fairly close relative of the Australian species, still closer affinities should be expected with forms from the earlier and earliest Cretaceous.

It is indeed with *I. neocomiensis* d'Orbigny and even more with *I. anglicus* Woods that the Australian form shows closest affinity. The moderate inflation, the slightly oblique and subrhomboidal outline, the long and straight hinge-line, the terminal umbones, the simple and rather narrow convexity of the symmetrically concentric ribbing, the shape of the ribs and furrows themselves—all these features are repeated in almost every respect on the Australian form. There are, however, significant differences in the angle between cardinal and anterior margin and in the inclination of the umbonal axis in relation to the hinge-line. In addition, the English species has umbones which are rather clearly prosogyrate once they curve down on to the hinge-line. *I. neocomiensis* shows less symmetry and less convexity in its concentric ribbing, and the angle between cardinal and anterior margin is over 120°, which feature enlarges the whole anterior portion of the shell considerably by comparison with both *I. anglicus* and the Australian species. On the whole, however, there is no doubt that the Leveque form belongs to the early Cretaceous group whose most typical members are *I. neocomiensis* and *I. anglicus*. It is also interesting to note that none of the Aptian and Albian species known from Australia is similar to the Leveque form.

The material described above partly escaped the 1953 fire and it is kept under C.P.C. 584/5 and F.21675.

INOCERAMUS sp. nov. *b* cf. I. ANGLICUS Woods.

(Pl. II., fig. 5, and text-fig. 20.)

Inoceramus cf. *naumanni* Yokoyama (part)—Brunnschweiler, 1951a, p. 8.
Inoceramus—Fairbridge, 1953, p. X/8.
Inoceramus n. sp. *a* aff. *I. naumanni* Yokoyama—Brunnschweiler, 1957, p. 9.
Inoceramus—McWhae et. al., 1958, p. 107.

At first sight this species appears to be no more than a variety of the previous one. It has similar size and degree of inflation, subrhomboidal outline, terminal and non-prosogyrate umbones, long straight hinge-line. On closer study one notices, however, differences which are about of the same order as those which separate *Inoceramus* sp. nov. *a* from *I. anglicus* Woods. Consequently it is described as a separate new species under *nomenclatura aperta.*

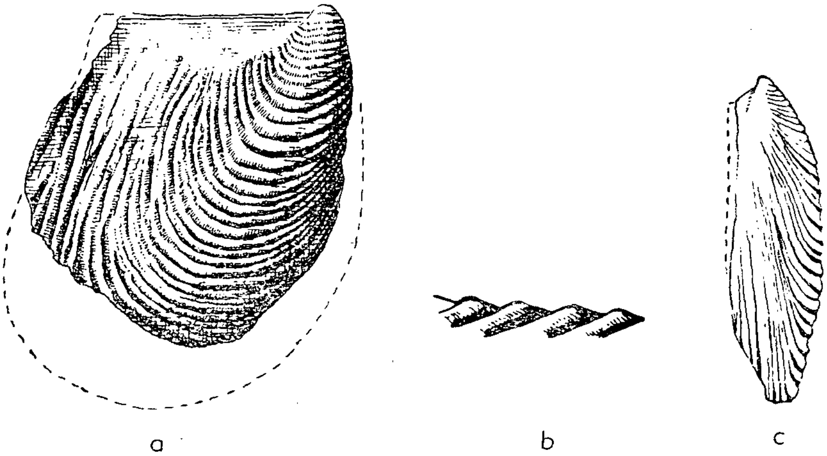

Figure 20.—*Inoceramus* sp. nov. *b* cf. *I. anglicus* Woods, X 1.
a = Internal cast of a right valve.
b = Schema of ribbing.
c = Posterior aspect of right valve shown in (a).

Firstly *Inoceramus* sp. nov. *b* is longer in relation to its height than sp. nov. *a*, and its outline is less oblique. The angle between cardinal and anterior margin is greater than 90°. Secondly, the umbo is more acute and its angle with the hinge-line smaller; the umbonal crest-line is gently convex towards the posterior region, not straight. Thirdly, the concentric ribbing is not only more sharply convex but also more irregular on the posterior and ventral slopes of the shell. The ribs themselves are of a different type, too. Crests and furrows are angular, not rounded. The slope on the convex side of the ribs is lower, i.e. shorter, than the slope on the concave, outer, side. This gives the ornament an imbricate, roof tile, appearance. Finally, the flat area behind the umbo and along the cardinal margin is smooth, not striate as on sp. *a*.

The affinities of this form are still with *I. anglicus* and *I. neocomiensis,* but the peculiar imbricate ribbing foreshadows an evolutionary trend that was soon to become more pronounced in *Inoceramus* of the later Cretaceous lineages.

The specimens of this species were lost in the fire.

INOCERAMUS sp. nov. *c* aff. I. NEOCOMIENSIS d'Orbigny.

(Pl. 2, fig. 4, and text-figs. 21, 22.)

Inoceramus n. sp. *b*—Brunnschweiler, 1957, p. 9.

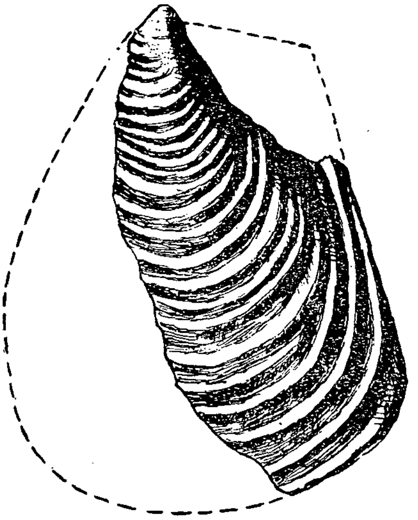

Figure 21.—*Inoceramus* sp. nov. *c* aff. *I. neocomiensis* d'Orbigny, X 1. C.P.C. No. 586. Internal cast fragment of a left valve with likely outline reconstructed.

Of this characteristic form only fragmentary material is available. On the best specimen (text-fig. 21) the posterior, wing-like, area is broken away, but it seems that the hinge-line is relatively shorter than on the two previously described species. It cannot be said whether it is straight. One may, however, assume that in outline this form is less distinctly oblique rhomboidal, because the less pronounced convexity of the

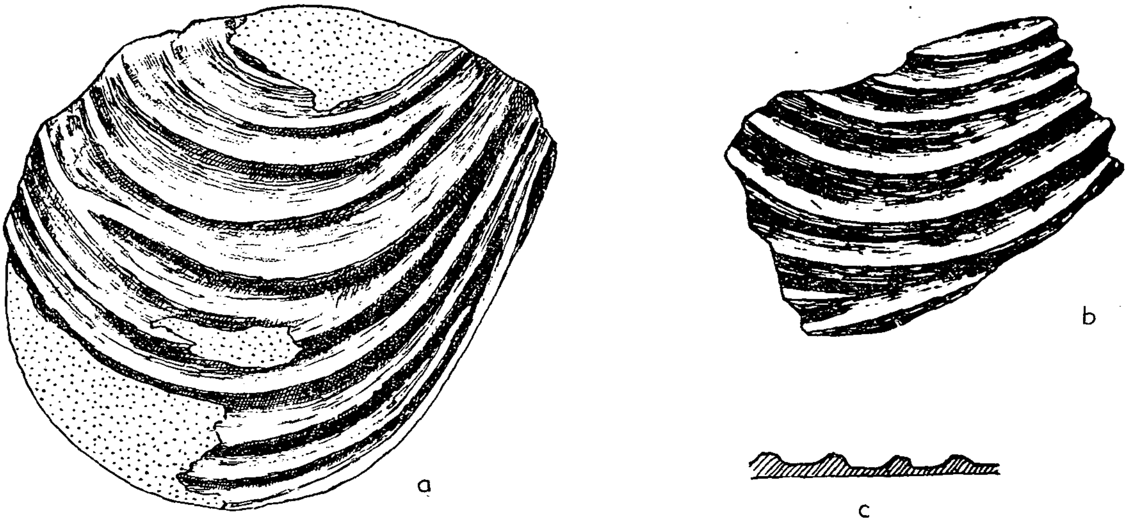

Figure 22.—*Inoceramus* sp. nov. *c* aff. *I. neocomiensis* d'Orbigny, X 1.

a, b, **= Fragments of external moulds (plasticine) of right valves of large individuals.**

c **= Schema of ribbing.**

concentric ribbing suggests an appreciably more expanded antero-ventral region of the shell. From the fragments in text-fig. 22, it can also be concluded that sp. *c* grew to a larger size than the previously described forms.

The most conspicuous difference lies in the style and the density of the ornament. Form *c* has scarcely more than half the number of ribs seen on the other two species, and these ribs, except in the umbonal region, are not only very coarse but also show a tendency to be subrectangular in cross-section, i.e. their crest becomes flattened, particularly in the later growth stages.

None of the known Upper Jurassic and Lower Cretaceous species seems to have the peculiar style of ribbing of sp. *c*, although, no doubt, its affinities are on the whole with primitive Jurassic *Inocerami* rather than with the Middle and Upper Cretaceous ones. The nearest species appears to be the European *I. neocomiensis* d'Orbigny, at least as regards general features such as outline, terminal umbones, and low density of ribbing. The more strongly elongate and oblique *I. subhaasti* Wandel (especially its var. *denseplicate* Wandel) from the Oxfordian of Misol Island has, as might be expected, rounded and less dense ribbing and its umbones are more prominent and typically prosogyrate. The Himalayan *I. stoliczkai* Holdhaus, although displaying some similarity in the style of ribbing, is much broader and rounder in outline and it possesses a produced antero-cardinal shell area. *I. everesti* Oppel (fide Holdhaus, 1913) has thinner, rounded, ribs which are rather attenuated on the postero-cardinal, wing-like area. It is also more oblique.

A specimen of this species is kept under C.P.C. 586, in Canberra.

FOSSILS FROM THE MELLIGO QUARTZITE.

(APTIAN.)

The Melligo Quartzite contains marine fossils in a number of places, but the toughness of the rock and the commonly rather coarse grain make extraction and preparation of the fossil material rather difficult. Only casts and moulds are found on the surface and most of them are fragmentary.

PELECYPODA.

Genus FISSILUNULA Etheridge Jun. 1902a.

The isocardiid genus *Fissilunula* is a rather common and characteristic pelecypod in the Aptian (Roma Formation) of the Great Australian Artesian Basin. However, well preserved and complete specimens are scarce. Fortunately the genus displays a number of features which facilitate identification of even very fragmentary material.

FISSILUNULA CLARKEI (Moore).

(Pl. 11, figs. 8, 9; text-figs. 23, 24).

Fissilunula cf. *clarkei* (Moore)—Brunnschweiler, 1951a, p. 8
Fissilunula—Fairbridge, 1953, p. X/7.
Fissilunula clarkei (Moore)—Brunnschweiler, 1957, p. 10.
Fissilunula—Guppy et al., 1958, p. 63.
Fissilunula—McWhae et al., 1958, p. 107.

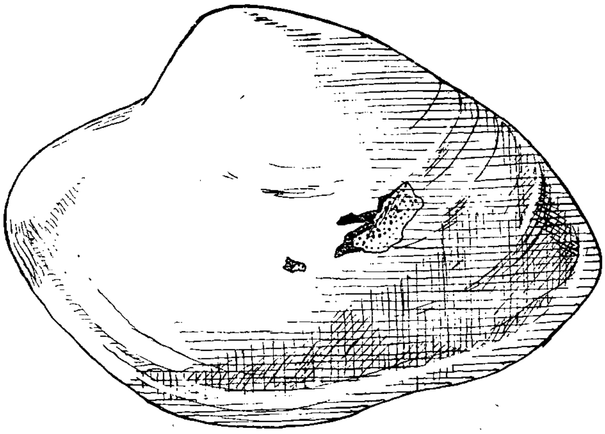

Figure 23.—*Fissilunula clarkei* **(Moore), X 1. Internal cast of a left valve, C.P.C. No. 587.**

This is a medium to rather large sized shell, ovate rhomboidal in outline, inequilateral, and moderately inflated. The umbo is prominent, prosogyrate, bent in and downward at the apex. The antero-dorsal end is produced but evenly rounded, much more compressed laterally than the posterior end, which is gently and evenly curved from the umbo down to the postero-ventral corner whence it turns rather sharply around into the gently convex ventral margin. Along the latter there is a compressed rim. The lunule is rather widely excavated. The ornament consists of fine concentric growth striae and a few irregular low and broad folds which are strongest posteriorly. Details of hinge, muscles, pallial line, etc., are not preserved on the specimens before me.

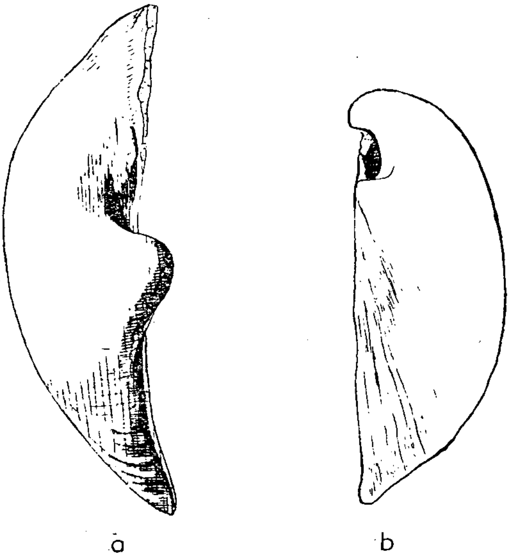

Figure 24.—*Fissilunula clarkei* **(Moore), X 1. C.P.C. 587.**

a = **Dorsal aspect of left valve (same as fig. 23).**

b = **Anterior aspect of same.**

Even the few observable features preserved on this steinkern specimen leave no doubt that it is *Fissilunula clarkei* as represented, for example, by figs. 5, 6 on pl. 5 in Etheridge (1902b), of fig. 1 on pl. 13 in Moore (1870). Some other heterodont genera, notably among Astartidae and Cyprinidae, have a similar general appearance, but none of them comes quite as close in similarity to the species from the Melligo Quartzite as does the Australian *Fissilunula.*

Topotypic material from the Melligo Quartzite is kept under No. R7889.

Genus PANOPEA Menard de la Groye 1807.

PANOPEA RUGOSA Moore.

(Pl. 11, figs. 10, 11, 12; text-figs. 25, 26.)

Panopaea rugosa (Moore)—Brunnschweiler, 1951a, p. 8.
Panopaea—Fairbridge, 1953, p. X/7.
Panopaea cf. *P. rugosa* (Moore)—Brunnschweiler, 1957, p. 10.
Panopaea—Guppy et al., 1958, p. 63.
Panopaea—McWhae et al., 1958, p. 107.

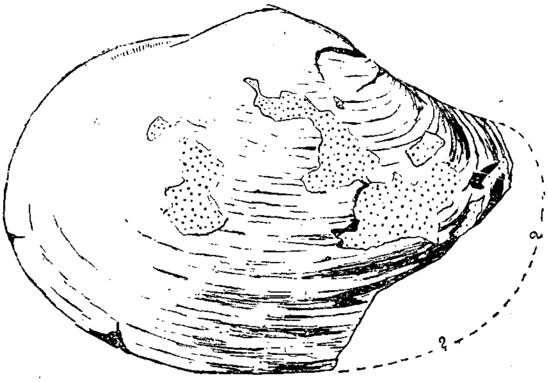

Figure 25.—*Panopea rugosa* Moore. Right valve, internal cast, X1. C.P.C 588.

The figured specimen is a damaged steinkern of a moderately inflated, equivalve, shell with transversely ovate outline and rather gibbous umbonal region. The umbo is subcentral (slightly anterior), little incurved, and moderately acute. The dorsal margin is rather straight and has a raised, rim-like ridge, especially behind the umbo, for attachment of the ligament. The venter is broadly rounded with an almost straight stretch in the centre. The anterior margin is slightly produced and probably somewhat truncate if my interpretation of other fragmental material is correct. The posterior margin is evenly and broadly rounded. Because of lateral compressive distortion it cannot be seen whether, or how much, the shell was gaping in front or behind. The ornament is concentric only, consisting of weak irregular folds and rather dense striae, and it is better developed anteriorly than posteriorly. Muscle scars and pallial line are not preserved.

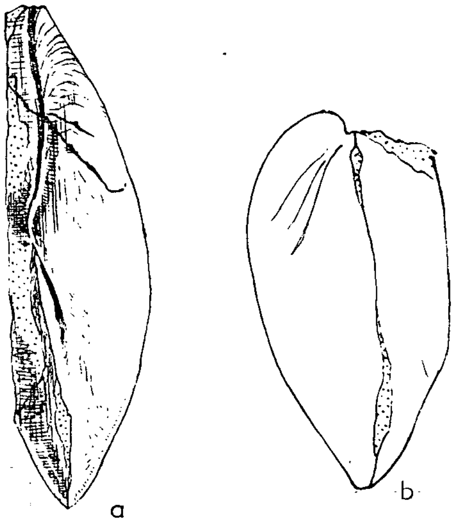

Figure 26.—*Panopea rugosa* **Moore, X 1, C.P.C. 588.**

a = **Cardinal aspect of specimen shown in text-fig. 25, a right valve (parts of left valve also preserved).**

b = **Posterior aspect of same specimen.**

This form falls within intraspecific variations of *Panopea rugosa* Moore as described by Etheridge (1892, 1902b). It is indistinguishable from, for instance, South Australian representatives of the species (Etheridge, 1902b, pl. 4, figs. 8, 9), whereas Queensland forms are more oblong and more inequilateral, with acuter umbones. Once additional and well preserved material becomes available one may well come to regard these two phenotypes of *P. rugosa* as distinct species, or as two geographical subspecies. Etheridge (1892) commented on the apparent absence of gaping of the valves, a feature which is a generic characteristic. The valves of the Melligo Quartzite form gape not at all or very little. Whether such non-gaping species can be retained in *Panopea* seems indeed rather doubtful, but this question cannot be decided here.

Other, mostly very fragmentary material is kept under No. R.7889 in Canberra.

Genus ind. cf. HOMOMYA Agassiz 1843.

(Pl. 11, fig. 7; text-fig. 27.)

One fragmental external mould of a moderately gibbous left valve in the collection is very similar to a Queensland representative of *Homomya* described by Etheridge Sen. (1872). It is transversely elongated inequilateral, with gently curved ventral margin in the middle almost straight. The anterior end is broken away; the posterior margin is evenly and only moderately sharply rounded. The umbo is slightly anterior, prominent but blunt, sloping steeper posteriorly than anteriorly. The ornament is concentric and consists of weak and irregular folds and dense striae.

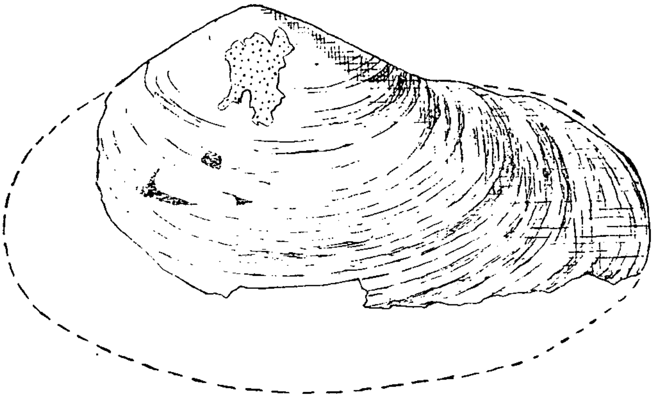

Figure 27.—Genus Ind. cf. *Homomya* **Agassiz, X 1. C.P.C. 589. Plasticine cast of external mould of a left valve.**

The form can be distinguished from *Panopea rugosa* Moore by its much more oblong outline, more distinctly anterior umbo and much stronger ornamentation posteriorly. On the Queensland *Homomya* (Etheridge Sen., 1872; also Etheridge Jun., 1892, p. 480) the ornament is much weaker than on the form from the Melligo Sandstone, yet in outline they are very similar. Whether both belong to the genus *Homomya* is an open question. Other members of the genus are much smaller. Moreover, the validity of Agassiz's genus is doubtful. There is, of course, an appreciable likeness to form of *Pleuromya* such as *P. orbigniana* (Rouillier)*. The poor preservation prevents proper identification.

Other topotypic material is kept under No. R.7889 in Canberra.

Genus APIOTRIGONIA Cox 1952, em. Nakano 1957.

APIOTRIGONIA sp. nov. cf. A. MINOR var. NANKOI Nakano.

(Pl. 3, fig. 1.)

Material and repository: Two internal casts of left valves, both on the same rock specimen. The better preserved cast is figured. The specimen is kept under No. 3389 in the Melbourne University Collection. Collector: F. Reeves, 1948, Vacuum Oil Co. Survey.

Description: This representative of the genus *Apiotrigonia* is better preserved than the one described above from the Jowlaenga Formation. The outline is moderately elongate triangular, the length about half as long again as the height. The anterior margin is evenly but rather sharply rounded. Posteriorly the shell is nasute with a sharp dorso-posterior corner. The ventral margin is evenly but only moderately convex. The shell is only moderately inflated, the umbo well defined but blunt and set well forward. The area is narrow and steeply inclined and the carina is only weakly defined.

The ribbing on the central and anterior portion of the disc is exclusively concentric and consists of weak folds and rather thin striae. On the posterior third of the shell there are three to four broad radial folds which disappear quickly upwards before reaching the weak carina. The concentric ornament intersects the radial folds in

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* *P. uniformis* (Sowerby).

L-fashion. This creates a weak " square-mesh " pattern of pits and nodes, especially near the ventral margin, and makes the margin itself wavy or crenulate. Close to the posterior end of the area, between carina and cardinal margin, there is an additional, very weak and broad, radial fold. The described ornamental features are typical of internal casts. It can be assumed that externally the ornament is stronger.

Remarks: In the lesser elongation and in the restriction of the radial ornament to a few broad folds close to the posterior end of the disc this species differs unmistakeably from that I have described on p. 21. It falls, however, still within the varieties of the Japanese *Apiotrigonia minor* (Yabe & Nagao), among which it resembles most var. *nankoi* Nakano (1957). The latter also shows radial ornament restricted to the posterior end and it is similarly shortened in outline.

In the absence of more detailed information about the Australian form little could be gained by further comparative analysis. The significant fact is that a series of pennate Trigoniidae, although as yet little known, does occur also in north-western Australia, but apparently it appears earlier in the Cretaceous than in Japan.

OTHER FOSSILS.

A number of additional fossils were mentioned in previous papers (Brunnschweiler 1951a, 1957). Among the material which escaped destruction by the 1953 fire there are unfortunately no specimens left which would be well enough preserved for description in the systematic part of the present paper. It will have to suffice that they are simply listed again here:

Cyrenopsis opallites Etheridge jun.
Cyrenopsis cf. *C. meeki* Etheridge jun.
Panopea cf. P. maccoyi Moore.
Belemnites sp. ind. (possibly *Neohibolites*).

The generic composition of the assemblages from the Melligo Quartzite is conspicuously different from that of all underlying formations. It shows strong affinities to the Cretaceous faunas of Eastern Australia. The faunal discontinuity substantiates field observations which indicate that Jowlaenga Formation and Melligo Quartzite are separated by an important stratigraphic disconformity (Brunnschweiler, 1957).

DISCUSSION AND CONCLUSIONS.

Even in the early years (1948-50) of the current exploratory activities in these remote areas of the Australian continent it was not particularly difficult to determine roughly the time intervals during which the Mesozoic formations of north-western Australia had been deposited. More serious problems arose only when accurate dating was required. One of these has always been the uncertainty about the state of late Jurassic to earliest Cretaceous stratigraphic data from the Southern Hemishpere as such as well as their correlation with standard sequences in the Northern Hemisphere. This problem is largely due to the doubtful zonal position of some important and common ammonoid genera and species.

The genus *Kossmatia* Uhlig, for example, was until very recently (Arkell, 1956) regarded as being typically Tithonian, even upper Tithonian, but it is now believed to have arisen in the early Kimmeridgian (Arkell, 1957, footnote p. L323). The evidence for this appears to be based on new collections from, and new interpretations of, the late Jurassic sequences at Kawhia Harbour in New Zealand. It is unfortunate that on account of Dr. W. J. Arkell's untimely death the detailed reasoning for the new contentions has not yet appeared in print. It is, however, evident that he had definitely accepted the evidence submitted to him from New Zealand. This may be seen also in the sudden change of his interpretation of the Jurassic sequence encountered in the oil bores Cape Range No. 1 and No. 2 (McWhae et al., 1958, p. 91).

The extension of the range of the genus *Kossmatia* naturally affects earlier contentions held on the age of the Jurassic formations in the Canning Basin (Brunnschweiler, 1951a, 1954, 1957, 1958). In addition, important subsurface information has been gained from several wells drilled by West Australian Petroleum Proprietary Limited. Although the details of this information are not accessible to me it appears that, on the whole, some corrections ought to be made to my previous age determinations in the Canning Basin Jurassic. No changes seems to be necessary for the formations in Dampier Peninsula.

With regard to the Edgar Range sequence (Brunnschweiler, 1954) the corrections introduced by McWhae et al. (1958) can be supported by evidence from ammonites. I hope to describe the relevant species in the near future, including the forms listed as *Virgatosphinctus* and *Kossmatia* from the Alexander Formation (Brunnschweiler, 1954), identifications which are probably in part erroneous. The species are more likely early Perisphinctidae of Oxfordian age. For the present it will suffice to furnish the evidence with regard to the Jarlemai Siltstone. This is done in Appendix II. on p. 4).

With that dating now well established as upper Oxfordian, and before the individual faunules are discussed, a brief recapitulation of what are believed to be the main Jurassic events affecting the Canning Basin as a whole may be appropriate.

Transgressions of the sea upon the margins of the Westralian Shield began some time during the Middle Jurassic, in places even as early as late Lower Jurassic (Cape Range bores), and it had reached inland areas as far as 200 miles from the present coast-line by Oxfordian times. In the Edgar Range the first onlap is characterized by rather coarsely clastic shoreline deposits such as the Jurgurra Sandstone (Brunnscheweiler, 1954; McWhae et al., 1958). After an apparently minor regressive phase (early Oxfordian ?) the sea remained over parts of the Canning Basin area probably all through Kimmeridgian into early Tithonian times. The Alexander Formation and the Jarlemai Siltstone were deposited during that interval. The rather sudden change of sedimentary environments reflected in the abrupt lithological change at the boundary between these two formations has also affected the composition of the respective faunas in the original near-shore regions. It is likely, of course, that some of the striking differences disappear farther off shore, i.e. in the subsurface sequence below the coastal region of to-day.

The Alexander Formation is richly fossiliferous almost everywhere, whereas fossils occur only sporadically in the Jarlemai Siltstone. Representatives of the genus *Buchia* ("*Aucella*") are absent from the Alexander Formation, yet very typical of the Siltstone. On the other hand, ammonites are common in the Alexander Formation but extremely scarce in the Jarlemai Siltstone. *Meleagrinella* is common to both formations, but in the Alexander Formation is represented by a different, much larger, species (see Appendix I. on p. 39). The *Meleagrinella* species occurring in the Jarlemai Siltstone belong to a separate phenotypic group which is more closely related to the forms found in younger beds of Dampier Peninsula (Jowlaenga Formation).

They are small and have very delicate ornament quite unlike *Meleagrinella maccoyelloides* sp. nov. (see Appendix I.) from the Alexander beds. Belemnites do not appear to have entered the Edgar Range region, although they are very common in off-shore equivalents of the Edgar Range sequence such as the *Buchia-Belemnopsis* beds between 1170 and 1300 feet in the Broome water bores (Teichert, 1940a) and in a similar sequence in the Yeeda Homestead water bores. They are very common also in the Langey Beds (p. 11), which, however, are younger than the Edgar Range Beds.

At some time during the early Tithonian the final regression commenced. By mid-Tithonian times only a small gulf in the Dampier-land portion of the Canning Basin was left covered by the sea: deposition of the formations exposed in Dampier Peninsula began about this time.

The oldest sediments cropping out on the Dampier Peninsula sequence are the Langey Beds, whose marine fauna has now been described. It contains the following species:—

Belemnopsis cf. *B. aucklandica* (Hochstetter).
Belemnopsis cf. *B. alfurica* (Boehm).
Kossmatia sp. aff. *K. tenuistriata* (Gray)—or a *?Substeueroceras.*
Kossmatia cf. *K. tenuistriata* Gray).
Buchia malayomaorica (Krumbeck).
Calpionella cf. *C. undelloides* Colom.
Calpionella schneebergeri sp. nov.

It is most unlikely that this assemblage is much older than mid-Tithonian. In the first place *Calpionella* Lorenz does not range much lower. *Kossmatia tenuistriata* is generally considered to be a mid and late Tithonian species too (viz. *Durangites*-beds of Mexico). It seems also significant that the *Kossmatia* species mentioned from the subsurface Dingo Claystone in the Cape Range oil bores (McWhae et al., 1958) are—according to information received from Dr. Arkell some time ago—quite unlike the *K.* cf. *tenuistriata* from Langey Crossing. The Cape Range species has subcircular whorl section and much more regularly biplicate ribbing. *K. tenuistriata* has not been found in those bore cores. The Langey Beds are the only known sediments of late Tithonian age to date. The strong likeness of one of the ammonite fragments to the genus *Substeueroceras* Spath need therefore not come as a surprise. It will also be noticed that the Langey assemblage has a decidedly Jurassic facies; it in no way foreshadows the early Neocomian fauna which follows immediately after.

The fauna of the Jowlaenga Formation is quite different from that of the Langey Beds; it contains some Jurassic elements, but they are now mingled with Cretaceous species. The species described from the Jowlaenga Formation are:

Hibolites cf. *H. subfusiformis* (Raspail).
Gen. ind. aff. *Protancyloceras* Spath.
Meleagrinella sp. nov. aff. *M. curta* (Hall).
Meleagrinella cf. *M. superstes* (Spitz).
Apiotrigonia cf. *A. minor* (Yabe and Nagao).
Quenstedtia sp. nov. aff. *Q. rodborensis* (Lycett).

Of these forms, *Hibolites,* aff. *Protancyloceras,* and *Apiotrigonia* indicate Cretaceous, *Meleagrinella* and *Quenstedtia* Jurassic. But the *Meleagrinella* species differ considerably from those in the Edgar Range Group, as can be seen from the description of *M. maccoyelloides* from the Alexander Formation (Appendix I., p. 39); and though *Q.* sp. nov. aff. *Q. rodborensis* appears to be closely related to Oxfordian forms in the Canning Basin, the resemblance may be only superficial. The material is too poorly preserved to show such important features as dentition, pallial line, muscle scars, and hinge-line characters, which would establish or disprove the relationship.

Therefore the Formation has been placed in the early Neocomian (Brunnschweiler, 1951a, 1954, 1957). Admittedly, the evidence is slender, and it is possible that the Formation belongs in the Jurassic. In the centre of the Fraser River anticline, according to McWhae et al. (1958), the Jowlaenga sits directly, and apparently conformably, on a probable correlate of the Oxfordian and probably Kimmeridgian Jarlemai Siltstone. But the Jowlaenga fauna is completely distinct from the Tithonian fauna of the Langey Beds (which are not represented at Fraser River), and conspicuously different from the undoubtedly Upper Jurassic formations of the Edgar Range, and it seems best therefore, to place it in the earliest Cretaceous.

The Jowlaenga Formation has been grouped by me (1954, 1957) with the Broome Sandstone and Leveque Sandstone in the Dampier Group, and I regard it, on lithological and palaeogeographical grounds, as probably a lateral equivalent of the Broome Sandstone. Only 40 feet of the latter are exposed, but some 900 feet were cut in the Broome Bore (McWhae et al., 1958), resting on an equivalent of the Jarlemai Silstone. The plants of the Broome Sandstone could be either Cretaceous or late Jurassic; but the top of the formation, at least, is Cretaceous, for it grades almost imperceptibly (Brunnschweiler, 1951a, 1957; Smith and Williams, 1956) into the Leveque Sandstone, whose *Inoceramus* assemblage—sp. nov. *a* and *b* aff. *I. anglicus* Woods and sp. nov. *c* aff. *I. neocomiensis* d'Orbigny—and *Rhizocorallium* tracks have unmistakable early Neocomian affinities.

After the deposition of the Dampier Group the sea must have withdrawn completely from this region, and it was not until Aptian times that there came another, short-lived, transgression. It resulted in the deposition of the Melligo Quartzite. This formation contains the following marine fossils:—

Belemnites (*?Neohibolites*) sp. ind.
Apiotrigonia sp. nov. cf. *A. minor* var. *nankoi* Nakano.
Fissilunula clarkei (Moore).
Cyrenopsis opallites Etheridge jun.
Cyrenopsis cf. *C. meeki* Etheridge jun.
Panopea rugosa Moore.
Panopea cf. *P. maccoyi* Moore.
Gen. ind. cf. *Homomya* Agassiz.

It seems obvious that this assemblage represents a record of events which are not directly related to the Upper Jurassic to lowest Cretaceous cycle of marine sedimentation in this area. It presents a new aspect, namely the mid-Cretaceous—i.e. Aptian to Cenomanian—transgressive phases of the circum-Australian seas which resulted in the final in-filling of the Great Artesian Basin and its outliers and also left significant traces in the Eucla Basin of southern Australia, in the Western Australian basins southward of Exmouth Gulf, and in the Darwin region in the north.

Most of the species in the fossil assemblage from the Melligo Quartzite are also characteristic of the mid-Cretaceous formations in these other large basins. *Apiotrigonia* may appear as a stranger in this group, but its presence is readily explained by its ancestors having found their way to these northern shores of Australia during the early Neocomian (Jowlaenga Formation). The absence of *Apiotrigonia* elsewhere in the Australian mid-Cretaceous may be due to either adverse ecological conditions or to the incompleteness of the fossil record.

APPENDIX I.

A NEW SPECIES OF *MELEAGRINELLA* WHITFIELD FROM THE ALEXANDER FORMATION IN THE CANNING DESERT, W. AUST.

MELEAGRINELLA MACCOYELLOIDES sp. nov.

(Plate 3, figures 2-9; text-figures 28, 29).

Meleagrinella n. sp.—Teichert, 1952, p. 131 incl. footnote.
Meleagrinella n. spp.—Brunnschweiler, 1954, p. 48.
Meleagrinella spp. nov.—Guppy et al., 1958, p. 59.
Meleagrinella—McWhae et al., 1958, p. 88.

Holotype: Left valve (Pl. 3, figs. 2a, b), Melbourne University Collection No. 3391.

Paratypes: Right valve (Pl. 3, figs. 9a, b, specimen in centre of group), Melbourne University Collection Nos. 3394a, 3394b.

Left valve (Pl. 3, fig. 3 and bottom specimen on 9a, b), Melbourne University Collection Nos. 3392, 3394a, 3394b.

Topotypes: Right valves (Pl. 3, figs. 5, 6, 7, 8 and top specimen on 9a, b), Melbourne University Collection Nos. 3391, 3394a, 3394b.

Left valves (Pl. 3, fig. 4), Melbourne University Collection No. 3393.

Collector: F. Reeves, 1948, Vacuum Oil Co. Survey.*

Diagnosis: A large *Meleagrinella* with very long, almost oxytominid, hinge-line. Anterior ears of both valves more or less rounded, distinct and rather large; posterior ears produced, alate. Hinge in left valve without knob-like thickening at bottom of anterior part of ligament area, and without anterior articulation sinus. Ligament pit long, trapezoidal, concave but not much excavated, with 4 to 8 deeply incised, parallel, ligament grooves. Ligament pit or right valve elongate triangular, rather wide anteriorly; bounded by a transverse warp just in front of the umbo but extending upon the posterior ear. Radial ornament consisting of 15 to 20 sharp, regular, primary, and regularly interspersed, sharp, secondary ribs on both valves. Interspaces flat. Interspersed ribbing of the third order appearing near margin of left valves of large individuals only.

Additional description: Left valve: Well inflated, tumid. The largest specimens in the collection are from 50 to 60 mm. long and nearly as high, but the most common adult size appears to be 35-45 mm. The height/length ratio varies somewhat with size. Large individuals are commonly slightly longer than high, whereas the reverse applies to small and intermediate specimens. The left valve is only little inequilateral and—the umbo being acline—not oblique. The outline is semicircular to transversely ovate with an evenly and broadly convex ventral margin. The anterior margin is very little convex in its upper part, the posterior margin more or less concave because of the posterior alate ear.

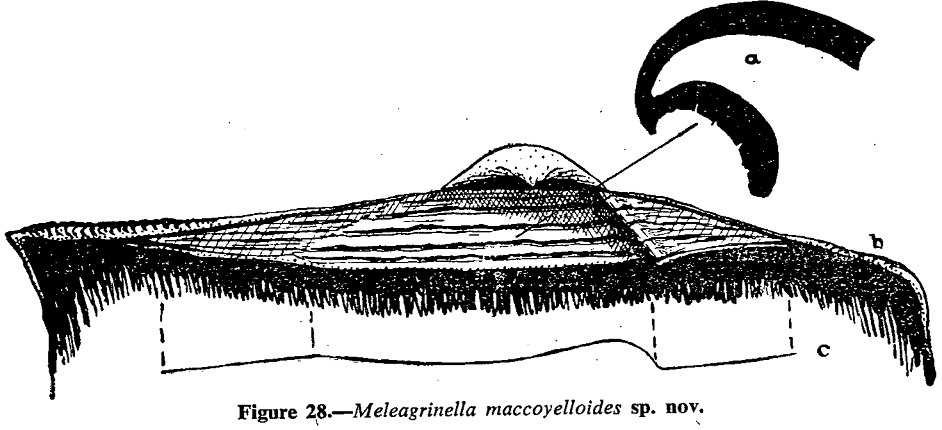

Figure 28.—*Meleagrinella maccoyelloides* sp. nov.

Hinge features of adult left valve.
Reconstruction from several casts and moulds.
***a* = Vertical section through beak and ligament pit, x 6.**
***b* = Hinge seen from inside, X 4.**
***c* = Horizontal section through centre of ligament pit, X 4.**

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* The record of the exact locality within the Alexander Formation was lost in the fire, but the material was from within two or three miles of Mt Alexander itself.

All ribs have slightly crenulated, sharp, crests. On some casts progressive imbrication of the growth stages of the shell is well visible. On the anterior marginal part of larger specimens, (e.g. holotype) the ribs are commonly "zigzagged". On some valves (Pl. 3, fig. 3) the primary ribs protrude over the margin as short spines, as in *Oxytoma*. Concentric ornament consists usually only of very dense and fine growth-lines, but on larger specimens a few low irregular folds and strong striae, appear along the ventral margin and on the ears (Pl. 3, figs. 2 and 4). The earliest part of the shell, at the umbonal apex, possesses fine radial ribbing (not smooth as on right valves). On both ears the cardinal margin is thickened and corrugate (especially anteriorly) because of the concentric growth lamellae which cross over it (see holotype, and text-figs 28b). The deep parallel grooves in the ligament pit end anteriorly on the oblique protruding hinge-fold (text-fig. 28b, c), but finer grooves continue on an elongately triangular area which eventually ends against the anterior ear. A similar finely grooved and even more elongate triangular area (in some large specimens it extends over the full length of the cardinal margin of the posterior ear) exists behind the ligament pit (text-fig. 28b). The junction between this area and the coarsely grooved ligament pit is marked by a slight oblique concavity (text-fig. 28c), not a fold as anteriorly.

Right valve: None have as yet been found in aposition with left valve, but right valves are obviously considerably smaller than left. They are very little inflated, with small and pointed acline umbo which is slightly higher than but does not overhang the hinge-line. Height and length are about equal. The outline is similar to that of the left valve except for the less produced and less sharply pointed posterior ear. The hinge-line is very long and straight. The anterior byssal notch is deep and narrow, the byssal ear parallel to the hinge-line, slim, and very elongate spoon-shaped. It is ornamented by dense, concentric, lamellae. The ligament pit (text-fig. 29a) is shallowly excavated and inclined towards the left valve at about 30°. The ribbing is as strong as on the left valve but the earliest portion around the umbonal apex ("prodissoconch") is smooth except for two or three low concentric folds (Pl. 3, figs. 8, 9a, b).

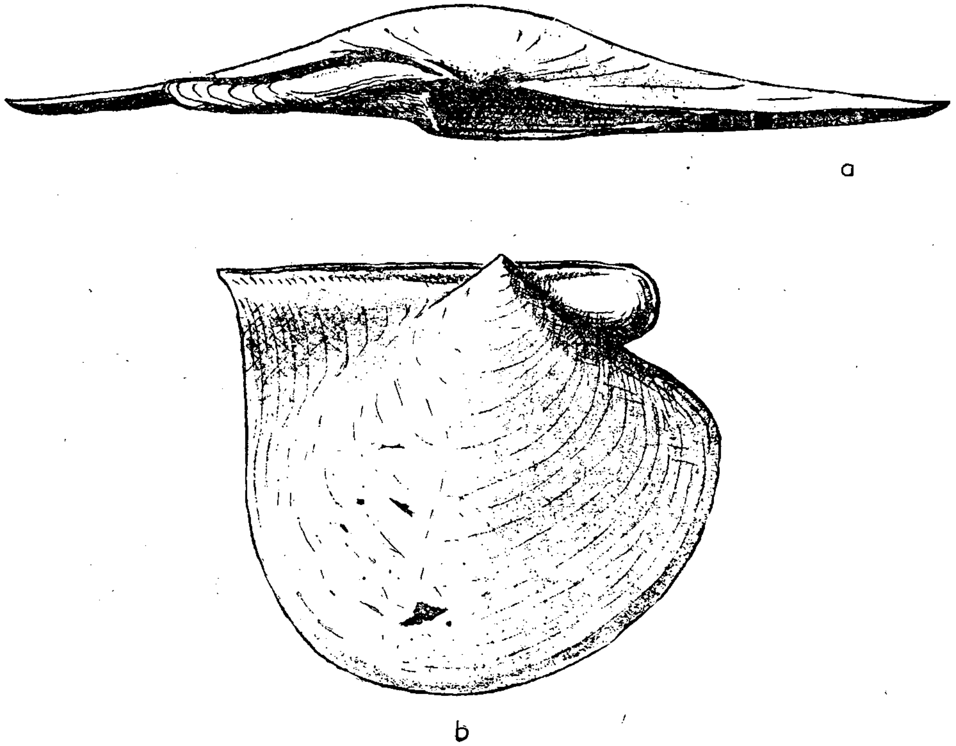

Figure 29.—*Meleagrinella maccoyelloides* **sp. nov.**

a = **Hinge features of adult right valve. From above, X 6.**

b = **Internal cast of right valve of very young specimen, X 30. (Melbourne University Collection No. 3391).**

Note: Concentric lines are not ornament, only form lines of drawing. The specimen is quite smooth.

The internal cast of a very young right valve ("prodissoconch") is shown in text-fig 29b. It is quite smooth and has a very long and straight cardinal margin. The ligament pit is subcentral, very shallow, and horizontal. The posterior ear is produced, alate, whereas the anterior ear (byssal ear) is short and broadly spoon-shaped. The byssal notch is shallow. The anterodorsal alation of the main portion of the shell itself (below the byssal notch) falls much more steeply away—at ca. 30°—than on adult specimens such as figs. 6-8 and 9 on pl. 3. All such tiny right valves, whether internal casts or external moulds, lack ornament.

Discussion and comparisons: Meleagrinella maccoyelloides displays a rather puzzling combination of anatomical features. Some of them are characteristic of *Meleagrinella,* others of *Oxytoma* Meek (1864), of *Maccoyella* Etheridge (1892), of *Otapiria* Marwick (1935), and of *Entomonotis* Marwick (1935).

With *Oxytoma* and *Maccoyella* it has in common a distinctly intercalate ribbing ("Schaltrippen") and conspicuous alation, with *Maccoyella* also the rather large size. The hinge characters, on the other hand, recall *Otapiria* or *Entomonotis,* especially with regard to the left valve. How to evaluate such conflicting affinities in classification is rather difficult.

The new species is considered to belong to *Meleagrinella* chiefly because in overall appearance it seems to be most closely allied to Teichert's (1940b) *M. sinuata* from the Bajocian of Geraldton (Western Australia). The latter is smaller, but it possesses an elongate ligament pit and uninterrupted grooving like *M. maccoyelloides* along the whole length of the left valve's cardinal margin. The hinge features of right valves in the two species are almost identical. In addition *M. sinuata* clearly shows the beginnings of a differentiation of the ribbing into primaries and interspersed secondaries and tertiaries.

Because of the apparent absence of relevant intermediate forms (Bathonian and Callovian) it cannot directly be demonstrated that *M. sinuata* is an ancestral species of *M. maccoyelloides,* but it certainly foreshadows the latter's phenotype to such a degree that our new species can be classified with *Meleagrinella* rather than with other mentioned genera of Aviculopectinidae.

That *Oxytoma, Meleagrinella,* and *Maccoyella* are very closely related is, of course, obvious. In fact, very young specimens of these genera cannot even be distinguished from each other. Nevertheless, the adult phenotype of *Oxytoma* is already well established in the Triassic (Ichikawa, 1958) and persists to the end of the Mesozoic, whereas *Meleagrinella* appears in the Jurassic and *Maccoyella* only in the Cretaceous or perhaps the late Jurassic.

The phylogenesis of these genera cannot, however, be reviewed in this paper: neither the time nor the research facilities at my disposal allow of that.

There remains to mention that the *Meleagrinella* species from Curdamuda Well (Teichert 1940b, pl. 1, figs. 9-10) do probably belong to *M. maccoyelloides* too, not to *M. sinuata,* which means that the Curdamuda Sandstone is Oxfordian rather than Bajocian. Teichert (1952) himself has already drawn attention to this. Unfortunately the Curdamuda specimens are fragmentary and one still cannot be quite certain of their identification.

APPENDIX II.

ON A GIGANTIC *PERISPHINCTES* FROM THE UPPER OXFORDIAN (JARLEMAI SANDSTONE) IN THE CANNING BASIN, NORTH-WESTERN AUSTRALIA.

In 1948 F. Reeves found fragments of a large ammonite in the basal beds of the Jarlemai Siltstone at a locality ten miles west-south-west of Babrongan Tower in the Edgar Range (see map in Brunnschweiler, 1954). Teichert (in Reeves, 1949) identified the specimen as *Perisphinctes* sp. ind. During my own fieldwork in that region in 1952 Reeves' locality was searched for more ammonites. None were found, but it could at least be ascertained that the only formation exposed in the vicinity of Reeves' locality is the Jarlemai Siltstone. Previously this was suggested only by the type of matrix of the fossil. Since the "Edgar Range Beds" of Reeves (1949, 1951) became later subdivided (Brunnschweiler, 1954) the place of the *Perisphinctes* in the sequence had to be clarified.

The specimen could not be located during the preparation of an earlier paper (Brunnschweiler, 1954) but it was later found among the collections of the University of Melbourne (Vacuum Oil Collection). I subsequently cleaned it of adhering matrix and exposed a significant portion of the inner whorls.

Perisphinctes (? Perisphinctes) sp. aff. P. cautisignare Arkell.

(Pl. 3, figs. 10, 11; text-figs. 30a, b.)

Perisphinctes sp. ind.—Teichert, in Reeves, 1949 (Appendix).

Material: Nucleus and four fragments, internal casts—Melbourne University Collection Nos. 3390a and 3390b-e. Collector: F. Reeves, 1948, Vacuum Oil Company Survey, ten miles W.S.W. of Babrongan Tower.

The greater part of this fragmental specimen of a giant *Perisphinctes* is badly weathered and crushed. All fragments together represent about one quarter of the original individual, including a complete, but only partly visible, nucleus (Pl. 3, fig. 11). The last whorl and living chamber seem to be missing, because the umbilical imprint of an additional volution (y-y, text-fig. 30a) is preserved on the flanks of the fragment's outer whorl, and traces of badly crushed septa are observable on the surface of the central break in the last whorl (at x on text-fig. 30a).

The details of the sutures cannot be seen on any of the fragments.

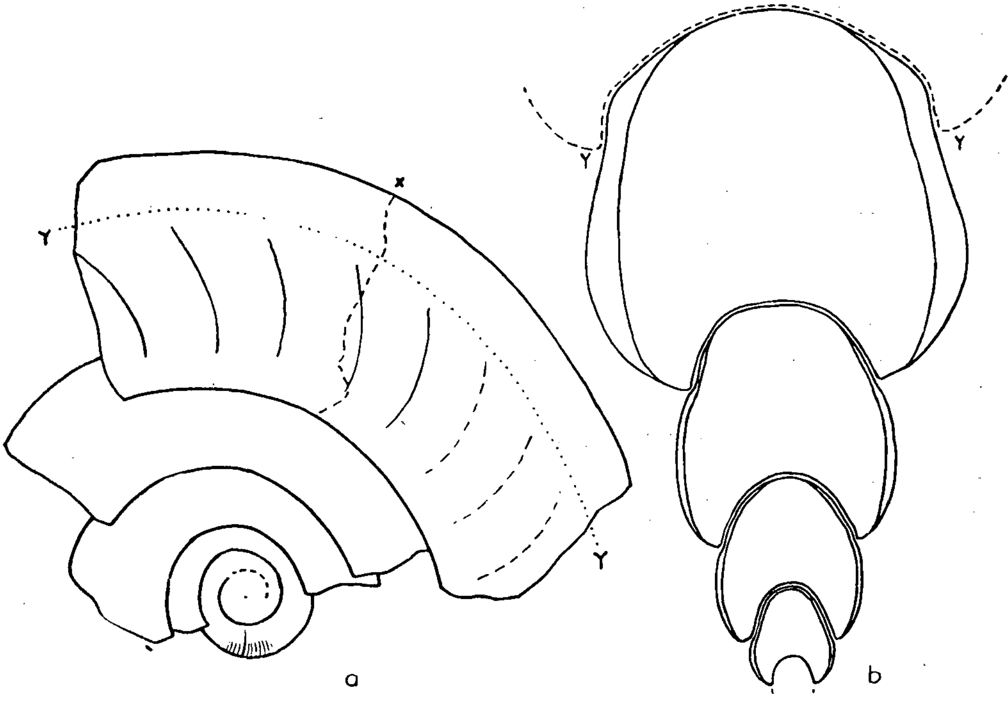

Figure 30.—*Perisphinctes* (*? Perisphinctes*) sp. aff. *P. cautisignare* Arkell.

***a* = Side view with umbilical parts restored, X 0.28.**

x = Break on which traces of septa occur.

y-y = Imprint of umbilicus of missing outer whorl.

***b* = Whorl sections, in parts restored, X ½.**

y = Imprint of umbilicus of missing outer whorl.

Since one has to assume that there was still another volution—probably the living chamber—this species appears to have belonged to the real giants of the genus. Its greatest diameter would have been about 600 mm. Dimentions of the actual fragment are as follows:—

Median radius (section taken here)	206 mm.
Height of last whorl at median radius	101 mm.
Width of last whorl at median radius	101 mm. (on ribs)
Width of last whorl (between ribs)	84 mm.
Umbilical radius	104 mm.

The conventional measurements have to be based upon the reconstruction. In the plane of the smaller radius of the fragment (SR), where an estimate can be made with reasonable accuracy, the figures are as follows:—

Diameter	311 mm. (SR = 183 mm.)
Height of last whorl	.30
Width of last whorl	.30
Umbilicus of last whorl	.48

Because of the crushed state of the specimen the given dimensions for height and width may be in error to the extent of one or two per cent. i.e., width may gain a little at the expense of height. Dimensions of the inner whorls can be estimated only very roughly and they are therefore not listed here.

The venter on the inner whorls carries numerous approximate, only little prorsiradiate, low and rounded ribs. 26 to 28 of them per quarter whorl can be counted (Pl. 3, fig. 11). Some of these are evidently annular, i.e. they are not secondary ribs ending at a bifurcation point; so there are at least 60 primary ribs at these smaller diameters. The bifurcation points appear unusually low on the flanks. This is not due to oblique crushing because on the reverse side of the nucleus (shown in fig. 10, Pl. 3) the secondaries are seen to reach well down the flanks too. It can therefore be assumed that the bifurcation points are in this species not overlapped by the succeeding whorl.

On the outer whorl sector 7 broad strong prorsiradiate primaries are present (Pl. 3, fig. 10), suggesting 28 to 30 ribs per volution. The venter is smooth.

On the inner whorls (Pl. 3, fig. 11) the secondary ribs cross the venter without interruption, whereas on the outer whorls the venter is smooth, the secondaries having disappeared. Where and how the change from the dense to the wide and broad ribbing and the corresponding obliteration of the secondaries takes place is not observable. Most likely it happens on the second last whorl (of the fragment) because on the third last volution crowded secondaries are still present. Their external moulds appear in places on the flanks of the impressed dorsal area of the second last whorl. From the study of this impressed dorsum it is, however, also evident that on the third last whorl the venter has already a narrow smooth zone.

On the inner whorls there are four (perhaps five) narrow and shallow constrictions. None are preserved on the outer whorls.

The cross section of the early whorls is compressed oval with rather flattened flanks (text fig. 30b), but the compression is very probably due in part to lateral crushing. In the latest whorls the width (if measured on the ribs) catches up with the height and the section becomes compressed subquadrate (if allowance is made for the impression left by the missing last whorl). The venter is rounded on the last, but almost flat on the second last, whorl.

Remarks: There is no doubt that this ammonite from the basal Jarlemai Siltstone belongs to the genus *Perisphinctes* Waagen 1869. Its dimensions compare fairly well with those of species of *Perisphinctes* s. str. such as *P. cautisignare* Arkell and *P. uptonensis* Arkell (Arkell, 1934). What can be seen of the ribbing also suggests a species of the subgenus *Perisphinctes,* if one assumes that the change from dense to coarse ribbing takes place suddenly on the missing last whorl. If there is no such sudden change, but rather a gradual one, the subgenus *Arisphinctes* Buchman 1924 must be considered, especially in view of the smooth venter on the outer whorls, a feature which is very conspicuous on the Australian specimen.

For comparison the following rib countings may be useful:—

Perisphinctes uptonensis—Holotype (Arkell 1934)
  Ribs number 18 at 350 mm. diameter.
  Ribs number 47 at 75 mm. diameter.
Perisphinctes cautisignare—Holotype (Arkell 1934)
  Ribs number 29 at 350 mm. diameter.
  Ribs number 60 at 75 mm. diameter.
Perisphinctes sp. from Jarlemai Siltstone
  Ribs number 28-30 at 350 mm. diameter (estimation).
  Ribs number 60-64 at 75 mm. diameter (estimation).
Arisphinctes cotovui Simionescu (Sedgwick Mus. No. J 3839, Arkell 1939)
  Ribs number 26 at 350 mm. diameter.
  Ribs number 50 at 75 mm. diameter.

Since the Australian specimen is too poorly preserved further comparisons would be futile. Its identification as a *Perisphinctes* that is closely allied to *P.* (*Perisphinctes*) *cautisignare* Arkell or to *P.* (*Arisphinctes*) *cotovui* Simionescu is as near as one can get in this case.

As the main result emerges the fact, stratigraphically, that the lower portion of the Jarlemai Siltstone is of upper Oxfordian age because the genus *Perisphinctes* (with all its subgenera) is restricted to this stage of the Upper Jurassic (Arkell, 1957). Whether the upper part of the Jarlemai is of Kimmeridgian or even younger age cannot be demonstrated by the fossil evidence available to me at present.

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PLATE 1.

A. Fossils from the Langey Beds (type locality).

Belemnopsis cf. *B. aucklandica* (Hochstetter), p. 5.

Figure 9. Stem fragment, ventral view. Bottom of fragment still about 20 mm. away from apex. Same specimen as text-fig. 1. Natural size.

Belemnopsis cf. *B. alfurica* (Boehm), p. 7.

Figure 5. Fragment of apical region, ventral view. Same specimen as text-fig. 2. Natural size.

Kossmatia cf. *K. tenuistriata* (Gray), p. 8.

Figure 3. Ventral view of best out of five septate fragments. Same specimen as text-fig. 3. Enlarged x 2.

Figure 4. Side view of specimen fig. 3. Enlarged x 2.

Kossmatia sp. aff. *K. tenuistriata* (Gray), p. 9.

Figure 1. Side view of the only specimen, a septate fragment. Same specimen as text-fig. 4. Enlarged x 2.

Figure 2. Ventral view of specimen fig. 1. Enlarged x 2.

Buchia malayomaorica (Krumbeck), p. 10.

Figure 6. Left valve, steinkern. Most of anterior ear broken off. Same specimen as text-fig. 5c. Enlarged x 2.

Figure 12. Left valve, steinkern, the most elongate and narrow specimen in the collection. Same specimen as text-fig. 5a. Enlarged x 2.

Figure 13. Left valve, steinkern, the broadest specimen in the collection. Same specimen as text-fig. 5b. Enlarged x 2.

Figure 8. Left valve, steinkern, both ears damaged. Showing traces of characteristic radial ornament. Same specimen as text-fig. 5d. Enlarged x 2.

Figure 7. Left valve. Plasticine cast of external mould belonging to steinkern fig. 8. Showing typical ornament of species. Same specimen as text-fig. 5c. Enlarged x 2.

Figure 10. Right valve. Fragmental steinkern. Same specimen as text-fig. 6b. Enlarged x 2.

Figure 11. Right valve. Steinkern fragment with some of the outer shell layers preserved and showing typical lamellar structure. Same specimen as text-figs. 6a and 6c. Enlarged x 2.

B. Fossils from the Jowlaenga Formation (Mt. Clarkson).

Hibolites cf. *H. subfusiformis* (Raspail), p. 14.

Figure 14. Lower (posterior) half of a rostrum preserved as hematitic infilling of an external mould. Same specimen as text-fig. 10. Natural size.

Figure 15. Ventral view of alveolar region and anterior portion of stem of a partly exfoliated fragment. Note adapical attenuation of ventral groove. Same specimen as text-fig. 11. Natural size.

Ancyloceratoid genus ind. (*?Protancyloceras* Spath), p. 16.

Figure 27. Side view of only specimen, probably a fragment from a living chamber. Same specimen as text-fig. 12. Natural size.

Meleagrinella sp. nov. aff. *M. curta* (Hall), p. 18.

Figure 21. Left valve, steinkern with slightly damaged anterior margin. Same specimen as text-fig. 13a. Enlarged x 2. Plasticine cast.

Figure 18. Left valve, steinkern of another specimen, finer ornament abraded. Same specimen as text-figs. 13b, c. Anterior aspect, enlarged x 2.

Figure 19. Left valve. Same specimen as fig. 18 (hinge damaged). Dorsal aspect, enlarged x 2.

Figure 23. Right valve, steinkern, delicate radial riblets preserved. Same specimen as text-fig. 14a. Enlarged x 2.

Figure 24. Right valve. Steinkern of another, smaller, specimen. Same specimen as text-fig. 14b. Enlarged x 2.

Meleagrinella cf. *M. superstes* (Spitz), p. 20.

Figure 20. Left valve. Steinkern with posterior ear partly broken off. Same specimen as text-fig. 15a. Enlarged x 2.

Figure 25. Left valve. Steinkern of another specimen with damaged posterior ear. Same specimen as text-figs. 15b, c. Enlarged x 2.

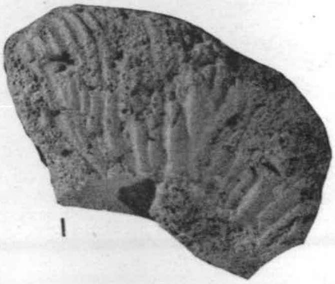
Figure 26. Left valve. Anterior aspect of specimen fig. 25. Enlarged x 2.

Figure 22. Right valve. Steinkern with posterior and anterior margins. Same specimen as text-fig. 15d. Enlarged x 2.

Apiotrigonia cf. *A. minor* (Yabe & Nagao), p. 21.

Figure 16. Right valve, steinkern fragment. Same specimen as text-figs. 16b, c. Natural size.

Figure 17. Plasticine cast of natural external mould belonging to specimen fig. 16. Same specimen as text-fig. 16a. Natural size.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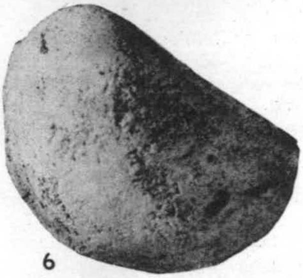
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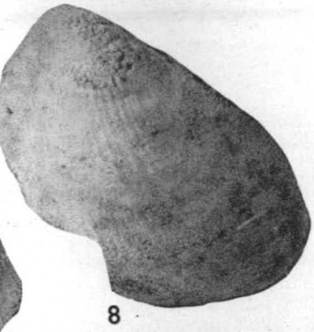
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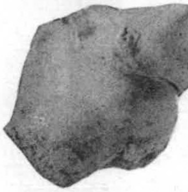
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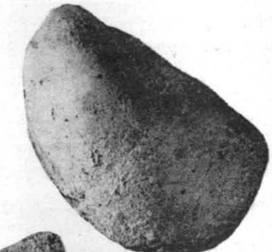
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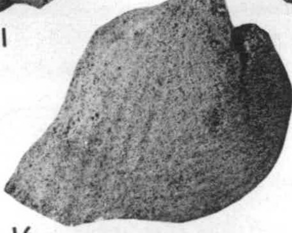
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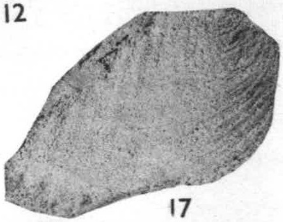
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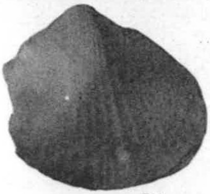
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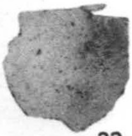
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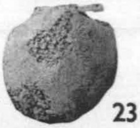
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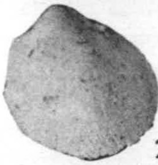
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PLATE 2.

FOSSILS FROM THE JOWLAENGA FORMATION (*continued*).

Quenstedtia sp. nov. aff. *Q. rodborensis* (Lysett), p. 23.

FIGURE 1. Steinkern of an almost complete specimen. Damaged slightly anteriorly. Same specimen as text-figs. 18a, b. (also from Mt. Clarkson). Enlarged x 2.

FIGURE 2. Internal cast of a right valve. Same specimen as text-fig. 17 (Mt. Clarkson). Natural size.

C. FOSSILS FROM THE LEVEQUE SANDSTONE (TYPE LOCALITY).

Inoceramus sp. nov. *a.* cf. *I. anglicus* (Wood), p. 26.

FIGURE 6. Left valve. Plasticine cast of an external mould. Hinge area and posterior margin damaged. Same specimen as text-fig. 19b, c. Natural size.

FIGURE 3. Right valve. Plasticine cast of an external mould. Posterior portion of shell missing. Same specimen as text-fig. 19a. Natural size.

Inoceramus sp. nov. *b.* cf. *I. anglicus* (Woods), p. 28.

FIGURE 5. Right valve, internal cast. Ventral and anterior margins damaged. Posterior aspect. Same specimen as text-figs. 20a, b, c. Natural size.

Inoceramus sp. nov. *c.* aff. *I. neocomiensis* (d'Orbigny), p. 29.

FIGURE 4. Right valve. Plasticine cast of an external mould of a fragment of a large individual. Same specimen as text-fig. 22a. Natural size.

D. FOSSILS FROM THE MELLIGO QUARTZITE.

Fissilunula clarkei (Moore), p. 30.

FIGURE 8. Left valve, internal cast, anterior aspect. Same specimen as text-figs. 23 and 24a, b. From Stony Ridge (2 miles south of Broome-Derby Highway). Natural size.

FIGURE 9. Left valve. Side view of specimen fig. 8. Natural size.

Panopea rugosa (Moore), p. 32.

FIGURE 10. Right valve, steinkern, damaged anteriorly. Same specimen as text-figs. 25 and 26a, b. From Stony Ridge (2 miles south of Broome-Derby Highway). Natural size.

FIGURE 11. Posterior aspect of specimen fig. 10. Natural size.

FIGURE 12. Dorsal aspect of specimen fig. 10. Natural size.

Genus ind. cf. *Homomya* (Agassiz), p. 33.

FIGURE 7. Left valve. Plasticine cast of an external mould. Anterior and ventral margins missing. Same specimen as text-fig. 27 (from White Cliffs, north of Fraser River). Natural size.


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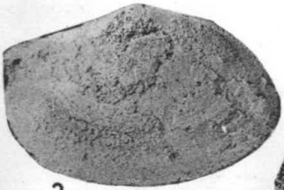
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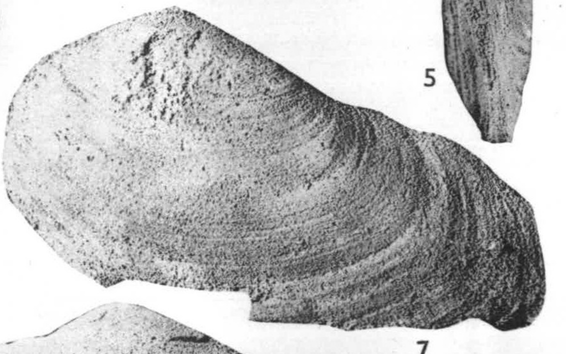
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PLATE 3.

FOSSILS FROM THE MELLIGO QUARTZITE (*continued*).

Apiotrigonia sp. nov. cf. *A. minor* var. *nankoi* (Nakano), p. 34.

FIGURE 1. Left valve. Internal cast, slightly damaged along dorso-posterior margin. Specimen from top of Mt. Jowlaenga. Melbourne Univ. Coll. No. 3389. Natural size.

A new *Meleagrinella* from the Alexander Formation.

All specimens from 33 miles S.E. of Dampier Downs (Reeves' Coll. No. 887). Natural size.

Meleagrinella maccoyelloides sp. nov., p. 39.

FIGURE 2a. Holotype—Left valve. External mould with ventral half of shell missing. Melbourne Univ. Coll. No. 3391.

FIGURE 2b. Plasticine cast of holotype.

FIGURE 3. Paratype—Left valve. Internal cast. Posterior wing, slightly damaged. Melbourne Univ. Coll. No. 3392.

FIGURE 4. Two left valves. Plasticine cast of a small and a large fragment, the latter showing in top corner ribbing of the third order. Smaller valve showing the typically large, rounded, anterior ear. Melbourne Univ. Coll. No. 3393.

FIGURE 5. Right valve. Oblique side view of specimen figure 7, showing the strong ribs. Melbourne Univ. Coll. No. 3393 (on same rock specimen as and next to holotype).

FIGURE 6. Right valve. Plasticine cast of specimen fig. 7.

FIGURE 7. Right valve. An internal cast. Melbourne Univ. Coll. No. 3391 (next to holotype).

FIGURE 8. Right valve. Plasticine cast from the external mould at top of fig. 9a. Showing concentric folds and absence of radial ornament on earliest growth stages.

FIGURE 9a. A left valve at bottom; paratype—right valve—in centre; right valve at top. All external moulds. Melbourne Univ. Coll. No. 3394a (fitting on to specimen fig. 9b).

FIGURE 9b. Left valve at bottom (seen obliquely from in front); paratype—right valve—in centre; right valve at top. All internal casts fitting into the external moulds of specimen fig. 9a. Melbourne Univ. Coll. No. 3394b.

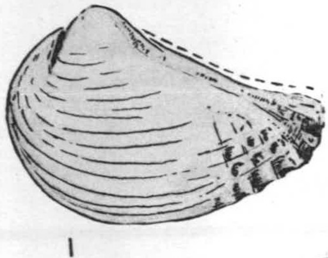
A large *Perisphinctes* from the Jarlemai Siltstone.

This specimen from the foot of the Edgar Range scarp 10 miles W.S.W. of Babrongan Tower.

Perisphinctes (*?Perisphinctes*) sp. aff. *P. cautisignare* Arkell, p. 41.

FIGURE 10. Side view of the specimen. An internal cast, aperture turned to the left X O.26. Melbourne Univ. Coll. No. 3390a-e.

FIGURE 11. Nucleus of specimen fig. 10. Natural size. Showing reverse side of that shown in fig. 10. Constrictions at Y. Melbourne Univ. Coll. No. 3390a.



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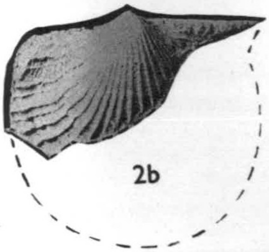

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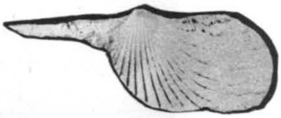

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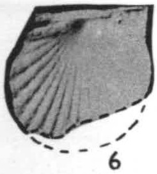

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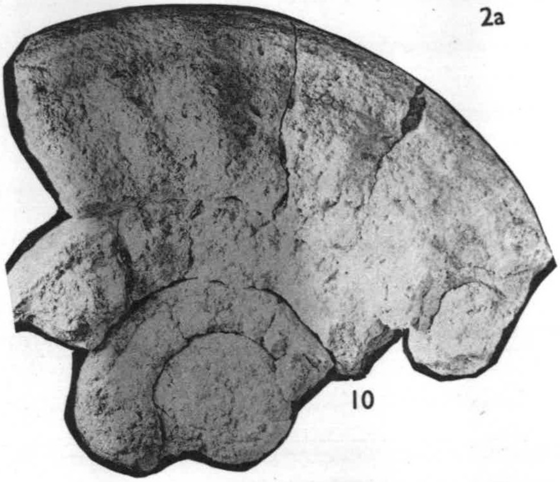

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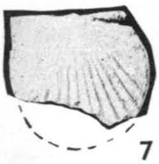

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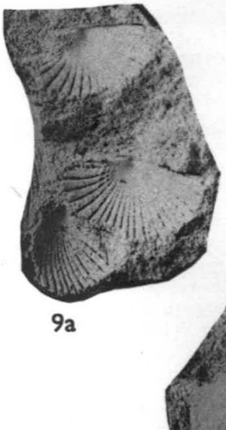

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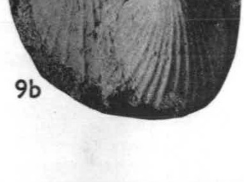

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