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AUSTRALIAN PERMIAN TEREBRATULOIDS

BY

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FOREWORD

The Permian faunas of Australia are of considerable importance both in their own right, as being large, varied, and not exhaustively studied hitherto, and as the key to the stratigraphy and palaeoecology of a period which is of vital interest in the search for petroleum in Australia.

The Bureau has made the study of the Permian faunas one of its major projects in palaeontology. These studies, which are based largely but by no means exclusively on its own collections from Western Australia and Queensland, are carried out mainly by the Bureau's palaeontologists, but certain collections are entrusted to research workers outside the Bureau who have special knowledge of particular faunas. Accordingly, the study of the Bureau's collections of Permian terebratuloids was undertaken by Dr K. S. W. Campbell, Senior Lecturer in Geology at the Australian National University, and this Bulletin presents the results of Dr Campbell's studies of these and other similar collections.

J. M. RAYNER,
Director.

CONTENTS

SUMMARY

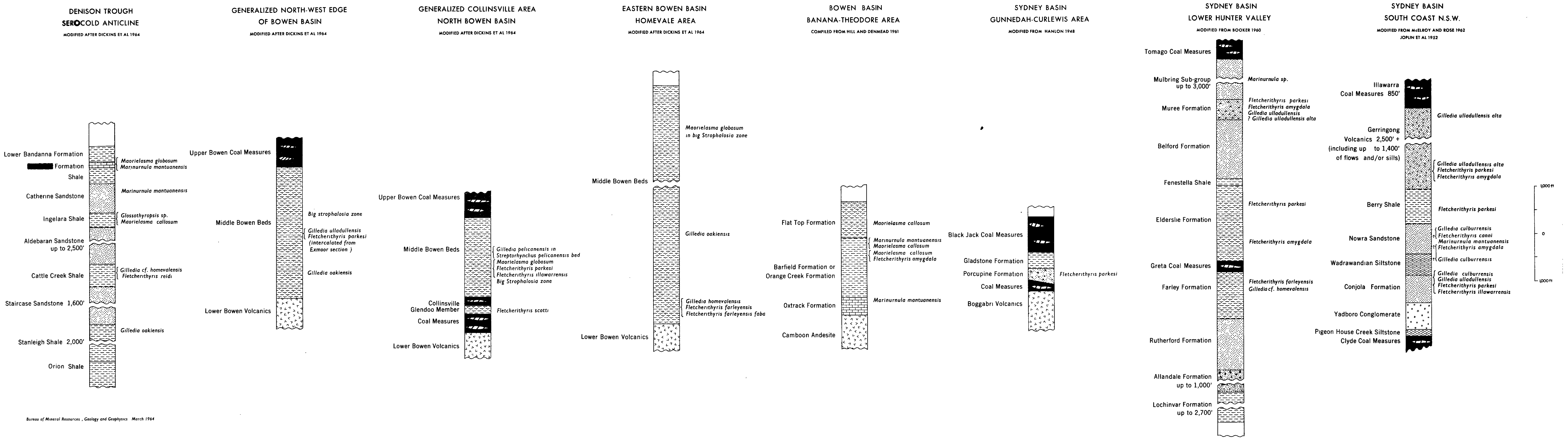
Terebratuloids have a sporadic distribution in the Australian Permian rocks, but at some localities they are abundant. Two distinct provinces, an eastern and a western, are recognised. The eastern is dominated by the genera *Gilledia* Stehli and *Fletcherithyris* nom. nov. pro *Fletcherina* Stehli; less abundant genera are *Maorielasma* Waterhouse, *Marinurnula* Waterhouse, *Glossothyropsis* Girty, *Pseudodielasma* Brill, and *Jisuina* Grabau. The last three genera are represented by a few specimens only, and are of little zoogeographical significance. The only other area in which similar faunas are known is New Zealand. The western province is dominated by *Hoskingia* gen. nov., but it also has representatives of *Fletcherithyris*, *Gilledia*, and *Yochelsonia* Stehli. The abundance of *Hoskingia* indicates possible relationships with the Tethyan and Uralian provinces, though the absence of the *Notothyris* group shows that there was no open migration from these areas. This distribution supports other evidence of a climatic difference between eastern and western Australia at this time.

The group is of interest stratigraphically. The genera *Maorielasma* and *Marinurnula*, and the species of *Gilledia*, *Fletcherithyris*, and *Yochelsonia*, are all short-ranged. Many of the species are restricted to single basins.

An attempt is made to provide a consistent terminology for the internal plates of terebratuloids, and a theoretical discussion of the homologies of these plates is given. It is shown that despite previous assertions to the contrary, punctation density can be a taxonomically useful feature in the group.

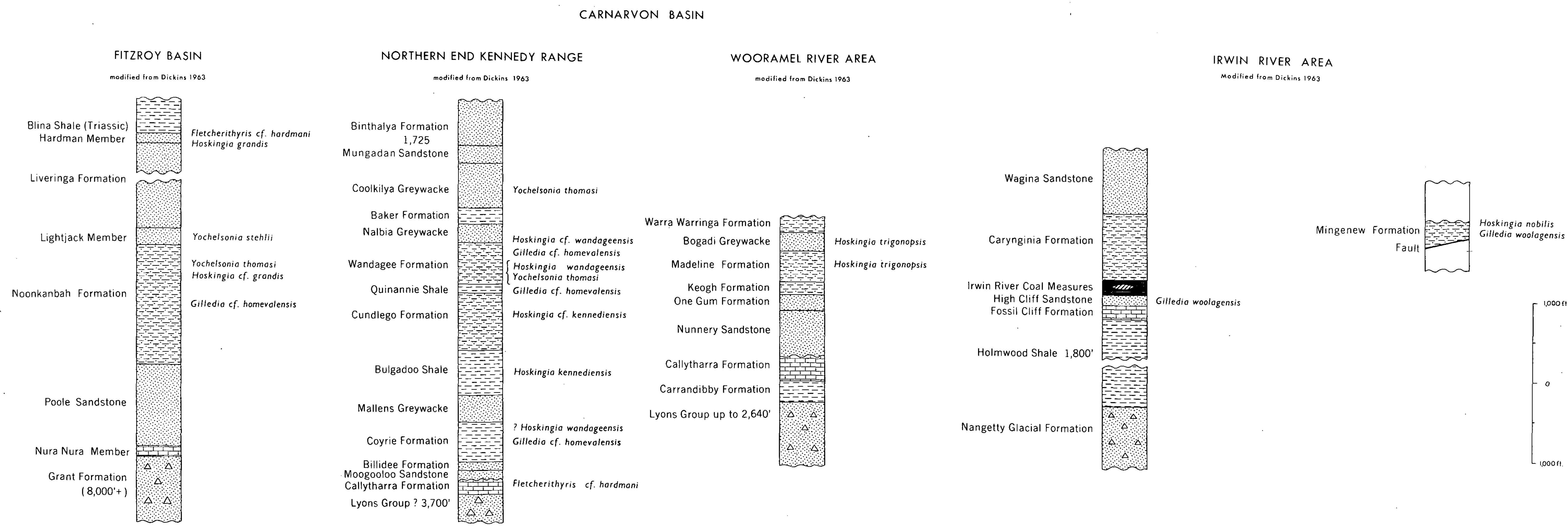
In the systematic section the new Family Gillediidae and Subfamily Gillediinae are established, together with the new Genus *Hoskingia* of the Subfamily Dielasmatinae. In addition to the genera mentioned above, *Beecheria* Hall & Clarke is discussed in detail. The status of the long established species '*Rhynchonella*' *inversa* de Koninck, *Gilledia jervisensis* (Etheridge), and *G. cymbaeformis* (Morris) is considered, and it is shown that they cannot be adequately interpreted at the present time. The species *Fletcherithyris amygdala* (Dana), *Hoskingia trigonopsis* (Hosking), *Hoskingia nobilis* (Etheridge), and *Yochelsonia thomasi* Stehli, are redescribed. It is shown that *Terebratula biundata* McCoy is a synonym of *F. amygdala* (Dana). New species of *Fletcherithyris*, *Hoskingia*, *Yochelsonia*, *Gilledia*, *Maorielasma*, and *Marinurnula* are described.

Table 1: Permian Successions, Eastern Australia



Bureau of Mineral Resources, Geology and Geophysics March 1964

Table 2: Permian Successions, Western Australia



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INTRODUCTION

Terebratuloid brachiopods occur in abundance on certain stratigraphic levels in the Permian rocks of both eastern and western Australia, and in lesser numbers throughout most sections. They have not hitherto been studied systematically, and only occasional descriptions of single species have appeared. Their wide distribution in both space and time here and overseas, suggested that study of the group would aid in stratigraphic correlation, both within Australia and overseas, and contribute to the problem of the marine zoogeography of the Permian.

So far as I am aware, I have examined all the available material in the country; but terebratuloids are often inconspicuous fossils and have almost certainly been overlooked at many localities. Several collections contain only one or a few poorly preserved individuals. In general such occurrences have been ignored, but they indicate that patient collecting will yield much more material. In addition material from Europe, India, Pakistan, and Timor has been examined in London. The co-operation of the following workers is gratefully acknowledged: Dr J. M. Dickins of the Bureau of Mineral Resources, who has continually supplied me with specimens and the opportunity for stimulating discussion; Mr T. Nicholas and Dr Irene Crespin of the Bureau, Mr J. T. Woods and Mr J. Dear of the Geological Survey of Queensland, Professor D. Hill and Mr F. S. Colliver of the University of Queensland, Mr H. O. Fletcher of the Australian Museum, Sydney, Mr M. R. Banks of the University of Tasmania, Dr G. A. Thomas of the University of Melbourne, Dr J. Roberts, then of the University of Western Australia, all for the provision of specimens or of locality data. Dr D. McLaren of the Canadian Geological Survey made available topotypes of *Beecheria davidsoni* Hall & Clarke; Dr H. M. Muir-Wood provided access to the collections in the British Museum, Natural History, and Professor O. M. B. Bulman to those in the Sedgwick Museum, Cambridge. The head of the Department of Geology at the University of Bonn, Professor MacGillavry of Amsterdam, and Professor Ubaghs of Delft made available collections from Timor. Mr J. D. Campbell of Otago and Dr M. J. S. Rudwick of Cambridge have discussed certain aspects of the work with me.

Photographic assistance has been given by Mr J. Zawartko, Mr A. Barlow, and Miss S. Jephcott.

Finally I am grateful to the Trustees of the Nuffield Foundation for the award of a Dominion Travelling Fellowship which enabled me to visit Europe.

History of Research

The history of the study of the terebratuloids in Australia is one of isolated descriptions of species based on inadequate material, absence of attempts to discriminate genera, citing of species in faunal lists apparently on the basis of superficial external similarities, and until recently failure to appreciate the distinctive nature of the Australian fauna.

In the period 1845–1878 four authors, Morris, Dana, McCoy, and de Koninck, each described a single species from eastern Australia. The first two assigned their species to the genus *Terebratula*, while the latter two referred theirs to *Atrypa* and *Rhynchonella* respectively. Robert Etheridge Jr in a series of small papers published from 1898 to 1919 described one new species and redescribed the established species from new localities. Among the new species was the first from Western Australia—*Dielasma nobile*. He placed all the species in *Dielasma*, though he was well aware that they exhibited a wide variety of internal structures.

A feature of all this early work was the poverty of the type material of new species. Of the six new species described three were based on a single specimen, one on two specimens, one on three, and only one on a much larger collection. This has made subsequent work difficult, especially as one of the solitary types has been lost, and it has not proved possible to collect further material at the type locality of this or three of the other species.

Hosking (1933), in describing *Dielasma trigonopse*, was the first to use serial sectioning techniques to elucidate the internal structure of a species, but her example was not followed until Stehli (1961) made a detailed study of several species from both eastern and western Australia, and erected three new genera to contain them. In so doing Stehli recognised for the first time that the Australian faunas were largely indigenous, and that reference of several of our species to the Old World genus *Dielasma* was improper.

No attempts have been made to use the dielasmatids as a group for purposes of correlation, though they have figured in a minor way in the discussion of the stratigraphic significance of whole faunas (e.g. Raggatt & Fletcher, 1937; Osborne, 1949). Their use in such studies, however, has been vitiated by inadequate knowledge of the taxonomy of the group.

AUSTRALIAN PERMIAN STRATIGRAPHY

The Permian System has been the subject of a great deal of interest and investigation since the war, and work is continuing at an increasing tempo. The results of the research into the Western Australian basins have been summarized by several workers. Dickins (1963) has given an account of the molluscan biostratigraphy, Glenister & Furnish (1961) have dealt with the ammonoids, Crespin (1958) with Foraminifera, Crockford (1956) with Bryozoa, and Thomas (1958) and Coleman (1957) with separate groups of Brachiopoda. References to accounts of the physical stratigraphy and other works on the biostratigraphy can be found in the bibliography of Dickins (1963).

No recent faunal studies have been made on the Tasmanian Permian, but the physical stratigraphy has received a comprehensive treatment by Banks (1962). The New South Wales Permian also awaits biostratigraphic investigation. However, McElroy & Rose (1962) have recently re-interpreted the physical stratigraphy of a large part of the South Coast area, and Booker (1960) has summarized work in the middle Hunter Valley. Earlier references can be found in Hill (1955).

Queensland has been the scene of much activity in recent years owing to the impetus of oil prospecting, and the regional survey work of the Bureau of Mineral Resources and the Geological Survey of Queensland. Work done up to 1960 was summarized in Hill & Denmead (1960). The basic picture remains the same as was given there, but numerous modifications to our knowledge of the distribution of the rocks, their tectonic setting, and their correlation have been made. Most of this work remains unpublished. In preparing the accompanying stratigraphic columns I have drawn on published sources which are acknowledged at the heads of the various columns.

Stratigraphic Ranges

Ranges of Genera

Most genera are long-ranging even within single basins. The exceptions are *Marinurnula*, *Maorielasma*, *Pseudodielasma*, *Yochelsonia*, *Jisuina*, and *Glossothyropsis*. The last two can be ignored because of their scarcity. *Marinurnula* occurs in the upper part of the Ingelara Shale, the Catherine Sandstone, the Mantuan Formation of Queensland, and the Nowra Sandstone of New South Wales. All of these are considered to be correlates of the Ingelara-Mantuan sequence on general faunal and stratigraphic evidence. In New Zealand, the only overseas occurrence, it is in the lower Arthurton Group, which Waterhouse (1963) considered to be younger than the Mantuan Formation, and is therefore approximately equivalent to the Flat Top. *Maorielasma* is found in the Ingelara Shale, the Mantuan Formation, the Big *Strophalosia* Zone, and the Barfield Formation of Queensland, and the Mangarewa Formation of New Zealand, which Waterhouse correlates with the Mantuan. *Pseudodielasma* occurs only rarely, but in Queensland has a similar range to *Marinurnula*, while in New Zealand it is in the Wairaki Breccia (Tartarian).

It appears then that these three genera can be used throughout eastern Australia and New Zealand as indicators of an Ingelara or later age (uppermost Artinskian and later). There are no terebratuloid genera restricted to the lower Permian in Australia.

In Western Australia *Yochelsonia* is known from the Wandagee Formation, the Coolkilya Greywacke, the upper Noonkanbah Formation, and the Lightjack Member of the Liveringa Formation, all of which are approximately coeval, and have been correlated with the uppermost Artinskian or lower Kungurian.

Ranges of Species

Several of the species are at present known from a single locality or group of closely spaced localities and their ranges remain unknown, though they are probably limited. In this category are *Gilledia woolagensis*, *Fletcherithyris canni*, *F. reidi*, *F. scotti*, *Yochelsonia stehlii*, *Hoskingia kennediensis*, and *H. nobilis*.

A second group consists of species which have short ranges within a sedimentary basin and are not known outside it. *Fletcherithyris amygdala* occurs in the Shoalhaven Group and the Gerringong Volcanics of the south coast section of the Sydney Basin, and in the Branxton Subgroup of the Hunter Valley section. *Gilledia culburrensis* is widespread in the Shoalhaven Group and the Gerringong Volcanics, while *G. ulladullensis alta* is restricted to the Gerringong Volcanics in the south, and the lower part of the Capertee Group in the north-west of the Sydney Basin. This supports a correlation of these two units on the basis of the molluscs, suggested by Dr Dickins (pers. comm.). *Gilledia pelicanensis* is widespread in the *Streptorhynchus pelicanensis* bed of the Bowen Basin.

The lowest units of the Middle Bowen Beds north and south of Homevale are characterized by *Gilledia homevalensis*; and the beds slightly higher in the section here, and in the equivalents of the Glendoo Member at the northern end of the Bowen Basin, carry *G. oakiensis*.

Maorielasma globosum is widely distributed in the upper part of the Catherine Sandstone (sensu Hill, 1955) and the Mantuan Formation, and it is also known from between the *Streptorhynchus pelicanensis* bed and the Big *Strophalosia* Zone in the Collinsville area of the Bowen Basin. *M. callosum* is more widely distributed in time and also occurs throughout the Bowen Basin. It is common in the Ingelara Shale and the Barfield and Flat Top Formations, and is also known from the Orange Creek Formation and the Big *Strophalosia* Zone. It may prove to be a useful index of the Ingelara Shale and lower Catherine Sandstone (sensu Hill, 1955) stratigraphic interval.*

In Western Australia three species of *Hoskingia* are valuable members of this second group of species. *H. grandis* is widespread in the Hardman Member of the Liveringa Formation in the Canning Basin, *H. wandageensis* in the Wandagee Formation in the Carnarvon Basin, and *H. trigonopsis* in the Madeline Formation and the Bogadi Greywacke of the same basin.

In a third category are species which are more widespread and offer the possibility of inter-basinal correlation. *Fletcherithyris farleyensis* from the Farley Formation, Hunter Valley, also occurs in the basal beds of the Middle Bowen Beds at Homevale, where the closely related *F. farleyensis faba* is also common. The occurrence of *Gilledia* cf. *homevalensis* in the Farley Formation is another link with the Homevale Beds. *Fletcherithyris parkesi* occurs in the Woodbridge Formation and the Golden Valley Group of Tasmania, the Shoalhaven Group and Gerringong Volcanics of the south coast Sydney Basin, the Elderslie and Muree Formations of the Hunter Valley, the Porcupine Formation of the Oxley Basin, and from 500 feet below the Big *Strophalosia* Zone to about 200 feet above it in the Bowen Basin. Another useful species from the Conjola Formation is *Gilledia ulladullensis*, which occurs with *F. parkesi* in and below the Big *Strophalosia* Zone.

Yochelsonia thomasi, which occurs in the Wandagee Formation and Coolkilya Greywacke of the Carnarvon Basin, is also known from near the top of the Noonkanbah Formation of the Canning Basin. The approximate equivalence of these units has been suggested on other grounds (Hill, 1955; Dickins, 1963).

The only species common to eastern and western Australia is *Gilledia homevalensis*. In the east it is restricted to the Homevale Beds at the base of the Middle Bowen Beds, the Dilly Formation, and the Farley Formation. In the west specimens assigned to *G.* cf. *homevalensis* range from the Coyrie to the Wandagee Formations in the Carnarvon Basin, the middle part of the Noonkanbah Formation of the Canning Basin, and the Mingenew Formation of the Perth Basin. It may be of significance for correlation that it does not occur as low as the Fossil Cliff or Callytharra Formations, or the Nura Nura Member.

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* Recent work by the Bureau of Mineral Resources and the Queensland Geological Survey has resulted in a new subdivision of the Permian sequence in the Serocold Anticline (Mollan *et al.*, 1964/27; Mollan *et al.*, 1964). There are still some differences in the interpretation of the lower part of the sequence, i.e., that below the Ingelara Shale, but above it there is now general agreement that the following subdivision should be accepted:

Bandanna Formation.
Peawaddy Formation (with Mantuan *Productus* Bed at top).
Catherine Sandstone.
Ingelara Shale.

What is shown as shale above the Catherine Sandstone, together with the Mantuan Formation, on Table 1 should now be referred to the Peawaddy Formation. The specimens of *Marinurnula mantuanensis* sp. nov., CPC 5966 from SP 383/3, are from the Catherine Sandstone proper. At this locality they are associated with specifically indeterminable specimens of *Maorielasma.* All the terebratuloids at present known from the Peawaddy Formation are from the Mantuan *Productus* Bed.

PALAEONTOLOGY

Taxonomic Significance of Variation in the Punctae

The taxonomic value of variations in the punctation of terebratellaceans has been commented on by several workers (Buckman, 1910; Percival, 1916; Thomson, 1927; Cloud, 1942). These workers are unanimous on the following issues: (1) the density of the punctae increases in most specimens from the rear to the front and the sides; (2) there are growth stages in which the density is abnormally great; (3) size and shape of the punctae in cross section depend to a great extent on the position of the shell layer in which they are observed. There is however no agreement as to the significance of these data. Percival (p. 56) for example concludes that ' the amount of variation in a species is so great as to make the density almost valueless as a specific character,' and Muir-Wood (1955, p. 47) refers to his conclusion without comment, though she considers that the subject of size and density of distribution of punctae merits further investigation. Thomson (p. 105) agreed that Percival ' has certainly proved his case for the species studied, but it does not follow that species of other genera will show a similar behaviour,' and he concluded that further study was necessary before a satisfactory evaluation could be made. Cloud (p. 27) adopted the position that ' density of punctation appears to be a valid specific criterion in some groups'. No conclusions have been reached as to the significance of punctation at the generic level.

The only worker offering a blanket objection to the use of punctation density in systematic work is Percival, and since he alone has offered extensive numerical data his conclusions have tended to carry weight. He compared the punctation density at a given growth stage of the two species *Terebratula biplicata* (Brocchi) and *Terebratula punctata* Sowerby, and these data provided the basis for his generalization cited above. In my opinion his conclusion is not valid for three reasons. In the first place, assuming that the specimens examined were in fact samples of two species of the one genus and that the punctation densities were not significantly different, it would be possible to conclude only that these two species could not be separated on this character. However, Dr R. M. C. Eager, who kindly arranged for Percival's collection of *T. biplicata* to be examined by Mr E. F. Owen of the British Museum of Natural History, states (in litt.) that it consists of representatives of the genus *Concinnothyris,* and that though they are reported to be from the one horizon and locality there may be several species present. So far as I am aware, the collection of *T. punctata* has not been re-examined, but assuming correct identification (it is a common species in the Middle Lias, the horizon from which it came), it belongs to the genus *Lobothyris,* which is distantly related to *Concinnothyris.* Thus a second objection is that the comparison attempted by Percival is not a particularly apposite one, since there is no reason why two species belonging to different genera should not have a particular character and yet differ from other species of the same genus in that very character. For example, number of plicae is a specific character in many genera of rhynchonelloids, but species in unrelated genera often have the same number of plicae. Finally, an analysis of variation in punctation density shows that although variation is certainly very wide the two species *are* significantly different in this character.

		C. biplicata	*L. punctata*
Mean punctation density	....	69	135
Standard deviation	....	15·7	28·2

It is obvious from inspection that these values are significantly different, but the value of 'F' (variance ratio test) has been calculated as 3·2, which indicates that the two samples are not from the one population. (Percival's data are presented in terms of intervals of 10. In the above calculations it has been assumed that all individuals in any given interval have the median value, e.g. all individuals classed within the 41–50 interval have a value of 45.)

It can only be concluded that no case has been made by Percival against the view that punctation density is a specific character, and that on the contrary the use of this feature as a basis for generic differentiation is worth investigation.

In the present work it has not been proved possible to use punctation to differentiate between the species of any one genus, nor indeed to distinguish any of the Australian genera from one another. It does appear to be of value, however, in separating some Australian Permian genera from certain overseas forms with similar internal and external structures. For example, the Carboniferous genus *Girtyella* and the northern hemisphere Permian genus *Dielasma* are both structurally comparable with *Fletcherithyris* in many features. I have examined numerous specimens of *Dielasma elongatum* from both Germany and England, and specimens of *Girtyella* from the Mississippian of America, the Viséan of England, and the Tournaisian of New South Wales, and have taken measurements of the punctation densities on the median portion of the valves. The data are set out below.

		Dielasma elongatum	*Girtyella* (3 species)	*Fletcherithyris* (all species)
Mean	....	250	280	90
Range	....	150–350	180–400	35–180

It is obvious therefore that the species grouped in *Fletcherithyris* can be distinguished from the examined species of the other two genera. A similar case could be made with regard to the Western Australian Permian genus *Hoskingia* and the comparable Carboniferous genus *Beecheria*. It now remains to provide theoretical grounds for deciding whether these differences are of taxonomic value.

All of the common Australian genera considered in this study, i.e., *Fletcherithyris*, *Gilledia*, *Maorielasma*, *Marinurnula*, *Hoskingia*, and *Yochelsonia*, have low punctation densities, in the 35–180 per sq. mm. range. No specimens at all have been found with higher densities. They are considered to have lived in shallow, cool to cold water. On the other hand, all the Carboniferous or Permian genera from warm-water areas which I have been able to examine show higher densities, though they too have come mainly from shallow-water deposits. Examples are *Girtyella* (180–400), *Dielasma* (150–350), *Beecheria* (175–300), and *Cranaena* (150–250). This strongly suggests that temperature is an important factor in the control of punctation density.

In view of this and the provincial nature of the Australian Permian fauna, it seems reasonable to conclude that parts of several terebratuloid stocks became isolated in Australia during the cooling in late Carboniferous times and evolved independently, giving rise to distinctive adaptations. Among these was a decrease in punctation density. To take the example of *Dielasma* and *Fletcherithyris*, the basic Carboniferous stock (probably from *Girtyella*) continued to evolve in the warm waters of the northern hemisphere, where it produced *Dielasma*, while an isolated Australian stock evolved along slightly different lines to produce *Fletcherithyris*. In this case, therefore, punctation density is a valid taxonomic character as well as being a temperature indicator. The alternative view that the evolving warm-water stock provided successive groups of migrants to colonize the cold water areas, and that each group developed lower punctation densities phenotypically, does not take sufficient account of the distinctive septalium and loop possessed by all species of *Fletcherithyris*, nor of the remarkably provincial character of the Australian fauna as a whole.

Homologies of Internal Structures

The terminology of the cardinalia of the brachial valves of terebratuloids and rhynchonelloids is chaotic. In an ideal system of morphological terminology, all homologous structures should bear the same name and non-homologous structures should bear different names; in the above groups homologies are very imperfectly understood even though the structures are few and simple. In a useful summary of the criteria for the recognition of homologues, Szarski (1962), following Remane (1956), lists the following:

'(1) Principal Criteria.
- (a) The criterion of mutual location.
- (b) The criterion of particular structure.
- (c) The connection by intermediates.

(2) Accessory Criteria.
- (a) Even simple organs can be considered homologous if they are present in many affiliated species.
- (b) The probability that similar organs present in two forms are homologous rises proportionally to the number of similarities between the compared organisms.
- (c) The probability that similar organs present in two forms are homologous decreases proportionally to the number of non-affiliated organisms in which those organs are likewise found.'

The definition '. . . . those characters are called homologous which give evidence of the common ancestry of their bearers ' (Szarski, p. 190) is questionable. It would be more accurate to define them as structures which give evidence of having been evolved from a common parent structure. This in no way impairs the above list of criteria, which remains the most satisfactory and exhaustive statement of of which I am aware.

The various terebratuloid structures and terms applied to them are now examined in the light of the above criteria. 'The term *hinge plate* is conventionally restricted, as first used for *Magellania flavescens*, to the case where there are more or less horizontal plates separated anteriorly from the floor of the valve by a cavity ' (Thomson, 1927, p. 86). In many genera the hinge plates are sub-divided by the crural bases into inner and outer elements. The *outer hinge plates* are usually defined as lying between the inner socket ridges and the crural bases, and the *inner hinge plates* as lying medially from the crural bases (Cloud, 1942, p. 13). These three terms are thus defined by their spatial relations. All have been used to apply to both the terebratuloids and the rhynchonelloids, and in the past there has been no implication that all structures referred to by the one name, e.g. inner hinge plates, are homologous.

The *outer hinge plates* are composite structures. As the cardinalia grow forward during the growth of the shell the posterior ends of the crura are embraced by the material being deposited, and they are thus joined laterally to the inner socket ridges, or in some genera to the floor of the valve. The crural points are progressively resorbed along their posterior edge, but a flange remains along the ventral edge (sometimes the dorsal), and after incorporation in the hinge plate this protrudes as a *crural base*. The composite structure is clearly shown in transverse sections, though naturally it becomes more difficult to identify the old crus the closer the section is to the umbo (see Pl. 17, Figs. 1–5). Structures formed in this way occur in all terebratuloids and rhynchonelloids, and it is obvious that they satisfy all the criteria for homology, except perhaps that of mutual location. For example, in the genera described in the present paper their position in relation to the inner socket ridges is very variable (Text-fig. 1). In *Fletcherithyris* and *Maorielasma* they are in what might be called the ' normal ' position—joining on to the inner side of the inner socket ridge. In *Gilledia* they are closer to the shell floor than normal, and though they are invariably attached to the socket plates in the umbo, in some species they migrate to the floor of the valve anteriorly. *Marinurnula* and *Hoskingia* are even more unusual in that the homologous plates develop from the dorsal part of the inner socket ridge and move on to the valve floor anteriorly. In the last three genera these plates do not conform to the space-relation definition of outer hinge plates given above, but are homologous with them, and hence I propose to use the term with qualifying descriptions to indicate their position and shape. At first sight this usage seems to deserve Thomson's criticism that it is inappropriate (1927, p. 87) in view of the fact that the plates are often well removed from the hinge. However, from the point of view of homological terminology the criticism is irrelevant, and the adopted procedure is far more satisfactory than that of coining a new positional term for the structures. The practice of including a statement of the function of a structure in its definition is reprehensible, since from the time of Richard Owen it has been appreciated that homologous structures could change both their form and function. Thus it is not necessary that the hinge plates should serve as attachments for the dorsal pedicle adjustor muscles.

Though some authors believe that crura have developed more than once in the brachiopods (Williams, 1956), it is inherently improbable that they have developed independently in the Rhynchonelloidea, Terebratuloidea, and Spiriferoidea. In members of the Spiriferacea the ridges bounding the inner sides of the sockets are formed, at least in part, by what have been called the *crural plates* (Kozlowski, 1929; Brown, 1953; Campbell, 1959; Dunlop, 1962). These are composed of the posterior parts of the crura and overgrowths which join them to the socket plates. Hence in spiriferoids the crural plates have partly assumed the function of the inner socket ridges of the terebratuloids and rhynchonelloids. The crural plates and the socket plates of the spiriferoids are apparently homologous with the outer hinge plates and the socket floors respectively of the other two groups.

Inner hinge plates lie medially to the crural bases. Even in the genera discussed in this paper, plates which satisfy this definition vary widely in shape and in position. In *Fletcherithyris*, *Yochelsonia*, and *Hoskingia* they either unite on the floor of the valve, or they unite above the floor of the valve and then flex to form a supporting septum; in *Maorielasma* they join on the valve floor; in *Gilledia* they remain discrete (Text-fig. 1); and in *Marinurnula* there are no plates of this type

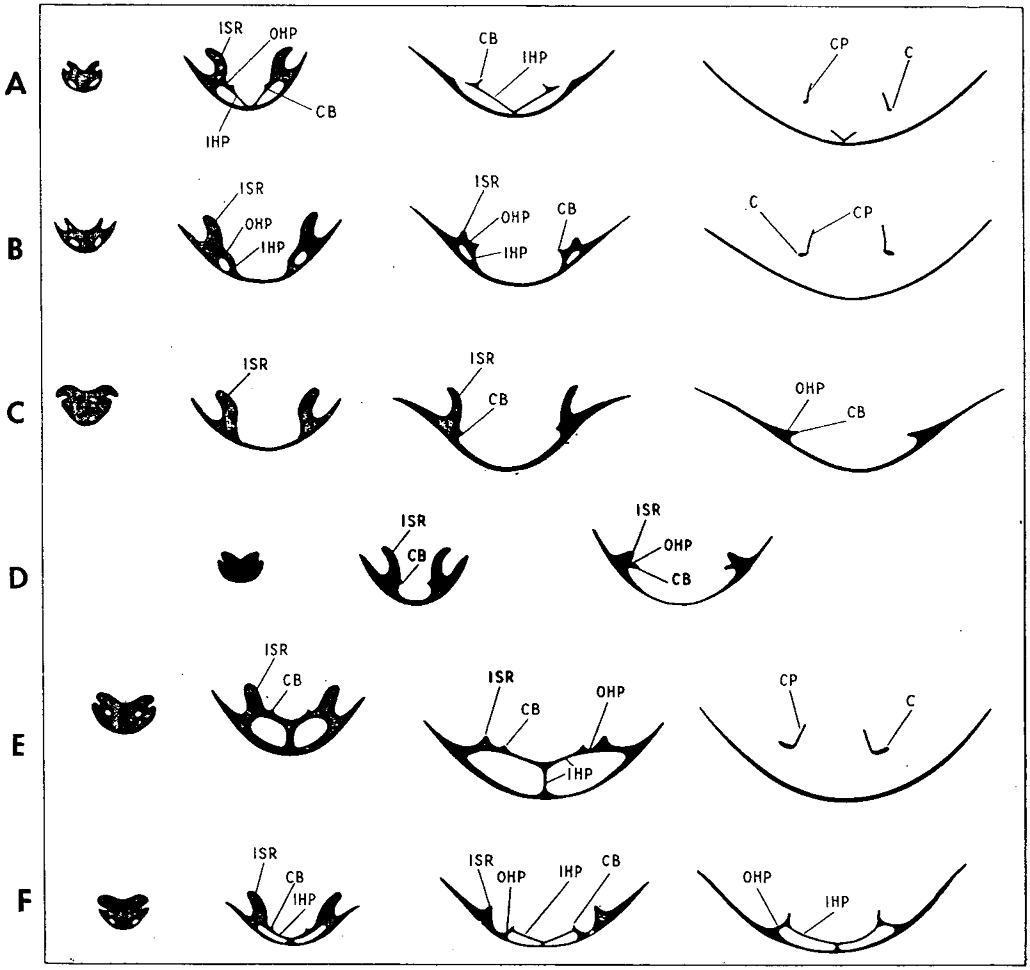

Fig. 1.—Diagrammatic serial cross-sections of the genera (A) *Maorielasma*, (B) *Gilledia*, (C) *Marinurnula*, (D) *Pseudodielasma*, (E) *Fletcherithyris*, (F) *Hoskingia*, to show inter-relationships of various internal plates of brachial valves. I.S.R. = inner socket ridge; O.H.P. = outer hinge plate; I.H.P. = inner hinge plate; C.B. = crural base; C.P.= crural point; C = crus.

at all. The genera *Maorielasma*, *Gilledia*, and *Marinurnula* form a compact group characterized by their shape, size, and pedicle umbonal structures and the absence of dental lamellae. Since they are at present known only from the Permian of the Australasian region, it is reasonable to assume that they evolved their distinctive characters in that region during the late Carboniferous and Permian. If this assumption is valid the structures referred to as inner hinge plates in this group are homologous, though they differ markedly in position, shape, and function. *Fletcherithyris*, *Yochelsonia*, and *Beecheria*, together with other forms with dental lamellae such as *Dielasma*, *Girtyella*, and *Whitspakia**, form another natural group. In these genera the inner hinge plates unite on the floor of the valve, or form a septum, or are discrete. All three conditions may be present in a single genus, e.g. *Dielasma*, and there is often considerable variation within a single species, e.g. *D. elongatum*. Within this group there is little doubt also that the structures referred to as inner hinge plates are homologous with one another. The problems of whether or not these structures are homologous with those of the first group, and also with similar structures in other groups of terebratuloids and rhynchonelloids, now have to be examined.

If we try to apply Szarski's criteria of mutual location and particular structure, the very simplicity of the structures concerned makes the method inconclusive. Application of the criterion of connexion by intermediates is beset by one great difficulty—the inadequacy of our knowledge of evolutionary relationships. However, the earliest known terebratuloids had hinge plates, and even if one accepts the phylogeny offered by Cloud (1942, p. 34) there is no reason to believe that inner hinge plates were developed more than once in the Devonian. (Compare, however, Cloud's comments on the Rhipidothyridae, p. 80.) All subsequent groups of terebratulaceans can be traced back to the Devonian stocks, and it seems probable therefore that inner hinge plates are homologous throughout this taxon. The terebratellaceans pose a more difficult problem, and so far as I am concerned it is not possible to make a decision on the basis of this criterion, and none of the above accessory criteria helps. Similar comments apply to the rhynchonelloids. In view of this lack of a decisive answer, the most satisfactory solution to the problem seems to be to continue to use the term inner hinge plates for both groups. No purpose would be served at present by the use of different terms in the different taxa.

For reasons stated above the term *crural plates* used by Cloud (1942, p. 10) to refer to ' a pair of shelly plates extending from the floor of the dorsal valve to the inner edges of the outer hinge plates, or the crural bases, in some shells,' and the term *septalial plates* used by Muir-Wood (1934) for a pair of plates running from the inner edges of the outer hinge plates to the floor of the valve, but uniting to form a septum, are regarded as synonyms of the term *inner hinge plates*. Where the inner hinge plates have a distinctive shape or are involved in the formation of some special structure, it is sufficient to use some qualifying phrase with the term, e.g. inner hinge plates uniting to form a septalium.

Plates analogous to the inner hinge plates are developed *inter alia* in certain spiriferoids, such as *Ingelarella*, where they are called dorsal adminicula (Brown,

* New name for *Pakistania* (a homonym): see Stehli, 1964.

1953; Campbell, 1959). In many genera the inner hinge plates serve as bases of attachment for the pedicle adjustor muscles, but in others they seem to be merely supports for the crural bases, as for instance in *Gilledia.*

The term *inner socket ridges* refers to structures which are obviously homologous throughout both terebratuloids and rhynchonelloids on almost all criteria.

For the trough-shaped structure supported on a septum in the brachial valve, Leidhold (1920) suggested the term *septalium* (see Wisniewska, 1932). This is a useful term to indicate a structure of a distinctive *shape* formed by the union of the inner hinge plates. Since it is only a shape term there is no reason why it should not apply to all groups in which the inner hinge plates form this shape, and it need not be restricted to the rhynchonelloids (for which it was first proposed) as implied by Cloud (1942, p. 11). That author has introduced the term *crural trough* for a structure which has the shape of a septalium but is formed ' by the basal convergence of crural plates to form a duplex median septum while their ventral ends remain in contact with the edges of the outer hinge plates,' whereas a septalium is ' formed by the forking of the dorsal median septum at its posterior end'. This latter type of definition is singularly unhelpful since it is concerned only with appearances and not with origins. Wisniewska's sections of *Septaliphoria* (the genus with reference to which the term septalium was first used) show clearly that a septalium is formed by the forward growth of the inner hinge plates over a septum. The height of this septum extending forward of the septalium is a matter of little importance since even within the one genus, for example *Fletcherithyris,* its height and length vary from very small to quite large. The important feature is the union of the inner hinge plates to form a structure which is Y-shaped in cross section. The statement of Shrock & Twenhofel (1953, p. 305) that a septalium ' is a trough formed by plates extending from the cardinal plate to a median septum with which they are united. The structure is not the result of the bifurcation of the septum, as it might seem to be, but is formed by the posterior reflection of the cardinal plate,' not only contradicts Cloud's interpretation, but is in its latter part meaningless.

The term *true median septum* is suggested by Muir-Wood (1934) for a septum which is embedded in the tissue of the ' septalial plates ' and appears also to be inserted in the shell wall. Such a structure appears only in species in which a median septum or low ridge of fairly uniform height extends well forward of the septalium along the valve wall. As the septalium grows forward it grows over this septum and embraces it. Further shell material is added to the shell wall on either side of the septum and this gives it the appearance of being embedded in the shell wall. Such structures occur in *Fletcherithyris* and *Glossothyropsis.*

Crus (plural *crura*) and *crural point* are terms lacking precise definition in terebratuloid terminology. At least in the forms described herein the crus is a short antero-ventral extension from the crural base. The crural point is attached directly to the ventral edge of the crus, but the two structures lie in different planes. Their line of junction is marked by a strong ridge, along which the direction of the growth-line changes abruptly. In many genera the crural points are situated immediately in front of the crural bases. The side branches of the loop are not extensions of the crura as is sometimes stated, but are anterior continuations of the crural points. All these relationships are shown in Text-figure 2. For the reasons given in the discussion of outer hinge plates the crura and crural points are considered to be homologous throughout the terebratuloids.

The plates extending freely into the interior of the umbonal region of the pedicle valve are termed *dental plates* or *dental lamellae.* Thin sections of these structures present in *Fletcherithyris* and *Hoskingia* show that they are not differentiated into two segments as are the similarly placed structures in the spiriferids, where they form both dental lamellae and ventral adminicula. So far as I am able to determine dental lamellae in all terebratuloids and rhynchonelloids show the same type of structure, and they thus satisfy the main criteria of homology.

In *Gilledia* and *Maorielasma* certain species have shell thickening in the umbonal region (Pl. 14, Figs 9–16) in such a way as to suggest the presence of dental lamellae which have been joined to the shell wall by a callus deposit. Thin sections show that this is definitely not so, and the structures therefore require a new name. I have called them *pseudo-dental lamellae.*

In summary then, it is shown that all plates bearing the same name in this paper (except possibly the inner hinge plates) are homologous. An attempt is made to show that the terminology is similarly consistent throughout all terebratuloids and rhynchonelloids, and this can be demonstrated for all except the inner hinge plates, on which further information is required. Several terms are rejected as synonyms on the grounds that they can be shown to refer to structures which are homologues. Finally definitions (below) are offered which appear to conform to the basic principles of morphological terminology.

Cardinal Process

The cardinal process in all the genera dealt with in this Bulletin (apart from *Glossothyropsis*, in which it has not been observed) consists of a modified shelf immediately under the umbo of the brachial valve. It is usually open V-shaped or simply curved in transverse section, and from its front edge the wall of the valve

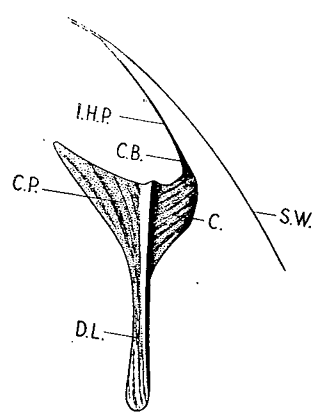

Fig. 2.—Diagrammatic lateral view of brachidium to show relationships of inner hinge plate (I.H.P.), crural base (C.B.), crus (C), crural point (C.P.), descending lamella (D.L.), and shell wall (S.W.) in *Hoskingia*. Note arrangement of growth-lines.

drops away sharply. The muscles presumably were attached to the entire ventral surface of the structure, which is usually crossed by transverse growth ridges. The term ' process ' is clearly a misnomer for such a feature, but it is used for convenience.

Anterior growth took place by the deposition of callus against the back wall of the umbonal cavity, which thus became very steep. The myophores extended themselves forward over this callus. At the same time the ventral edges of the posterior part of the inner socket ridges became extended in a ventro-lateral direction, completely covering up the posterior end of the socket (Text-fig. 9, 10; Pl. 16, Fig. 8). This enabled the myophores to extend laterally.

In some species a median boss extends down the back wall as a low ridge. The flattened areas remain on either side of the boss, and presumably still bore the muscles. I have not been able to determine whether or not the muscles encroached on to the boss.

Loop Structure

Sections and natural preservations show that the loops in almost all species of *Fletcherithyris*, *Gilledia*, and *Hoskingia* have no transverse band. The anterior ends of the descending lamellae are generally V-shaped in transverse section, suggesting that only the broad lateral parts of the band were developed. Two explanations of this phenomenon have been offered and found to be inadequate. The first was that the band had been broken away during preservation, and the second that it had been temporarily resorbed at various ontogenetic stages, the specimens examined all being at such stages by coincidence. There are, however, no signs of breakage in several well preserved specimens; and the fact that the interiors of about 30 individuals have been examined, nearly all of which were adults, seems to exclude coincidence. It is concluded therefore that the absence of a transverse band is normal for members of these species. The anatomical significance of this is obscure since it is notoriously difficult to infer the shape of the lophophore from the shape of the loop.

For no species has there been suitable material for an investigation of the ontogeny of the loop.

Definition of Terms*

The morphological terms used in this Bulletin are applied in the sense of Cloud (1942), except as is indicated below. Various terms of degree peculiar to this paper are also defined.

Outer Hinge Plates: a pair of plates in the cardinal region of the brachial valve lying between the crural bases on the inner side and the inner socket ridges or the shell wall on the outer side.

Inner Hinge Plates: a pair of plates in the cardinal region of the brachial valve lying between the crural bases on their outer edges and the shell wall on their inner edges.

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* Dimensions throughout this Bulletin are in millimetres and are given to the nearest 0·5 mm.

Septalium: a Y-shaped structure in the cardinal region of the brachial valve formed by the junction of the inner hinge plates. Where the septum is so reduced that the inner hinge plates join on the wall of the valve, the structure is referred to as a *sessile septalium.*

Socket Floors and *Inner Socket Ridges:* outgrowths from the walls of the brachial valve forming the floors and the inner walls of the dental sockets. The fibres of the shell run continuously from the outer wall to the edge of the inner socket ridge, as shown in Plate 17, Figures 1–5.

Anterior Socket Ridges: thickenings of the socket floors at their anterior edges forming slight ridges which partly close off the anterior ends of the sockets. They seem to have arisen several times in terebratuloid history.

Crura (sing. *crus*): antero-ventral extensions of the crural bases which act as supports for the crural points or the posterior part of the loop.

Length and Height of Crus: see Text-Figure 3.

Length of Septalium: the length of a straight line between the tip of the umbo of the brachial valve and the anterior tip of the trough of the septalium.

Length of Dental Lamellae: the length of a straight line between the ventral edge of the foramen and a line joining the most anterior points of the dental lamellae on the outer shell wall.

Width and Height of Median Fold, and Width and Height of Median Plication: see Text-figure 4.

Diameter of Pedicle Foramen: the maximum internal diameter of the foramen measured parallel with the width of the shell.

Degree of Sinuation of the Anterior Commissure: see Text-figure 5.

Degree of Sinuation of the Lateral Commissure: see Text-figure 5.

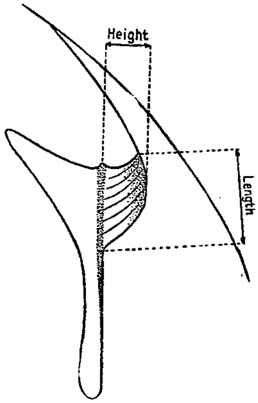

Fig. 3.—The sense in which length and height of the crus are measured.

EVOLUTION

The genera *Gilledia* and *Fletcherithyris* must have had a continuous history through the Permian in the eastern Australasian region. Both genera are known elsewhere only from Western Australia, where they are much less diversified and the time range of *Gilledia* is much shorter. It is clear then that it should be possible to trace the evolution of the genera in eastern Australia without having to take into consideration the possibility of the continued migration into the province of species which have evolved elsewhere. It is known however that sub-provinces were present in this area (Voisey, 1950; Campbell, 1961), and it is possible that some species were evolved and subsequently remained isolated within them: *G. culburrensis*, for example, is apparently restricted to the New South Wales south coast. Further, it is not possible to trace the complete development of the genus in a single basin since there are, at least at the present time, large gaps in the fossil record in each one. Consequently evolutionary lineages cannot be reconstructed with any degree of certainty. However, if the species are considered in stratigraphic sequence it should be possible to delineate trends which affected a genus as a whole. This method has been adopted here.

Evolution in Gilledia. The sequence of species in time in eastern Australia is *G. homevalensis*, *G. oakiensis*, *G. culburrensis*, and *G. pelicanensis*, representing a smooth stock, and *G. ulladullensis* and *G. ulladullensis alta*, representing a plicate stock. The latter shows little development and is not considered further.

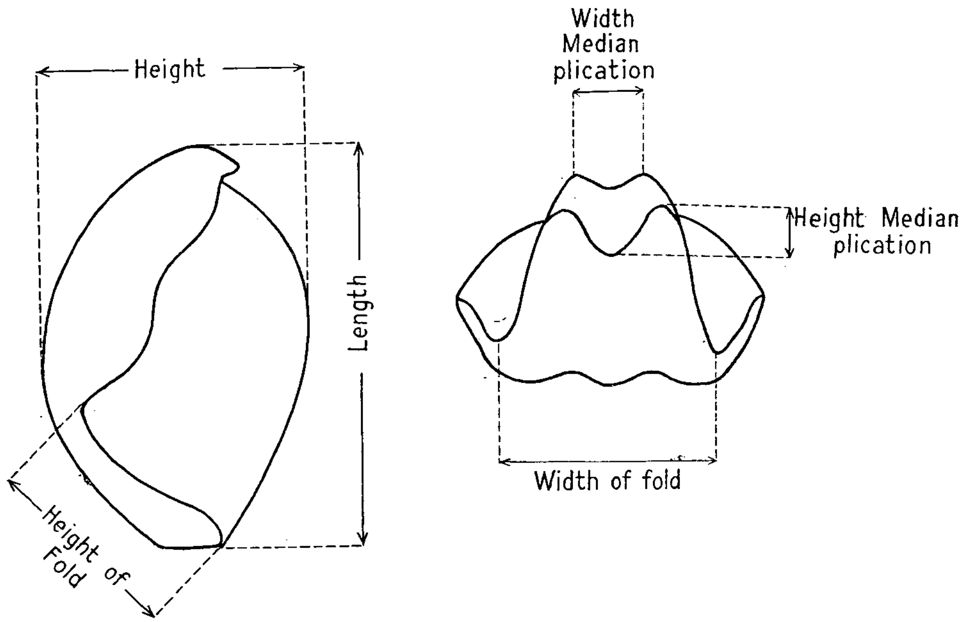

Fig. 4.—Outlines of *Gilledia ulladullensis* sp. nov. indicating the sense in which measurements have been made.

The evolutionary trends exhibited by the smooth stock can be detailed as follows:

(a) The pedicle valve changes from having a deep sinus in *G. homevalensis* to evenly convex in *G. culburrensis* and *G. pelicanensis.*

(b) The lateral and anterior commissures change from deeply sinuate in *G. homevalensis* to slightly sinuate in *G. pelicanensis.*

(c) The umbo of the pedicle valve gradually becomes longer and narrower until in *G. pelicanensis* it is almost protuberant.

(d) The dorsal pedicle adjustor scars increase in length from about two-fifths the length of the brachial valve in *G. homevalensis* to one half in *G. pelicanensis.*

Some of these trends are interdependent. A reduction in the sinuation of both the lateral and anterior commissures requires the production of a pedicle valve without a sinus, and the increase in the length of the umbo of the pedicle valve will require a change in the disposition of the pedicle adjustor muscles. There seems to be no necessary relationship, however, between the length of the pedicle umbo and the shapes of the commissures; and the depth of the sinus in the pedicle valve and the degree of sinuation of the anterior commissure.

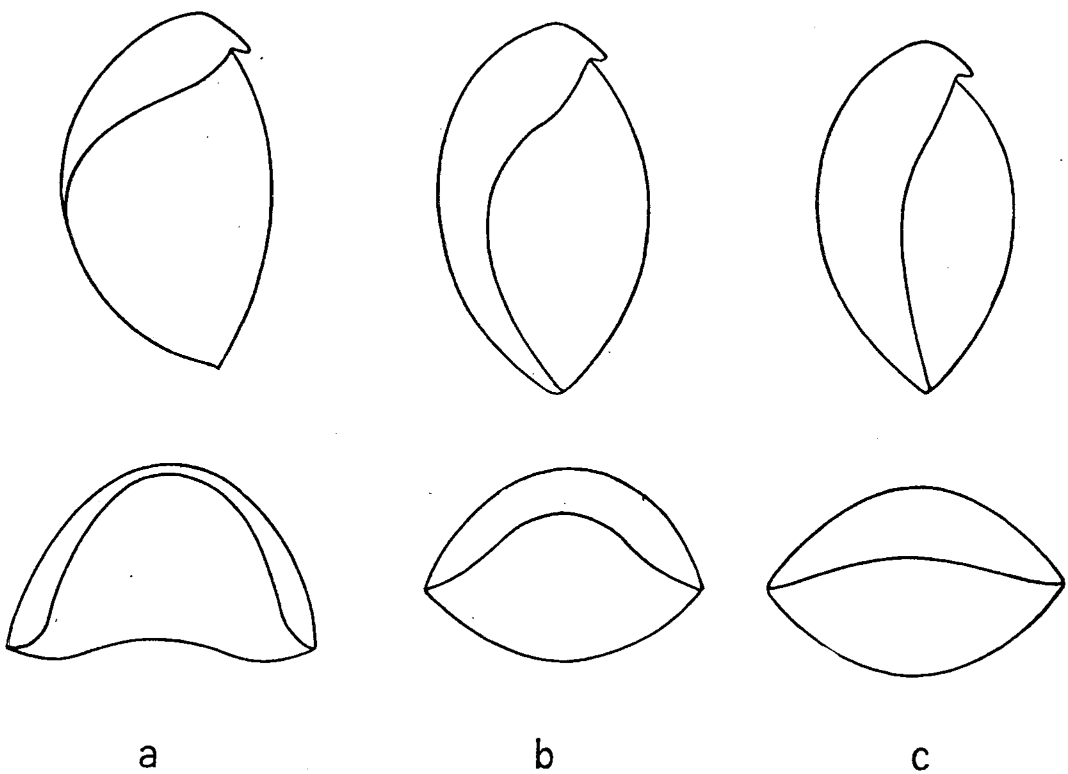

Fig. 5.—A, B, and C. Strongly, moderately, and slightly sinuate lateral and anterior commissures.

Evolution in Fletcherithyris. In *Fletcherithyris* there are two stocks—one including *F. farleyensis*, *F. farleyensis faba*, and *F. amygdala*, and the other *F. reidi*, *F. illawarrensis*, and *F. parkesi*. In both stocks the septalium in the later species is supported on a higher septum than the earlier. Otherwise no regular trends have been observed.

ZOOGEOGRAPHY

The distribution of the various terebratuloid genera known from the Permian of Australia is shown in Table 3. No attempt has been made to list all the regions in which the various genera occur. The table, however, does give an accurate picture of the known general Permian geographic distribution of the genera concerned. A major defect is the absence of reliable data from most of South America.

Table 3

	Queensland	N.S.W.	Tasmania	Perth Basin	Carnarvon Basin	Canning Basin	New Zealand	Timor	Pakistan/India	Urals	Sicily	Mongolia	Southern U.S.A.
Fletcherithyris	√	√	√		√	√	√	?					
Gilledia	√	√	√	√	√	√	√						
Marinurnula	√	√					√						
Maorielasma	√						√						
Pseudodielasma	?						?						
Glossothyropsis	√												√
Jisuina	√								√		√	√	
Hoskingia				√	√	√			?	?	?		?
Yochelsonia					√	√			?				
Hemiptychina						?			√	√	√	√	

The following negative points are of importance:

1. The complete absence of the *Notothyris* faunas which are so common in the Tethyan province from Sicily to Timor, as well as in the Urals, and the Cathaysian and the Texas-New Mexico-Central American provinces.
2. The absence of the *Dielasma* fauna of the Arctic province.
3. The almost complete lack of similar species in Timor and Pakistan-India on the one hand and Western Australia on the other. Other studies (see Dickins, 1963, for references) have suggested some faunal comparisons between these areas. It is possible that the Western Australian genus *Yochelsonia* is a near relative of *Whitspakia*, and that further study of

the interiors of some of the Indian and Pakistani species will reveal the presence of *Hoskingia* in that area. Similar detailed studies of some of the Timor species at present referred to *Dielasma* may indicate the occurrence of *Fletcherithyris*. However, at the present time the established relationships are negligible.

4. By modern standards, almost nothing is known of the Permian terebratuloid faunas of South-East Asia, China, and Mongolia, and it is impossible to identify most of the illustrated forms with certainty even at the generic level. A single specimen of the Mongolian genus *Jisuina* has been found in the Sydney Basin, but this could be of minor importance only. According to Stehli the same genus occurs in Sicily, and probably also in the Caucusus, the Karakorum Mountains and the Salt Range.
5. The species from the Urals and the Himalayas which have been compared with *Gilledia cymbaeformis* are not congeneric with that species.

On the positive side the following conclusions are significant:

1. The whole eastern Australian fauna is relatively homogeneous. The dominant genera are *Fletcherithyris* and *Gilledia*, and these range throughout the marine sequence from Tasmania to northern Queensland. In addition *Marinurnula* and *Psuedodielasma* are known from both the Sydney and Bowen Basins, though they are not yet recorded from Tasmania; and *Maorielasma* and *Glossothyropsis* are known only from northern Queensland. The limited geographic ranges of these genera will probably be extended by more intensive collecting.

   At the species level one is also struck by the wide latitudinal distribution. For example *Fletcherithyris parkesi* and *Gilledia oakiensis* are known from Tasmania in the south to Collinsville in the north, a distance of 23° of latitude; and numerous species are known from various parts of both the Sydney and Bowen Basins.
2. The faunas of New Zealand and eastern Australia are remarkably similar. In New Zealand *Fletcherithyris*, *Gilledia*, *Marinurnula*, and *Maorielasma* are well represented, and *Pseudodielasma* occurs more rarely. These similarities have been brought to light mainly by the work of Waterhouse (1964), and they neatly support previous suggestions of faunal affinity between the two countries made by Fletcher, Hill, & Willett (1952), and Waterhouse (1963).
3. There are marked contrasts between the faunas of the eastern and western sides of Australia. In the west *Gilledia* occurs, but it is never particularly abundant except at occasional horizons low in the sequence; this is presumably a consequence of the colder conditions at that time. *Fletcherithyris*, however, occurs right to the highest fossiliferous horizon in the west as it does in the east, but there are no species common to the two regions. By far the most common genus in Western Australia is *Hoskingia*, which ranges throughout the sequence and is represented by at least five species. Not a single specimen has been found on the eastern side of

the continent, and it has not been recorded from New Zealand. *Yochelsonia* also is unknown in the east, and *Marinurnula, Maorielasma, Glossothyropsis, Pseudodielasma*, and *Jisuina* are unknown in the west. Perhaps some of these absences can be explained as due to inadequate sampling, particularly of *Glossothyropsis, Pseudodielasma*, and *Jisuina*, all of which are represented in the east by a handful of specimens. It is highly improbable, however, that this is a general explanation, and it seems far more likely that the distribution of *Hoskingia, Yochelsonia, Marinirnula*, and *Maorielasma* was controlled by temperature, the western part of the continent being consistently warm in post-Sakmarian times (Dickins, 1963, p. 18–19), while the east was subjected to several episodes of extreme cold.

At the species level there are few close comparisons. *Gilledia homevalensis* is probably represented on both sides, but it is the only known case of specific identity.

4. Two surprising features are the similarity of some of the *Hoskingia* species of Western Australia to those of the Urals, and the doubtful occurrence of the North American genera *Glossothyropsis* and *Pseudodielasma* in Queensland. These are not common and show some morphological differences from the American forms, which are difficult to evaluate. More material needs to be examined before the significance of either feature can be estimated.

Suborder TEREBRATULOIDEA Muir-Wood, 1955

Superfamily TEREBRATULACEA Waagen, 1883, emend. Stehli, 1956

Family DIELASMATIDAE Schuchert, 1913

Diagnosis: Biconvex shells; smooth or slightly plicate; foramen mesothyrid to permesothyrid, and labiate; dental lamellae present; outer hinge plates joined to socket ridges or directly to valve wall; inner hinge plates present, uniting with valve wall separately, or forming a septalium, or forming a cardinal plate raised above floor of valve; loop in adult stages terebratuliform.

Remarks: Only two subfamilies are definitely included here, the Dielasmatinae and the Cranaeninae. Cloud (1942) included also the Brachyzyginae, the Mutationellinae, and the Cryptonellinae. The Brachyzyginae is acknowledged to be aberrant; the Mutationellinae seem to me to be more closely related to the Centronellidae, which should be placed in a separate superfamily as was suggested by Stehli (1956b); and the relationships of the Cryptonellinae expressed by the same author (p. 198–199) also seem to be more satisfactory than those indicated by Cloud.

The Cranaeninae probably developed in Lower Devonian times from a member of the Centronellacea, and persisted until the Lower Carboniferous. During the Upper Devonian the Dielasmatinae were derived from the Cranaeninae through the genus *Afilasma* Stehli. This in turn gave rise to *Beecheria* Hall & Clarke. Stehli 1961 b, p. 460) suggests that the change from a *Cranaena*-like form to *Afilasma* was brought about by the enlargement of crural bases below the cardinal plate of some genus of the Cranaeninae (possibly *Cranaena* itself), to such an extent that ' crural plates ' were formed. ' The cardinal plate would then have become obsolete between the crural plates and the socket plates.' This seems to be most unlikely, since crural bases are not known to develop on the dorsal surface of the ' cardinal plate ' in Palaeozoic terebratuloids. A more probable explanation is that the plates which I call outer hinge plates migrated down the inner faces of the inner socket ridges on to the floor of the valve during evolution. Accompanying this change was a tendency for the posterior part of the cardinal plate to become sessile, and its apical perforation, therefore, to disappear. These modifications would produce a shell structure very similar to that of the type species of *Beecheria*, in specimens of which the anterior part of the cardinal plate is raised slightly above the floor of the valve. The *Beecheria* stock was a very viable one and continued on to the Upper Permian.

The main line of the Dielasmatinae, which originated in *Girtyella* and produced *Dielasma*, *Fletcherithyris*, and related genera in the Permian, could be derived from the *Beecheria* stock by a re-migration of the outer hinge plates. Alternatively *Girtyella* could have been derived independently from a cranaeninid by the union of the ' cardinal plate ' with the floor of the valve to form first a sessile septalium, and then a normal septalium. If this were so, the *Beecheria* stock should be recognised as a separate subfamily. At the present time however no genera intermediate between *Cranaena* and *Girtyella* are known to me, and hence the position remains undecided.

Cloud's suggestion (apparently based solely on the form of the cardinalia) that *Girtyella* was derived from the Rhipidothyrinae is not supported either by the morphology of the pedicle umbo or the form of the loop.

Subfamily DIELASMATINAE Schuchert, 1913

Diagnosis: Inner hinge plates uniting separately with floor of valve, or forming a septalium (either normal or sessile); outer hinge plates either joining inner socket ridges, or (in *Beecheria* and *Hoskingia*) floor of valve.

Genera included are *Dielasma* King, *Girtyella* Weller, *Fletcherithyris* Stehli, *Whitspakia* Stehli, *Yochelsonia* Stehli, *Lowenstamia* Stehli, *Beecheria* Hall & Clarke, and *Hoskingia* gen.nov.

Genus DIELASMA King, 1859

Type species (by original designation): *Terebratulites elongatus* Schlotheim from the Zechstein of Glücksbrunnen, Thuringia.

Diagnosis: Shells small to moderate in size for terebratuloids; pedicle valve evenly convex transversely, or flattened, or broadly sinuate; umbo sub-erect to erect; foramen labiate; umbonal ridges rounded to sub-angular; anterior and lateral commissures broadly sinuate; dental lamellae present; outer hinge plates attached to inner socket ridges; inner hinge plates meeting floor of valve separately, or forming a sessile septalium, or more rarely forming a normal septalium on a low septum; density of punctae averages 250 per sq. mm.

Remarks: The type species has been recently redescribed by Malzahn (1937, p. 56–59) and by Stehli (1956a, p. 301). The latter used material from an horizon at Pössneck, Thuringia, which is considered to be the same as that of Glücksbrunnen. In the British Museum (Nat. Hist.) there are numerous small specimens of *D. elongatum* from Glücksbrunnen as well as a large collection from Pössneck. I have examined this material together with specimens from the Magnesian Limestone of Humbleton Hill, England, catalogued as *D. elongatum* (Schlotheim) and *D. sufflatum* (Schlotheim), in the Sedgwick Museum, Cambridge. So far as the material permits a statement, I agree with Stehli that the specimens from Glücksbrunnen and Pössneck are conspecific.

In considering *D. elongatum* the status of *D. sufflatum* (Schlotheim) has to be taken into account. Supporting Schlotheim's original contention, King (1850, p. 150) asserted that the two species were 'obviously distinct.' The main bases of distinction were the degree of inflation of the shells, the roundedness of the shell outline, and the width and definition of the sinus in the pedicle valve. Geinitz (1861) and Malzahn (1937), however, both relegated *D. safflatum* to the synonymy of *D. elongatum.* My examination of the material mentioned above suggests that the variation in the characters considered by King to be of diagnostic value is continuous, and since the collections from individual localities contain specimens representative of both nominal species, it is concluded that the only one species is present.

On the other hand, Westoll (1950), after statistically examining large collections from England identified as *D. elongatum,* concluded that variation was discontinuous for the ratio thickness/length for specimens more than 6 mm. long. The distribution of this ratio is distinctly bimodal, with approximately equal numbers of individuals in each mode. This could be cited as evidence in support of the validity of *D. sufflatum,* but Westoll concluded that 'analysis of variation of several measurable characters showed that, according to the evidence of scatter plots and frequency of occurrence of ratios of breadth/length . . . . ., only one species is present,' and that the bimodal distribution of thickness/length 'may be regarded as evidence suggesting sexual dimorphism.' Before this suggestion is accepted the sources of the specimens examined, and the number of different horizons and different matrices involved, must be discovered. An examination of English specimens in the Sedgwick Museum shows that there is a marked tendency for the two types to be associated with different types of matrix, suggesting that they may be from slightly different horizons or environments. Perhaps the differences are purely phenotypic in origin or even possibly of evolutionary importance. The answer lies in the analysis of accurately localized specimens.

King has well illustrated the wide range of variation in shape in *D. elongatum* from England, and there is a similar range in the specimens from Pössneck. The variable external characters are:—(a) relative width/height (Westoll, 1950, text-fig. 22); (b) position of maximum width, which varies from approximately one-third to two-thirds the length of the shell (Westoll, 1950, text-fig. 22); (c) width and depth of the sinus, the more globose forms having relatively narrower and more sharply defined sinuses; (d) well rounded to sub-pentagonal outline, the relatively wider specimens tending to be more rounded; (e) prominence of the pedicle umbo;

(f) form of the pedicle foramen, which in most specimens is slightly labiate, but in an appreciable number is notched and probably attrite, the lip tending to be more strongly developed in the more globose forms.

Internally the position of the inner hinge plates seems to be the most variable feature. In some of the Pössneck specimens they diverge along the floor of the valve at angles up to 10° (or slightly more), in others they meet to form a sessile septalium, and in still others they unite to form a septalium on a low septum. Some English specimens are preserved as internal moulds and show more detail. The inner hinge plates extend one-quarter to one-third (usually nearer one-third) the length of the valve and they diverge at angles up to 20° along the floor of the valve. In many moulds their anterior tips converge, and though none become confluent, some are joined by a weak arcuate ridge.

In addition these specimens show the main trunks of the vascula media in the pedicle valve to be long, straight, slightly divergent, and extending almost to the front edge of the shell. In some brachial valves a median myophragm is present; the two pairs of adductor scars are not clearly distinguishable, but their posterior extremities are just outside and behind the tips of the inner hinge plates, while the well rounded ovate anterior scars extend well towards the midline of the shell, leaving just enough room for the vascula media to pass between them.

Sanders (1958) remarks that *Dielasmoides* and *Dielasma* may be distinguished by the presence of a cardinal process in the latter. The only type of cardinal process I have observed in *D. elongatum* is a flattened area just below the brachial umbo. Some have a sharp anterior edge and some do not. This feature is common to all the genera examined in this study, and it is unlikely to be of much systematic significance.

Finally, the description of the species given by Stehli should be modified in the following points. The pedicle umbo is not invariably erect, but is sometimes sub-erect. It is also somewhat flattened transversely, owing of course to the rather flat pedicle valve at the early growth stages. The umbonal ridges tend to be sub-rounded to subangular. The brachial valve is simply vaulted and no fold can be made out at all. The punctae number 150–350 per sq. mm., with an average of 250.

Genus FLETCHERITHYRIS nom. nov.

1961 *Fletcherina* Stehli, *J. Paleont.*, 35(3), p. 452 (non *Fletcherina* Lang, Smith, & Thomas, 1955).

Type species (by original designation): *Terebratula amygdala* Dana, from the Gerringong Volcanics at Black Head, South Coast, New South Wales.

Diagnosis: Shell of small to medium size; pedicle valve slightly sinuate to strongly sulciplicate anteriorly in adult stage, but invariably rectimarginate in early stages of growth; pedicle umbo sub-erect to erect; foramen labiate, rarely telate; cardinal margin sub-terebratuloid to terebratuloid; surface smooth or with irregular, discontinuous radiating furrows; beak ridges sub-rounded to well-rounded; dental lamellae and pedicle collar well developed; cardinal process as for family; sockets not denticulate; outer hinge plates narrow, joining the socket plates; inner hinge plates either joining on floor of valve, or more commonly joining to form a low median septum and a septalium; crural bases blunt or sharp; crural points high and long; loop terebratuliform but with transverse band incomplete; punctae coarse and only moderately dense.

Remarks: The name *Fletcherina* Stehli, 1961, is preoccupied by *Fletcherina* Lang, Smith, & Thomas, 1955, a genus of Rugosa. Stehli (in litt.) has requested me to suggest a new name for his genus, and *Fletcherithyris* is here proposed.

Comparisons: Fletcherithyris is closely comparable with *Dielasma*, from which it differs in the junction of the inner hinge plates to form a septalium, the incomplete loop, and the density of the punctae. As regards the first feature, there is some overlap in the range of variation between the two genera, but none of the species of *Fletcherithyris* ever has the inner hinge plates separated on the floor of the valve, as have *Dielasma elongatum* and many of its allies. Using this feature alone, it should be possible to place any given population in one genus or the other. However, there is always a clear distinction in the arrangement and density of the punctae.

The cardinal structures of the genus are similar to those of *Girtyella* from the Lower Carboniferous of America, Europe, and Australia. However, the loop of *Girtyella* has a complete transverse band, which is medially angular rather than evenly curved, its crural points are relatively shorter than those of *Fletcherithyris*, and its punctae are much more crowded.

Distribution: At present the genus is known only from eastern and western Australia, where it is very widespread. The earliest species occur in late Sakmarian or early Artinskian sediments (the basal Middle Bowen Beds), and the latest ones probably as high as the Kazanian (Hardman Member of the Liveringa Formation).

The distribution of the genus will probably be extended when the internal structures of species from Pakistan, India, and Timor, which are at present placed in *Dielasma*, are examined in detail.

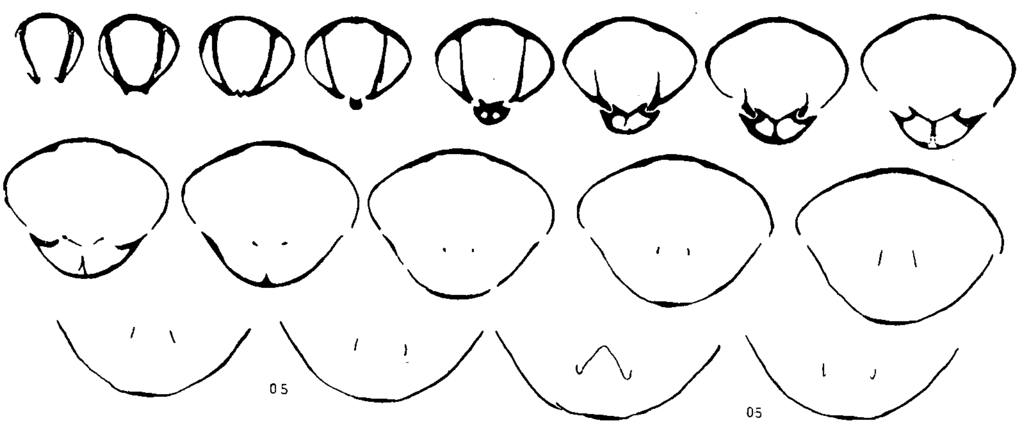

Fig. 6.—Serial section of a specimen of *Girtyella indianensis* Weller from Pella Beds, Iowa. Intervals between sections 0.25 mm. unless otherwise stated. x 2.5.

FLETCHERITHYRIS AMYGDALA (Dana)

(Pl. 3, Figs. 1–6; Pl. 6, Figs. 11–34; Text-figs. 7–9).

1847 *Terebratula amygdala* Dana, *Amer. J. Sci.*, 54, 152.

1847 *Atrypa biundata* McCoy, *Ann. Mag. nat. Hist.*, 20, 231, pl. 13, figs. 9–9a.

1849 *Terebratula amygdala* Dana, *U.S. Exploring Expedition under the command of Charles Wilkes, U.S.N.*, 10, 682, pl. 1, figs. 2a–c.

non 1877 *Terebratula sacculus* var. *amygdala* Dana; *in* de Koninck, *Mém. Soc. Sci. nat. Liège, Ser.* 2, 6–7, pl. 15, fig. 3d.

1961 *Fletcherina amygdala* (Dana); *in* Stehli, *J. Paleont.*, 35(3), 453, pl. 61, figs. 7, 10, 11, 14, 15, 19–22.

Lectotype (here selected): F3597b U.S.N.M. from the Gerringong Volcanics, Black Head, Gerringong, South Coast, New South Wales.

Diagnosis: Shell moderate size; strongly biconvex; anterior commissure broadly sinuate or slightly sulciplicate; pedicle umbo moderately acute; septalium 0.18–0.22 of length of brachial valve, raised on prominent septum; anterior outline of septalium not V-shaped; crural points very high.

Description: Shell of moderate size; very variable in degree of inflation, height/width ratios ranging from about 0·5 to 0·85; maximum width usually forward of the mid-length; variation in outline as in Figure 7; in lateral profile pedicle valve slightly more convex toward umbo than forwards, and brachial valve generally of even convexity; pedicle umbo rather prominent, narrow, and suberect; foramen oval, permesothyrid and moderately labiate; delthyrium low; deltidial plates conjunct, and showing a clear line of junction in transverse sections; beak ridges sub-rounded in forms of low convexity, to well-rounded in those of high convexity; hinge terebratulid; lateral commissures gently sinuate; pedicle valve non-sinuate, simply sinuate toward the front, or in some specimens sinuate with a low rounded fold in the sinus, thus producing a sulciplicate commissure; width of sinus and plication approximately proportional to width of specimen; outer shell layers rarely preserved, but some specimens show weak radial furrows in places; shell substance thick and in many specimens strongly lamellate; punctae on median anterior portions of adult shells usually number 40–60 per sq. mm., but up to 140 have been counted.

Pedicle collar strong; thickness of dental lamellae variable, but length about one-fifth to one-sixth of the total length of the shell; angle of divergence of dental lamellae varies with umbonal angle; denticula always present; muscle scars usually poorly defined; very low sharp keel runs forward from pedicle collar, and best preserved specimen shows hint of paired pedicle adjustor in this position; in occasional specimens whole muscle field slightly sunken; reconstruction of muscle scar pattern as in Figure 8; pallial trunks indistinguishable.

Inner socket ridges high, and articulate on their ventral edge with a ridge on inner faces of teeth; inner and outer socket ridges have opposed flanges enclosing the bulbous tooth; anterior socket ridges weak; posterior end of socket completely enclosed by a weak plate; usually no clear junction between inner socket ridges

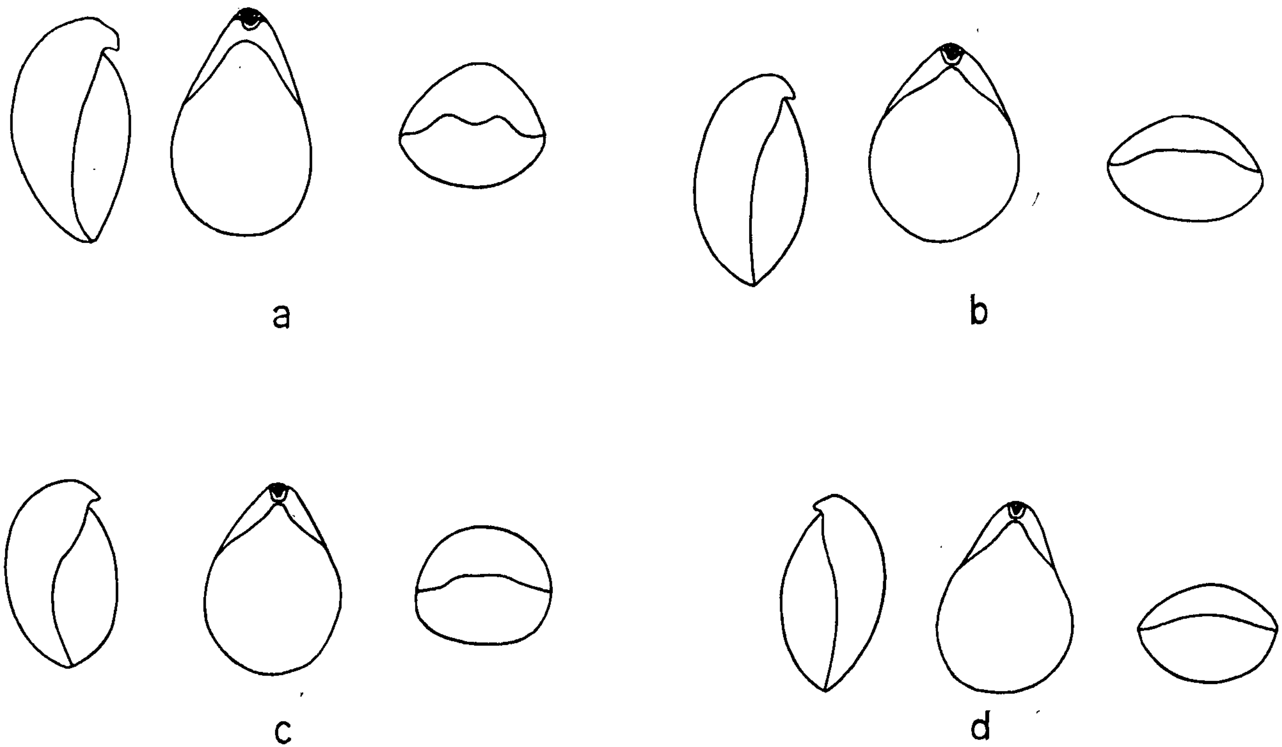

Fig. 7.—Outline diagram of *Fletcherithyris amygdala* (Dana) showing certain variants. (a) 11967 A.N.U., (b) 11965 A.N.U., (c) 22663 A.M., (d) 22660 A.M. x 1.

and outer hinge plates, though an angular junction present between them near their anterior edges in some specimens (Text-fig. 9); crural bases low, blunt, and distinguishable only toward front of trough; outer hinge plates very narrow; inner hinge plates much thinner than outer hinge plates and inner socket ridges, and forming a septalium almost invariably supported on a median septum for nearly, or quite, its entire length; height of septalium above valve floor increasing slightly towards the front, and its transverse section varying from V to open U-shaped; in early stages growth-lines on inner hinge plates forming an unbroken gently arched curve, but in adults tending to sweep back from the crural bases and arching slightly forwards to the mid-line, though some specimens show the juvenile arrangement throughout; anterior edge of septalium never having a sharp V-shaped outline; median septum dropping rapidly in height in front of crural trough, and continuing as a low median ridge to a point behind mid-length of valve; adductor scars lacrymate in outline and reaching mid-length of valve; outer limits of muscle track clearly defined as a low straight ridge; anterior edges of scars in most specimens indefinite; usually no sharp break in outline between posterior and anterior scars, the lines of junction between them running forwards and inwards; pallial trunks poorly impressed; vascula media separating at anterior edge of septum; crura short and relatively thick; crural points high and short, and slightly concave toward each other; descending lamellae also very short; transverse band incomplete.

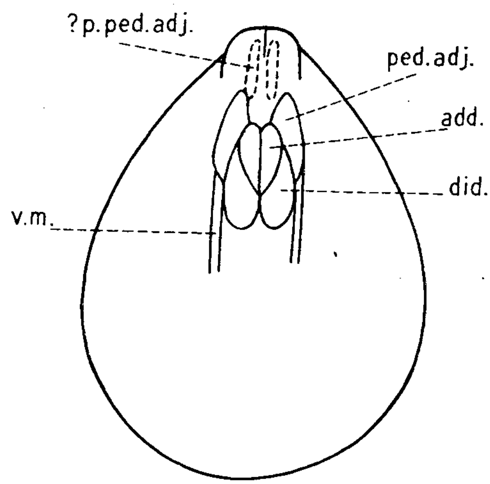

Fig. 8.—Reconstruction of muscle field on an internal mould, F22640 A.M., of *Fletcherithyris amygdala* (Dana); ped. adj. = pedicle adjustor scars; add. = adductor scars; did. = diductor scars; v.m. = vascula media. x 2.

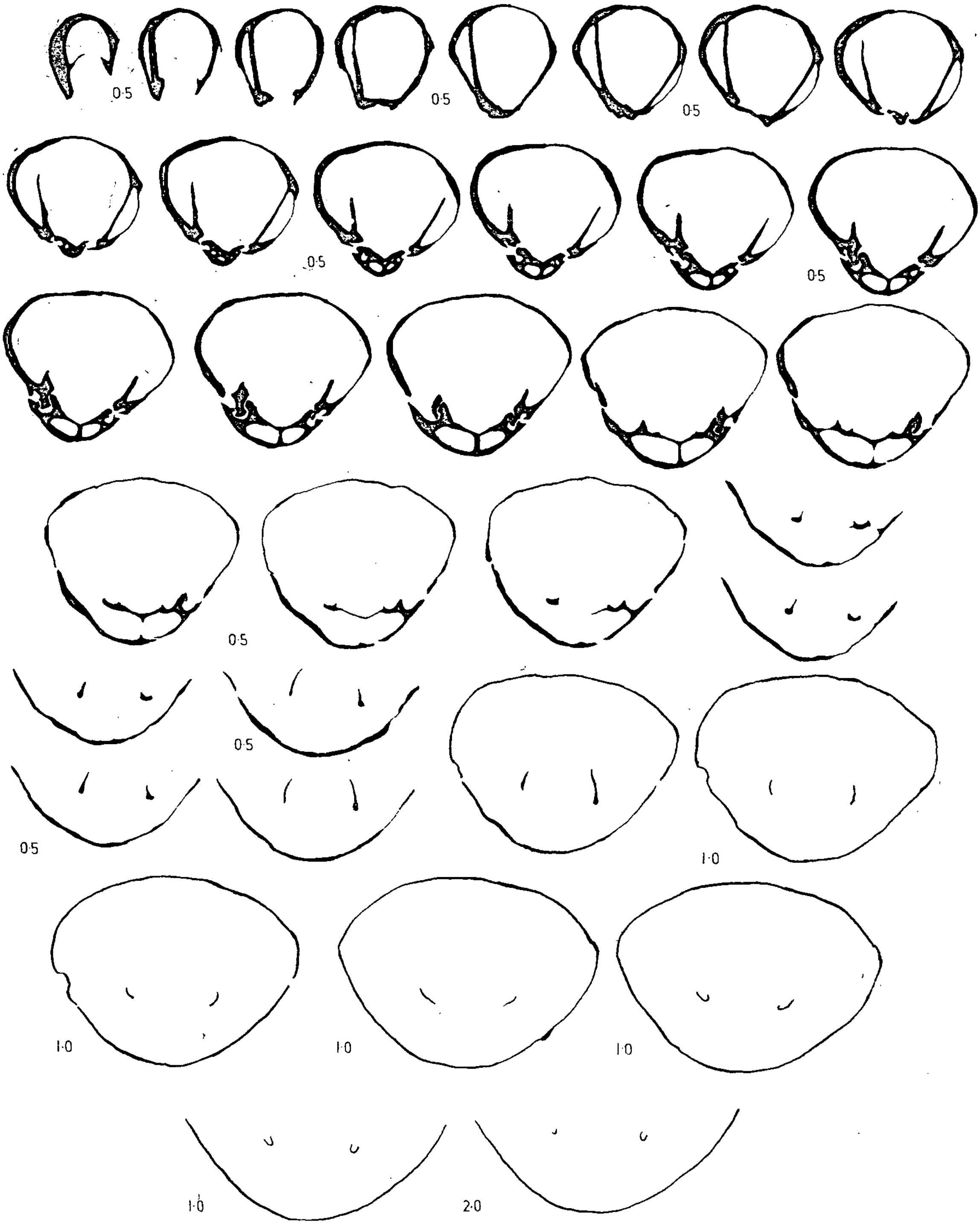

Fig. 9.—Serial sections of a specimen of *Fletcherithyris amygdala* (Dana), F22641 A.M. from Black Head, Gerringong. Intervals between sections are 0.25 mm. unless otherwise stated x 2.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Dental Lamellae	Length Septalium	Height Septalium
34	24	18	....	....	....	....
33	22	17	....	9	....	....
....	25	18	31·5	....	6·5	2
....	26	18	31	....	7	2·5
32	24	15·5	29	7·5	5·5	1
32	22	19	....	....	6·5	2
....	18	15	24	....	5	2
29	21	16	27	5	5	2·5
26	19	13·5	23·5	6·5	5	2
25	19	12·5	22	5·5	4·5	1·5
22	15	12·5	19·5	....	....	....
20·5	16	10	18·5	....	....	....

Remarks: Dana first described this species in July 1847, but the description was not accompanied by figures. In 1849 he published an illustrated description, but the figures have obviously involved considerable reconstruction. The specimen of his plate 1, figures 2a–d seems to be the individual now numbered F3597b U.S. National Museum, and so it is here selected as lectotype. The dimensions given by Dana are very close to those of this specimen.

The species is very abundant at the type locality. There is a fine collection of topotypes in the Australian Museum, and a smaller one in the Australian National University. The species is very variable in shape, outline, length and depth of the sinus, and strength of the median plication. Particularly noticeable is the wide range in the form of the sinus and its median fold. At one end of the range is a number of specimens with no vestige of a sinus or dorsal flattening; at the other is an occasional specimen with a distinct sinus, and median plication extending back onto the posterior half of the shell, accompanied by a corresponding flattening or slight sulcation of the crest of the brachial valve. It is clear from photographs supplied by Dr G. A. Cooper of the U.S. National Museum that Dana's syntypes were variable in the same way.

I have been able to examine the crural trough and other cardinal structures in sixteen specimens, and in all except one the height of the median septum increases toward the front. The form of the septalium is likewise fairly stable, its anterior edge rarely being V-shaped, and never forming a strong sharp V, while its length relative to the total length of the valve is almost constant. The dental lamellae do not vary in length. In only one specimen (F22661 A.M.) are the delicate surface grooves present, and even here they are preserved only on the postero-lateral surfaces of the shell. No decorticated specimens show traces of grooving on the internal shell layers.

I have been able to examine the three type specimens of *Atrypa biundata* McCoy, now E10590–92 in the Sedgwick Museum Collections. Of these only E10590 was figured. It is an almost complete specimen, though with most of the shell stripped off. E10591 is the anterior part of an adult shell filled with chalcedony, as are

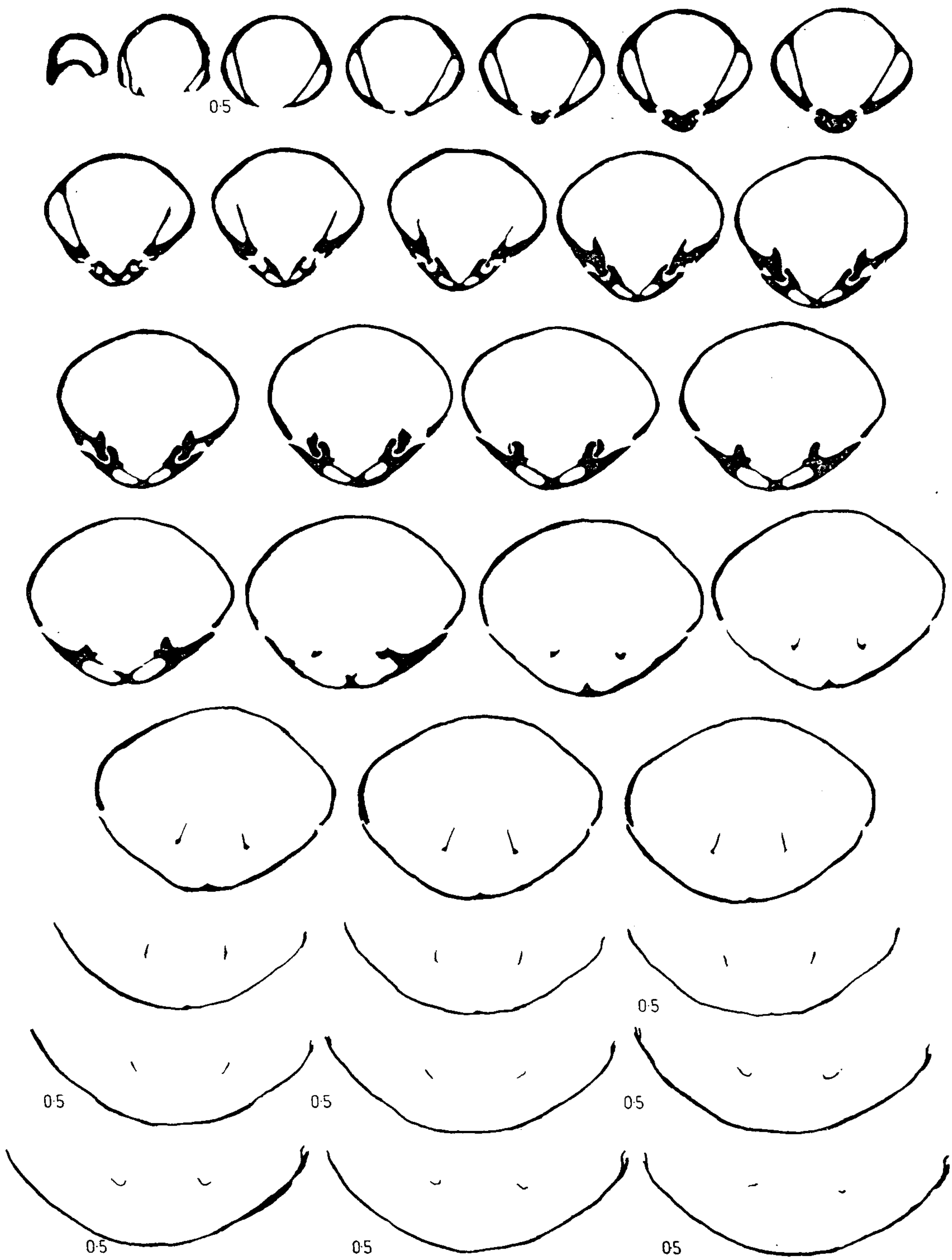

Fig. 10.—Serial sections of specimen of *Fletcherithyris* cf. *amygdala* from near the Font Hill Shaft, near Maitland. Intervals between sections are 0.25 mm. unless otherwise stated. x 3.

several of our Black Head specimens, and E10592 is a broken juvenile. E10590 shows slight sulciplication at the adult stage such as is common in topotypes of *F. amygdala*. These specimens are certainly conspecific with *F. amygdala*, which species has priority by three months.

Localities and Horizons: Several specimens from the Muree Formation on the bank of the Hunter River in front of Glendon Homestead, 11937–51 A.N.U., conform with the Black Head specimens in general shape, form and relative length of the septalium, height of the septum, and form of the dental lamellae. There are a few points of difference, however. The range of plication of the shell is far greater than in the types (see Pl. 3, Figs 2–6). The outlines of the dorsal adductor scars range from long and slender, showing no clear differentiation into posterior and anterior pairs, to much shorter types showing an abrupt expansion inwards of the anterior pair. The pallial trunks are well developed in some individuals and are outlined in Plate 3, Figure 4. There appears to be no virtue in distinguishing these specimens from *F. amygdala* on the basis of these minor differences.

In the Waterhouse Collection at Sydney University (F19480–19490) there are eleven specimens from a shaft about 150 yards on the Maitland side of the Font Hill Shaft, near Maitland. This shaft goes down into the Lower Coal Measures, and the specimens are therefore probably from the lower part of the Branxton Subgroup. It is difficult to assess their relationships; the evidence as a whole suggests a position between *F. amygdala* and *F. farleyensis*, with the form of the septalium and the relation of the outer to the inner hinge plates suggesting slightly closer affinities with the former (Text-fig. 10).

Specimens F22864–22866 A.M., labelled Jerrawangala, belong here. The horizon represented is probably Wandrawandian Siltstone or lower Nowra Sandstone.

Several specimens, all numbered F263 A.M., are labelled Jervis Bay. The exact horizon cannot be determined on present knowledge, but presumably it is somewhere within the upper Conjola Formation-Nowra Sandstone interval.

FLETCHERITHYRIS CANNI sp.nov.

(Pl. 8, Figs 24–31)

Holotype: 11988 A.N.U.; paratypes 11983–11987 A.N.U., all from the ? Nowra Sandstone at Wheeler's Point (Culburra Headland), south coast of New South Wales.

Diagnosis: Shells ovate in outline; typical length/width/height ratios approximate to 2/1·6/1; commissure rectimarginate or slightly sinuate; foramen moderately labiate; pedicle umbo very short; umbonal angle about 85°; septalium on high septum and extending about 0·12–0·15 of the length of the brachial valve; inner socket ridges rapidly losing height behind point where crura leave hinge plate; adductor scars in brachial valve not extending beyond mid-length of valve.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Dental Lamellae	Length Septalium	Height Septalium
32	26	19	30	5	4·5	2
31	25	17	29·5	....	....	....
31	25	16	29	....	4·5	1·5
29	23	13	26·5	....	....	....
25·5	21	12	24	4	3	1

Remarks: F. canni is very close in most respects to *F. amygdala* and so no formal description is given. The differences between the two species are as follows: *F. canni* is relatively much broader, and seems never to develop a deep sinus or a biplicate anterior, and its umbonal angle is invariably greater. The septalium in *F. canni* is slightly higher, slightly more upturned at the anterior edge, and relatively shorter. In transverse section the inner hinge plates are generally, though not invariably, arched towards the pedicle valve, a feature not observed in *F. amygdala*. The crural bases are situated closer to the socket plates in *F. amygdala*, that is, the outer hinge plates are narrower. The loops of the two species are closely comparable.

Locality and Horizon: The species is known only from the type locality, which is mapped as Nowra Sandstone or Wandrawandian Siltstone on the Wollongong 4-mile Sheet (1953). Rocks lithologically similar to the Nowra Sandstone outcrop on Culburra Headland, but their relationship to the rocks farther west is obscured by alluvium.

FLETCHERITHYRIS FARLEYENSIS sp.nov.

(Pl. 6, Figs 1–10)

Holotype: 14092 A.N.U.; paratypes F25510 A.M., and F19455–19479 S.U., all from the Farley Formation at Farley, near Maitland, New South Wales.

Diagnosis: Shape and external structures as for *F. amygdala*; septalium usually sharply V-shaped in transverse section; crural bases strong and sharp; front edge of septalium in adults forms an anteriorly directed V; axis of septalium either on valve wall or supported on a low septum; ratio length of septalium/length of brachial valve ranges from 0·21–0·29.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Dental Lamellae	Length Septalium	Height Septalium
32	24	14	29	5	7	1
31	23	14	28	6	7	1
31	24	14	28	5	7	0·7
26	20	11	23	4	6·5	0·5
25	19	11	22	4	5	0·5
21	16	8·5	19·5	4·5	5	0·5
20	15	10	18·5	3·5	4·5	0·7

Most specimens are slightly distorted and measurements of overall height and width have involved minor reconstruction.

Remarks: I have been doubtful of the propriety of separating this species from *F. amygdala* (Dana) since the two have so many features in common, and there is some overlap in the range of variation of most of the diagnostic characters listed above. Experience has shown, however, that though a single specimen can be difficult to assign to one species or the other, a small population can be readily identified.

The cross section of the septalium is V-shaped in almost all well-preserved specimens, but in a few it is moderately rounded. The shell of the septalium is rather thin and crushing sometimes simulates rounding. The septalium invariably sits close to the wall of the valve, the septum on which it is supported rarely being more than 1 mm. high, whereas in *F. amygdala* it is almost always higher than 1 mm. and sometimes is up to 3 mm.

Occasional specimens are sulciplicate at the adult stage. One individual, F19457 S.U., is sulciplicate almost throughout growth and the degree of folding is much greater than that observed in any specimen of *F. amygdala.*

The specimen F39582 A.M. has a pair of small symmetrically placed muscle scars in the brachial valve between the posterior adductors and just in front of the septalium. Several other well-preserved specimens show no such structures in a similar position, but the muscle scars are always lightly impressed, and this may not be significant. In other words, it is possible that three pairs of adductor scars were normal in this species, and perhaps even in the genus.

Localities and Horizons: Specimens F2213–2217 G.S.Q. from Hazelwood Creek, Eungella Station, are assigned to *F. farleyensis* because of their long septalia which lie close to the wall of the valve. In cross section, however, the septalia are more rounded than is normal. These specimens are associated with *Gilledia oakiensis* and *Ingelarella ovata,* which also occur together in the lower part of the Middle Bowen Beds at Oaky Creek near Homevale. F2273 G.S.Q. from the Homevale Beds is a moderately sulciplicate form within the range of variation of the topotypes, and F2263 G.S.Q. is a normal member of the species, which was found in association with *Ingelarella* cf. *ovata.*

FLETCHERITHYRIS FARLEYENSIS FABA subsp.nov.

(Pl. 2, Figs 45–59; Text-fig. 11)

Holotype: CPC 5319 from locality MC 485, 1½ miles south-east of Lizzie Creek road crossing of Hazelwood Creek, Bowen Basin, base of Middle Bowen Beds; paratypes CPC 5313–5318, 5320–5324 same locality; F15710 U.Q. and 14095–14100 A.N.U. from the Homevale Beds, Mount Britton, Bowen Basin.

Diagnosis: Like *F. farleyensis* but smaller, narrower in outline, tending to become sinuate at an earlier growth stage, and with stronger anterior socket ridges.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Septalium
c 26	18	10	24	5·5
21·5	17	9	19·5	4
21·5	15	9	19·5	4·5
19·5	13·5	8	18	4·5
17	11·5	6·5	15	4
14·5	11	6	13	3
14	9·5	5·5	13	....

Remarks: The specimens from Homevale are all small, the largest being only 17 mm. long, and in almost all of them the pedicle valve tends to become flattened at a length of 8–12 mm. These features are not shown by any of the types of *F. farleyensis.* However, specimens from the Hazelwood Creek locality, only 20 miles north-west of Homevale and on the same stratigraphic level, show a much wider range of variation, and there is considerable overlap in the above characters between these specimens and topotypes of *F. farleyensis.* The only constant difference is in the shape of the anterior socket ridges. The most satisfactory course seems to be to recognize the Bowen Basin form as a subspecies of *F. farleyensis* until more material becomes available.

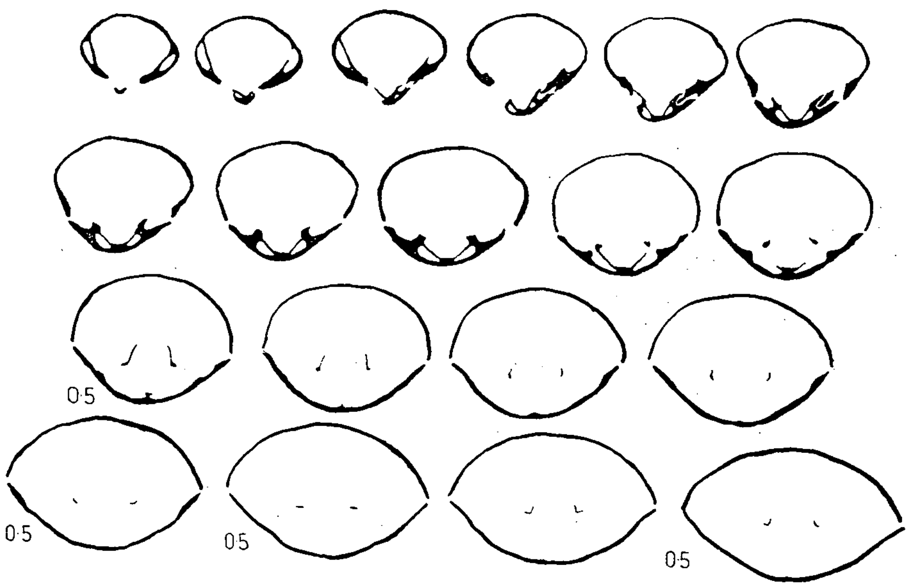

Fig. 11.—Serial sections of a small individual of *Fletcherithyris farleyensis faba* subsp. nov. from the Homevale Beds. Intervals between sections are 0.25 mm. unless otherwise shown. x 3.

FLETCHERITHYRIS REIDI sp.nov.

(Pl. 2, Figs 1–13; Text-figs 12–13)

Holotype: 11981 A.N.U.; paratypes 11977–11982 A.N.U., all from the Cattle Creek Shale in Cattle Creek, Serocold Anticline.

Diagnosis: Shell small, biconvex, with rather flattened brachial valve in lateral profile; sinus, when present, developed only on anterior half of shell; dental lamellae short; septalium supported on a very short septum which is usually cut away under its anterior edge; septalium above valve floor in umbo, rises much higher in front, and has a concave anterior outline; shell substance thick.

Description: Shell small, largest observed being about 17 mm. long; valves subequally convex in anterior profile; pedicle valve rather strongly convex in lateral profile, brachial valve much flatter; lateral commissure weakly to moderately sinuate; anterior commissure weakly sinuate to strongly uniplicate; outline rather broad and stubby; pedicle valve varying from weakly to strongly sinuate on the anterior half, the margins of the sinus being poorly to sharply defined; cardinal margin terebratulid; beak ridges sub-angular; foramen permesothyrid to mesothyrid, oval and slightly labiate; pedicle umbo erect; deltidial plates short and scarcely meeting; shell substance thick; punctae number 50–80 per sq. mm. on median anterior portion of one specimen.

Dental lamellae rather robust, very variably divergent and one-seventh to one-fifth of the length of the valve; pedicle collar strong; denticula robust; muscle scars inconspicuous.

Cardinal process very small, without median boss; inner socket ridges high and very thick, ventral edge interlocking with a very robust ridge on inner face of tooth complex; outer hinge plates not distinguishable from inner socket ridges; crural bases very low and placed well up on inner socket ridges; inner hinge plates meeting to form a septum which increases in height towards the front, and is cut away slightly beneath the anterior edge of the septalium; septalium very variable from broadly U to V-shaped in transverse section, with a distinctly concave anterior outline, and extending about 0·2 of total length of brachial valve; low median ridge extends forward from septum almost to mid-length of valve in some specimens, but in others is weak or absent; crura thick and more or less equi-dimensional in cross-section; crural points rather low, planar and in section convergent towards pedicle valve; descending lamellae short, thin, parallel to one another, and not twisted; transverse band incomplete; adductor scars with small posterior pair and abruptly expanded anterior pair; vascula media diverge from front of median ridge.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Septalium	Height Fold
16·5	14	8	14	....	4·5
14·5	13	9	13	2	2

Remarks: This description is based on six specimens, two of which are rather poorly preserved. The shape is highly variable, as can be seen from the figures, but of course the range of shapes cannot be determined. The group is united by the structures in the brachial valve. The septalium is supported on a short septum, is very close to the floor of the valve near the umbo but rises away from it towards

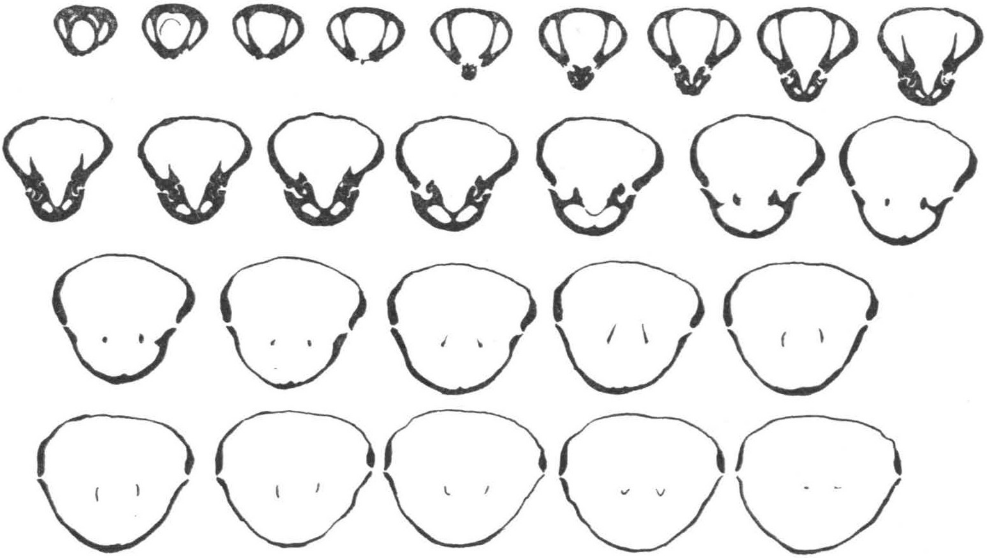

Fig. 12.—Serial sections of a specimen of *Fletcherithysis reidi* sp. nov. from the Cattle Creek Shale in Cattle Creek. Intervals between sections are 0.25 mm. x 2.

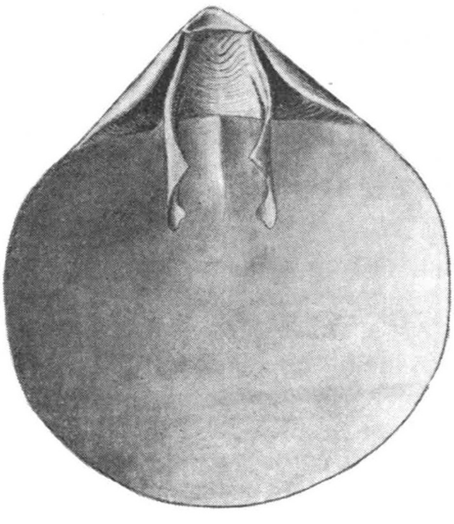

Fig. 13.—Reconstruction of interior of brachial valve of *Fletcherithyris reidi* sp. nov. based on Figure 12. x. 5 app.

the front. It has a markedly concave anterior edge. The species is most closely related to *F. illawarrensis* sp.nov., and the distinctions are discussed under that species. *F. farleyensis faba* subsp.nov. is another similar species, but it never has a pronounced and sharply defined sinus nor does the septum supporting its septalium ever get as high as that of *F. reidi*, while in outline the front of its septalium is in the form of an anteriorly directed V.

Horizons and Localities: The species is known definitely only from the Cattle Creek Shale (Sirius Shale equivalent).

Several rather poorly preserved specimens from the upper part of the Ingelara Shale at locality SP 115 are more closely related to *F. reidi* than any other species. Although many of them are badly distorted, it is clear that the pedicle valve rarely, if ever, has a sinus, and the dental lamellae are short and almost parallel. In all the features of the brachial valve they seem to be inseparable from *F. reidi*, and on the other hand are very different from *F. illawarrensis.* The material is not adequate to stand as the basis of a new species, and is herein referred to as *Fletcherithyris* cf. *reidi.*

FLETCHERITHYRIS SCOTTI sp.nov.

(Pl. 2, Figs 26–44)

Holotype: F5758 G.S.Q.; paratypes F5755–57 and F5758–62 G.S.Q.; all from the Marine Bed above Scott Seam in Creek on C.P.A. 20, Bowen River Coalfield; Glendoo Sandstone Member of Collinsville Coal Measures.

Diagnosis: Small; ovate in outline; sub-equally biconvex; no sinus or fold; septalium V-shaped in transverse section, 0·20–0·25 of length of brachial valve, sessile posteriorly and rising on a low septum anteriorly.

Description: Small (largest observed 12 mm. long); maximum width of shell forward of mid-length; outline with postero-lateral margins nearly straight as far as maximum width, and anterior part usually sub-semicircular, though occasionaly tending to become slightly trigonal; valves sub-equally convex; in lateral profile brachial valve more or less regularly convex, and pedicle valve usually so, but sometimes slightly more convex toward the umbo; anterior profile lenticular, with brachial valve slightly the more convex; commissure rectimarginate to slightly sinuate; pedicle umbo prominent, nearly straight to sub-erect; beak ridges wel, rounded; cardinal margin terebratulid; foramen of moderate size, mesothyridl non-labiate; deltidial plates narrow, very short, and either meeting for a very short distance beneath the foramen which is notched at their junction, or just failing to meet; sinus and fold never present.

Pedicle collar always strong; dental lamellae fine and extended approximately one-sixth of total length of shell; muscle scars indefinite; no pallial markings observed.

Septalium usually sessile near posterior end but rising on a septum towards the front, distinctly V-shaped in transverse section and invariably angular at axis; anterior edge of septalium runs slightly backward or more commonly slightly forward to mid-line from crural bases; total length of septalium 0·20 to 0·25 of total length of valve; low median ridge extends more than a third of length of valve; cardinal process with a triangular posterior edge and a flattened transverse section; myophores clearly defined anteriorly by a distinct, sharp ridge; outer hinge plates not distinguishable from inner socket ridges; crural bases moderately strong and rather blunt and situated well up towards inner socket ridges; crura short and robust; crural points moderately long; loop unknown; adductor scars long and lacrymate or sometimes tending to be parallel-sided and slightly pointed at the front; anterior edge of scars just behind mid-length of valve; pallial trunks indefinite; punctae coarse and numbering 120–160 per sq. mm.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Septalium
11·5	8·5	....	10	2·5
11	8	5·0+	10	2·2
10·5	8	5·5	9·5	2·5
9·5	6	4·5	8·5	2·1

Remarks: *F. scotti* is very abundant at the type locality, where it is preserved in a very ferruginous fine-grained sandstone. The shell substance has also been replaced by iron compounds, so that it is very difficult to use serial sectioning methods to determine the internal structure, particularly the structure of the loop. However, fine moulds of the cardinalia can be prepared with relative ease.

The shape of the septalium, and its relation to the supporting septum, are remarkably constant. Throughout ontogeny the plane containing the anterior edge of the septalium remains more or less vertical. The growth-lines run straight to the axis, and straight almost up to the crural bases, where they are deflected forwards sharply; though in some adults, the growth-lines in the latter stages tend to curve forward slightly to the median line. In almost every specimen inner hinge plates rest directly on the floor of the valve at their posterior end but unite to form a low septum toward the front.

The species nearest is *F. farleyensis faba*. *F. scotti* is distinguished by its smaller size, its less sinuate commissure, and the sharper angle in the axis of its septalium, which also rises higher in front. *F. illawarrensis* differs in its deeply plicate anterior commissure, sub-erect to erect umbo, much weaker crural bases, differently shaped septalium, and higher septum supporting the septalium.

Localities and Horizons: The species is known only from the type locality. Mr E. A. Webb has indicated the position of the locality to me (in litt.), and it falls within the Glendoo Sandstone Member of the Collinsville Coal Measures (see Hill & Denmead, 1960, p. 197). The associated bivalve fauna confirms this.

FLETCHERITHYRIS ILLAWARRENSIS sp.nov.

(Pl. 2, Figs 14–25; Pl. 14, Fig. 1; Text-figs 14–15)

Holotype: F6052 U.N.E.; paratypes F6053–F6068 U.N.E., F20365 and F21868 U.N.E., 11952–11959 A.N.U., and F20365 and F21868 A.M.; all from the Conjola Formation at Wyro, New South Wales.

Diagnosis: Shell small to medium size for genus; strongly biconvex to almost globose; umbo of pedicle valve long and acute; lateral commissure almost straight; anterior commissure sinuate or uniplicate; septalium with a concave anterior outline and supported on a high septum throughout; sockets very long; anterior socket rides weak; teeth massive.

Description: Largest specimen observed 21·5 mm. long; shell strongly biconvex with brachial valve less convex than pedicle valve; outline elongate, with maximum width at about three-quarters of shell length from umbo; pedicle umbo long, inflated, and sub-erect to erect; umbonal angle 50°–55°; umbonal ridges very well rounded; foramen mesothyrid to permesothyrid, with a moderately long thick labrum, and 2·0 mm. in diameter in largest specimens; deltidial plates thick and conjunct; lateral commissures slightly sinuate; pedicle valve well rounded, or with a very low poorly defined sinus on anterior half, or with a narrow well defined sinus, occasionally having a very slight swell within it; anterior commissure gently sinuate, uniplicate, or uniplicate with a ' pinched ' median part, corresponding with the three types of pedicle valve listed above; brachial valve usually broadly domed in transverse section, but a low distinct fold developed on anterior half of some forms; shell substance thick; punctae number 75–125 per sq. mm.

Pedicle collar moderately strong; dental lamellae 0·2–0·3 of length of valve; teeth very bulbous; denticula well developed; pallial markings indistinguishable.

Inner socket ridges moderately high, thick, and articulate with prominent ridges on inner faces of dental complexes; shell forming socket floor very thick; sockets particularly long (8·5 mm. measured down axis of socket from its tip in a specimen about 22 mm. long) and extend well beyond front edge of septalium; cardinal process V-shaped in transverse section; only a slight drop from cardinal process into septalium; shell substance of hinge plates particularly thick; outer hinge plates and crural bases scarcely distinguishable; inner hinge plates forming a septalium supported on a high median septum which rapidly increases its height toward the front; in section septalium usually U-shaped, but often with a slight V in its axis, and anterior outline invariably concave; in transverse section axis of septalium always ventral to socket floors; median septum usually cut back under anterior edge of septalium, and may or may not continue forward as a short low ridge; crura thick and slightly oval in transverse section; crural points of moderate height, planar, and converge toward each other ventrally; descending lamellae short, ribbon-like, parallel to each other, and joined by a highly arched transverse band; muscle scars and pallial markings not preserved.

Dimensions:

Length	Width	Height	Length Brachial Valve	Height Fold	Length Septalium
21·5	15·5	13	18	2·5	....
20·5	15	12	18	3·5	4·5
21	14	....	18	....	4
19·5	14	13	17	3	....
16·5	13·5	10	15	4	2·5
13·5	10·5	7·5	12	2·5	....

Remarks: This description is based on specimens from the type locality, all of which are preserved in calcareous sandstone, and many of which are filled with clear calcite which makes them difficult to prepare for study. One of the most remarkable features is the variability of the form of the sinus and fold, together with the appearance of a swelling within the sinus in some specimens. The globosity of the posterior part of the pedicle valve also varies somewhat. In some individuals the valve tends to flatten off along the venter when it is only a few millimetres long, whereas in others it remains evenly convex to a length of more than 10 mm. Variations in outline are shown in Figure 14.

The only species with which *F. illawarrensis* is likely to be confused are *F. reidi* and *F. hardmani*. From the former it can be distinguished by its more convex profile, higher pedicle umbo, higher septum in the brachial valve, shallower sep-

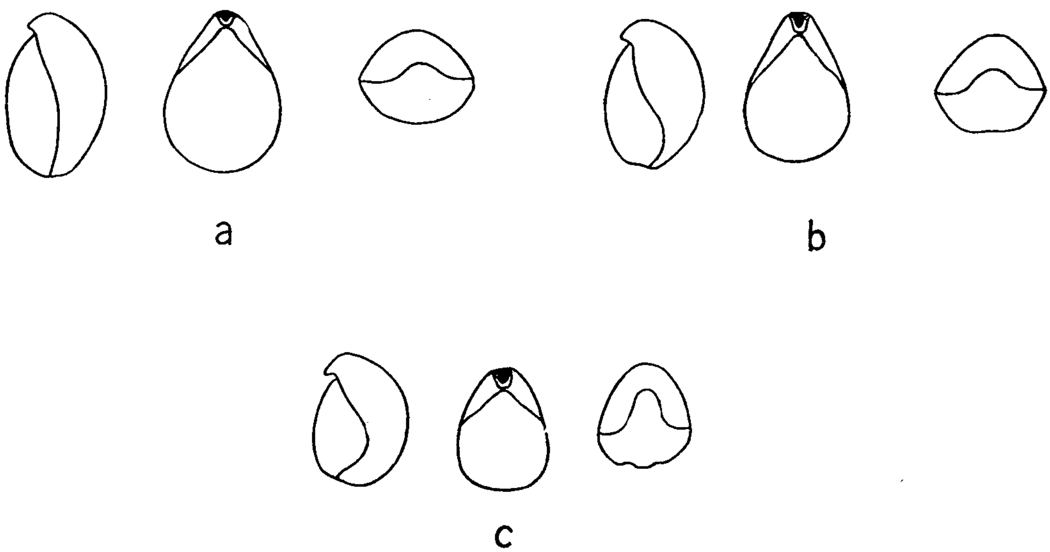

Fig. 14.—Lateral, dorsal, and anterior outlines of three specimens of *Fletcherithyris illawarrensis* sp. nov. (a) F6052 U.N.E., (b) F6064 U.N.E., both topotypes, and (c) 2226 G.S.Q. from Hazelwood Creek, slightly reconstructed in front. x 1.

talium, much stronger anterior socket ridges and more massive teeth. From *F. hardmani* it differs in its greater convexity, shorter inner socket ridges, and higher septalium with a differently shaped anterior outline, and in the shape of its fold and sinus.

There is no evidence of the existence of any forms transitional from this species to *F. parkesi.*

Horizons and Localities: F. illawarrensis is moderately abundant at the type locality. It is also abundant in the Bowen Basin at a locality in Hazelwood Creek mentioned by Reid (1929, p. 74), whose exact horizon cannot be determined. Reid notes that it is somewhere near the top of the Middle Bowen Beds, but the boundary between Middle and Upper Bowen is not exposed in the vicinity. Recent mapping by the Bureau of Mineral Resources has failed to relocate the horizon. The specimens available are F2218–2230 G.S.Q.

Two juveniles, F2245–6 G.S.Q. from CPA 18, near the junction of Sonoma and Camp Roads, Bowen River Coalfield, most probably belong to the species. They both show the ' pinched ' fold and slight swelling in the sinus, together with the characteristically shaped septalium and inner socket ridges. They are comparable with the topotypes F6053 U.N.E. The horizon is within 200 feet above or below the Big *Strophalosia* Zone.

Fig. 15.—Serial sections of a specimen of *Fletcherithyris illawarrensis* sp. nov. from the Conjola Formation at Wyro, N.S.W. Intervals between sections 0.25 mm. unless otherwise stated. x 3.

FLETCHERITHYRIS PARKESI sp.nov.

(Pl. 8, Figs 1–23; Text-fig. 16)

1898 *Dielasma inversa* de Koninck (in part); *in* Etheridge, *Rec. geol. Surv. N.S.W.*, 5, 175–6, Pl. 19, Figs 4–6, 10–11.

1949 *Dielasma inversa* de Koninck; *in* Hanlon, *J. Roy. Soc. N.S.W.*, 82, 244.

Holotype: F6048 U.N.E.; paratypes F21846–21851 A.M., F21853 A.M., and F20822 A.M.; all from the Conjola Formation, Wyro, New South Wales.

Diagnosis: Shell small to moderate in size for genus; early stages rectimarginate, later sulciplicate; lateral profile of commissure sigmoid; septalium on a high septum which becomes progressively higher anteriorly.

Description: Largest topotype 22 mm. long; maximum width forward of midpoint; height from three-quarters of width to equal to it; width from three-fifths to three-quarters of length; in anterior profile brachial valve moderately to strongly convex, pedicle valve slightly less so; in lateral profile pedicle valve the more strongly convex; lateral commissure weakly to moderately sinuate; anterior commissure sulciplicate; juveniles (up to about 7 mm. long) rectimarginate; subsequent stages increasingly strongly sulciplicate; plication in middle of sinus varying from narrow and only slightly more prominent than those of flanks of sinus, to very broad, almost filling sinus and very much higher than its flanks; no fold on brachial valve, but strong median furrow with its base rounded posteriorly and flattened or even slightly arched anteriorly; crests of flanks of this furrow diverging at 15–18°; pedicle umbo prominent, acute and sub-erect to erect; foramen 1·0–1·5 mm. across in specimens 20 mm. long, mesothyrid to permesothyrid and weakly labiate; deltidial plates short and conjunct.

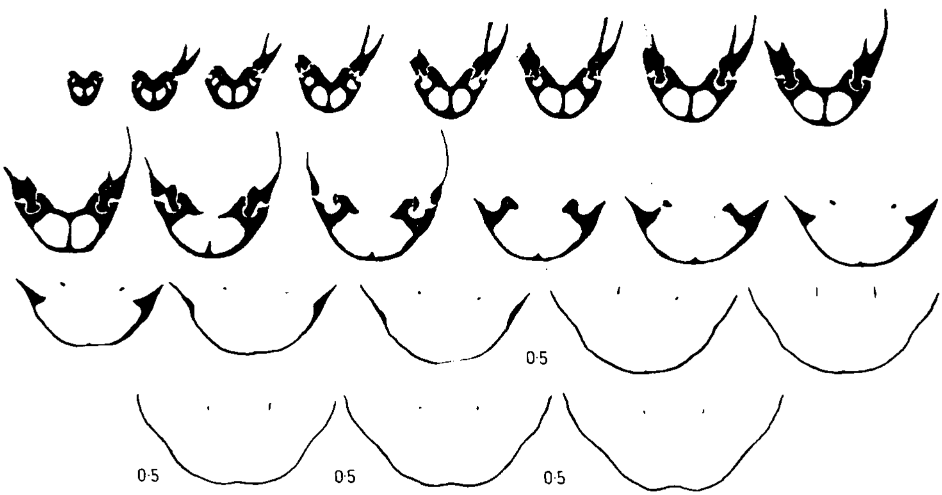

Fig. 16.—Serial sections of a specimen of *Fletcherithyris parkesi* sp. nov., F21846 A.M. from the Conjola Formation at Wyro. Intervals between sections 0.25 mm. unless otherwise stated. x 2.

Pedicle collar strong and complete; dental lamellae about one-fifth of total length of valve; muscle field very poorly defined, but in larger specimens slightly sunken into shell; outlines of individual scars not determinable.

Inner socket ridges high; crural bases very low and well up towards inner socket ridges, and therefore outer hinge plates very narrow; septalium on a septum at all stages, and becoming progressively higher towards the front; in transverse section septalium tending to be V-shaped towards the front; anterior edge of septalium occasionally with a narrow ventrally deflected border; in ventral view, outline of anterior edge of septalium markedly and evenly concave, but occasionally with a slight V-ing forward at mid-line; crura always given off well forward of median edge of septalium, relatively thin, and equidimensional in section; crural points low; loop short and without a transverse band; muscle scars weakly impressed; low median ridge runs forward from edge of septum to a point between one-third and one-half length of valve from umbo.

Dimensions:

Length	Width	Height	Height of Fold
20	14·5	10	2·5
19	13	8	1·5
18·5	12	11·5	2
16	12	10	2·5
16	12	9	1·5

Remarks: The proportions of the type specimens are highly variable, and it was thought possible that this was the result of the mixing of collections from different localities, since some of the Australian Museum specimens were only doubtfully labelled Wyro. My own collections suggest that this is probably not the case.

Height relative to length is variable, the higher forms being also proportionately narrower. The sinus in each valve is relatively shallower in the lower forms, and there is a corresponding flattening of the folds bordering the sinus in the brachial valve and an increase in the height and breadth of the median fold in the pedicle valve.

F. parkesi is not now likely to be confused with any other species. The mode of plication is unique in this genus. As indicated above, *F. parkesi* has been confused previously with *Gilledia ulladullensis*, but the two are obviously different even in external shape.

Localities and Horizons: Seven badly distorted specimens from the Gerringong Volcanics at Gerringong (F17008–9) A.M., one labelled F24141 A.M., two labelled F24192 A.M., and 14256–7 A.N.U., are close to this species. All are larger than the types, the largest being about 25 mm. long. Two individuals show the irregular surface grooving often found in this genus. These structures probably occur in the types, but they are masked by decortication.

Numerous specimens from Bundanoon Gully, F13746a–f, F13747a–e, F13749a–d, F13750a–c, F13752a–c, F13753 all A.M., are placed with those from Gerringong. The horizon from which they come is not definitely known, but it is most probably in the Berry Siltstone.

The two specimens from near the reservoir at West Maitland, Hunter Valley, figured by Etheridge (1898, Pl. 19, Figs 4–6 and 10–11), now F35681 and F35679 A.M. respectively; and two other specimens, F35791–92 A.M. from the same locality, are doubtfully placed in the species. They are compressed and the septalium has been flattened so that it is not possible to give a definite identification. They are probably from the Muree Formation.

CPC 5972–3 from the Muree Formation at HV 5 Maitland, and CPC 5976 and 14258 A.N.U. from the Elderslie Formation in Redhouse Creek ¾ mile upstream from the New England Highway are confidently placed in the species, together with F42778–42783 A.M. from the Porcupine Formation near Curlewis, N.S.W. (Hanlon, 1949).

From the Capertee Group at Rylstone there is a single specimen, F45322b A.M., which is clearly identical with the Gerringong specimens.

Specimens CPC 5326–5328 from locality B683, near Exmoor Homestead, Bowen Basin, lat. 20° 56′ 45″ S, long. 148° 08′ 00″ E, which is in the Middle Bowen Beds about 500 feet below the Big *Strophalosia* Zone, can be matched with specimens from the type locality, as also can F2248 G.S.Q., from between the Big *Strophalosia* Zone and the *Streptorhynchus pelicanensis* Zone in *Derbyia* Gully, C.P.A. 21, Bowen River Coalfield.

From Tasmania, 25003 U.T., Woodbridge Formation above SE Quarry, Darlington, Maria Island, is close to the types, while specimens from the Golden Valley Group at Cave Hill, Ida Bay (25280 U.T.), and at Don River Bridge for Roland Highway (25279 U.T.), are more similar to the Gerringong specimens.

FLETCHERITHYRIS HARDMANI sp.nov.

(Pl. 9, Figs 22–32; Pl. 16, Figs 2–6, 8–9)

Holotype: CPC 5329 from locality KLC11, Hardman Member of Liveringa Formation, south slope of Mount Hardman, about 130 feet below top of formation; paratypes CPC 5230–5234, also from KLC11.

Diagnosis: Shell small; moderately to strongly globose; margins of valves sometimes inflected; slight sinus on anterior half of pedicle valve producing a gently pinched anterior commissure; dental lamellae short; septalium supported on a high median septum which runs to middle of valve, and is usually not cut away beneath front of septalium; anterior outline of septalium an anteriorly directed V; crural points high; loop short and with a strongly posteriorly directed V-shaped transverse band; adductor scars in brachial valve large and well rounded.

Description: Largest shell observed 13 mm. long and 10·5 mm. wide; pedicle valve slightly more convex than brachial in anterior profile; in lateral profile pedicle valve very highly convex, and brachial valve gently arched along crest; margins of valves inflected in several of larger specimens; a very narrow, poorly defined sinus almost invariably present along anterior half of pedicle valve, but no corresponding fold on brachial valve; lateral commissure very slightly sinuate; anterior commissure broadly and gently sinuate or with a distinct sub-angular peak in the middle; umbo of pedicle valve high, almost erect, and well rounded; foramen moderate (1·2 mm. in diameter in a specimen 13 mm. long) and with a long labrum which is easily destroyed; mesothyrid to permesothyrid; umbonal ridges subrounded; deltidial plates short; shell substance thin; punctae number 100–150 per sq. mm.

Dental lamellae short, reaching only about one-sixth the length of the valve; muscle scars obscure; vascula media long, straight, and slightly divergent from inside front edges of dental lamellae; very low median ridge extends from muscle field almost to anterior margin.

Sockets short; inner socket ridges moderately thick and rising rather sharply in height toward the rear; anterior socket ridge often well developed; a sharp drop from cardinal process to base of septalium; outer hinge plates very narrow; inner hinge plates forming a septalium usually V-shaped in transverse section and with a V-shaped anterior outline; median septum strong, increasing only a little in height towards front of septalium, where it rapidly diminishes and continues to middle of valve as low sharp ridge; crural bases prominent; crura short; crural points high, planar, with their tips convergent toward ventral valve in transverse section, and the planes divergent toward the front; descending lamellae short, convex outwards, and joined by a postero-ventrally directed V-shaped transverse band; adductor scars large, well rounded, almost meeting the median ridge, and with their anterior edges 0·5–0·6 of length of valve from umbo.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Septalium
13·5	10	....	....	....
13	11	5·5	11·5	....
....	10·5	....	11·5	3
....	9	....	9·5	2·7

Remarks: F. hardmani is a rather constant little species. There is some variation in relative width, the sinus on the pedicle valve varies slightly in definition and depth, the median septum is slightly cut away under the septalium in occasional specimens, and the brachial adductor scars vary in width; but considered in the round one is impressed by the compactness of the form rather than its variation.

It is distinguished from *F. illawarrensis* and *F. reidi* by the complete absence of a definite fold at any growth stage, by the shape of the anterior commissure, the length of the labrum, the height and shape of the septalium, the height of the crural points, and the shape of the descending lamellae.

It is possible that the form from Timor figured by Hamlet (1928, Pl. 10, Fig. 14) as *Dielasma nummulus* Waagen is a related species. I have examined this specimen, together with similar material housed at Bonn. Dental lamellae and a septalium supported on a median septum are present in the Bonn material, though the shell on Hamlet's specimen is too opaque for them to be observed. The shape of the septalium remains completely unknown. One important difference is in the size of the foramen, which is very small in the Timor and Indian material.

Localities and Horizons: The species is quite common at the type locality, and also at KLB11, a similar horizon on the slopes of Mount Hardman (CPC 5335). To date it is definitely recorded only from the Hardman Member of the Liveringa Formation.

Several specimens from the Noonkanbah and Callytharra Formations, however, differ from *F. Hardmani* in what appear to be minor features only, and are therefore tentatively identified as *F.* cf. *hardmani.* Those from the Noonkanbah Formation are CPC 5353–5356 from locality PR 288, about 2 miles at 255° from Bruten's Old Yard, Cherrabun Station, CPC 5350 from locality KNF 86, near PR 288, and one specimen from locality KNF 73, $2\frac{1}{5}$ miles bearing 288° from Bruten's Old Yard. These specimens are all larger (up to 18 mm. long) and thicker-shelled than the types of *F. hardmani,* and in outline they are slightly more transverse. In keeping with the generally thicker shell, the dental lamellae, the anterior socket ridges, and the pedicle collar are also more massive. The vascula media in the brachial valve are long and straight, diverge from one another at about 20°, and are given off from the most anterior part of the adductor scars, as is normal for the species. In addition these specimens show a set of short radial trunks on either side of the septalium, and bounded in front by a long strong trunk, set at about 30° to the adjacent limb of the vascula media. They are figured on Plate 16, Figures 2–5.

The specimens from the Callytharra Formation (CPC 5352) from locality GW 186 at Callytharra Springs, have a similar range of shape to the Hardman Member specimens, but they are distinguishable by their smaller pedicle foramen. In this respect they are closer to the Timor specimens of *Dielasma nummulus* mentioned above.

Genus Yochelsonia Stehli, 1961

1961 *Yochelsonia* Stehli, *J. Paleont.*, 35(3), 454.

Type species (by original designation): *Yochelsonia thomasi* Stehli, from the Wandagee Formation in the Minilya Syncline, Carnarvon Basin, Western Australia.

Diagnosis: Shell small to moderate size; outline sub-triangular; adults strongly sulciplicate; brachial valve concave in longitudinal profile; umbo sub-erect to erect, foramen mesothyrid; foramen margin slightly thickened, non-labiate; beak ridges rounded to sub-angular; shell margins inflected; surface smooth; dental lamellae present; outer hinge plates joined to socket plates; inner hinge plates form a short sessile septalium; crural points long; loop with short V-shaped transverse band; punctae coarse and only moderately dense.

Remarks: Stehli (1961a, p. 454) concluded that *Yochelsonia* was a close relative of *Whitspakia* Stehli, 1964 (= *Pakistania*) (type species *Dielasma biplex* Waagen), from which it was probably derived, and he used the same set of serial sections to illustrate the internal characters of both genera. He distinguished the two by the inflected margins and longitudinally concave brachial valve of *Yochelsonia.* I have examined specimens from Virgal (a syntype locality of *W. biplex*) in the British Museum. One is labelled *D. biplex* B18561, and three *D. problematicum* Davidson B18506. The latter seem to me to be inseparable from *W. biplex* on external characters. In these specimens the inner hinge plates can be observed through the shell wall. They clearly diverge along the wall of the valve at angles of about 20°, and do not unite to form a sessile septalium as illustrated by Stehli. One of the figured syntypes of *W. biplex* shows the same arrangement (Waagen,

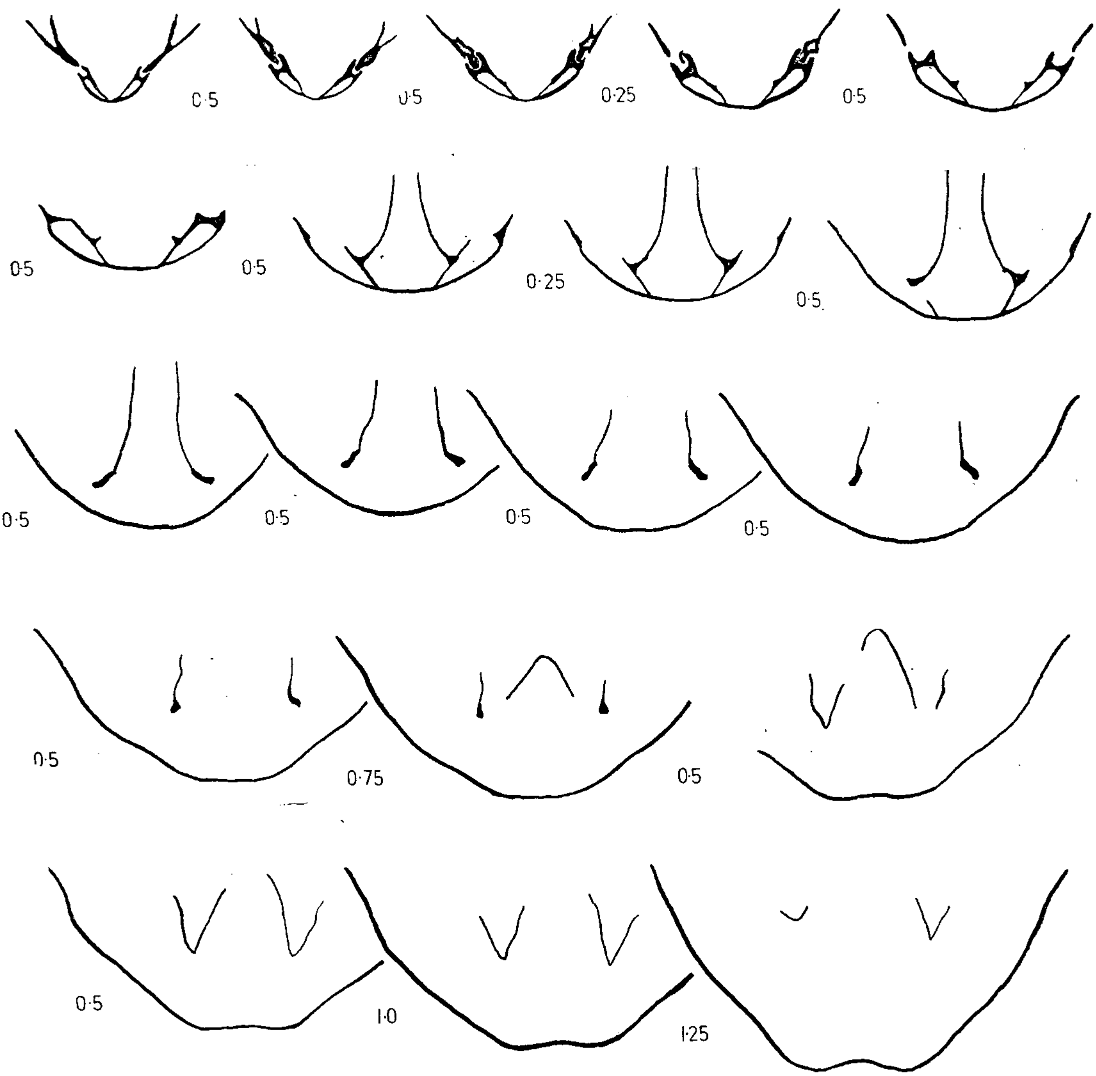

Fig. 17.—Serial sections of a specimen labelled *Dielasma problematicum* Davidson, B21041 B.M.N.H., from Virgal, India. Intervals between sections as stated. x 3.

1882, pl. 25, fig. 5a). Other genera are known to be variable in this feature and perhaps *Whitspakia* is also, but confirmation is needed (see Waagen's comments on *D. breviplicatum*, 1882, p. 357). Another specimen labelled *D. problematicum* B21041 has been serially sectioned (see Fig. 17). This specimen is externally more similar to the figured syntypes of *W. biplex* than to those of *D. problematicum*. As can be seen from the figure the inner hinge plates meet the wall of the valve independently, the crural points are developed from the crural bases before they become free of the hinge plates, and they are exceptionally long. The transverse band also is very robust. If further work should prove these characters to be typical of species of *Whitspakia*, then it will be readily separable from *Yochelsonia* on internal structures also.

YOCHELSONIA THOMASI Stehli, 1961

(Pl. 9, Figs 5–21; Text-fig. 18)

1961 *Yochelsonia thomasi* Stehli, *J. Paleont.*, 35(3), 454, pl. 61, figs. 17, 18, 23–25.

Types: Stehli's material came from the Wandagee Formation (previously *Calceolispongia* Stage) south of shed gate, Mungadan Paddock, Wandagee Station.

Diagnosis: Shell small; shape highly variable owing to range in amount of marginal inflexion; median fold on pedicle valve high; outer hinge plates narrow; loop short with a V-shaped transverse band; crural points high.

Description: Shell small, largest individual about 19 mm. long and 17·5 mm. wide; in lateral profile pedicle valve evenly convex except for sharply inflected anterior margin, and brachial valve slightly convex near umbo and gently concave in front; pedicle umbo sub-erect to erect; umbonal ridges rounded to sub-angular; foramen mesothyrid, margin slightly thickened and non-labiate; deltidial plates very short, conjunct; outline sub-triangular, with maximum width in anterior quarter of shell, and anterior margin rounded; lateral commissure moderately sinuate; anterior commissure at earliest stages broadly and gently uniplicate, but increasingly sulciplicate thereafter; median fold on pedicle valve high and broadly rounded, and in width between three-fifths and three-quarters of total shell width at any growth stage; sinus in brachial valve rapidly deepening toward the front; lateral and anterior margins of shell usually inflected to varying degrees; surface smooth apart from growth-lines; density of punctae on body of shell varies from 75 to 150 per sq. mm., and increases to 250 per sq. mm. on inflected edge of some specimens.

Pedicle collar small; dental lamellae extend about one-fifth of length of valve; muscle scars not preserved; pallial markings obscure except on inflected margin of anterior part of shell, which is covered by regular parallel terminal trunks (Pl. 9, Fig. 7).

Sockets large; cardinal process V-shaped in cross-section and with a sharp anterior edge; inner socket ridges thick and forming a massive junction with shell wall; outer hinge plates very narrow, and strong crural bases therefore close up against inner socket ridges; inner hinge plates meeting on shell wall or very slightly divergent along it, forming a sessile spondylium; anterior edge of inner hinge plates slightly concave, and reach approximately one-third length of valve; spondylium V-shaped both in anterior outline and in transverse section; crural points very high, short, and developed from anterior edges of crural bases, leaving no free crura; descending lamellae thin and short; transverse band thin, and forming a postero-ventrally directed V-shaped structure.

Dimensions:

Length	Width	Height	Height Fold	Width Fold
15	14	7·5	3	8·5
14·5	13	9	4	8·5
13·5	11	8	2	6
....	11·5	9	2	6

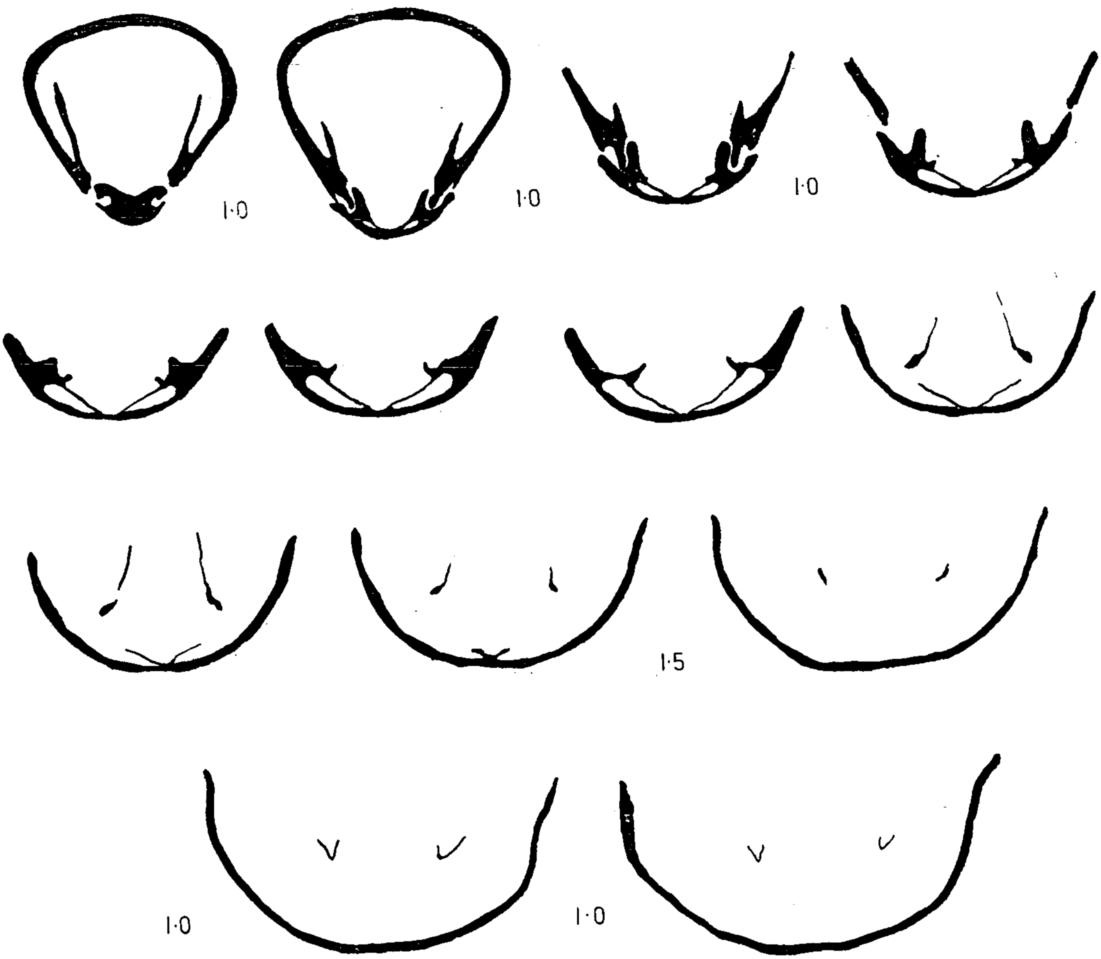

Fig. 18.—Serial sections of a specimen of *Yochelsonia thomasi* Stehli, from the Wandagee Formation at ML44, CPC 5220. Intervals between sections are 0.5 mm. unless otherwise stated. x 3.5.

Remarks: The above description is drawn up from specimens CPC 5219–5225, from locality ML 44, Minilya River, south bank, 9 miles west of Wandagee Homestead and $1\frac{3}{8}$ miles south-west of Coolkilya Pool. This is in the lower Wandagee Formation, and is close to the locality from which the type specimens came. There is quite a range of variation in shape among these specimens, particularly in proportionate width and height. Width/length ratios range from 0·77 to 0·93, and height/length ratios from 0·5 to 0·71. This latter variation is the result of the differing amounts of marginal inflexion of the valves. One individual is entirely without an inflexion and has a height/length ratio of less than 0·5, but it cannot be accurately measured. The inflexion on the others is usually angular, rarely curved, and in some the amount of inflexion is more than 90°. On the pedicle valve the umbonal ridges are continued around the shell as the line of flexure. On the brachial valve, inflexion is usually present only on the anterior and antero-lateral parts.

The density of the punctae is highly variable even on the one individual, and it increases from back to front, becoming very much greater on the margins. It has been noted that the inner hinge plates do not quite meet on the valve floor in some specimens, but they are always sufficiently close together to form a sessile spondylium.

Localities and Horizons: Eleven poorly preserved specimens, CPC 5226–5227, were collected from locality PR284A, 4 miles due west from Chestnut Bore, Christmas Creek Station, near the top of the Noonkanbah Formation. These reach a larger size than the topotypes (the largest being about 18 mm. wide), and have less strongly inflected margins (see Pl. 9, Figs 12–14).

A single specimen, F28079 U.W.A., from the Coolkilya Greywacke at locality WF 8·9, 160° north of IV Shed Paddock east of Fence, Wandagee, Carnarvon Basin, is also larger than the topotypes, and has a higher and more broadly rounded fold on the pedicle valve and a non-angular marginal inflexion. It is figured on Plate 9, Figures 15–18.

YOCHELSONIA STEHLII sp.nov.

(Pl. 10, Figs 22–26)

Holotype: CPC 5228; paratypes CPC 5229–5240, all from the Lightjack Member, Liveringa Formation, at locality KLD 64, 2·6 miles bearing 70° from Shore Range trig. point, Fitzroy Basin, Western Australia.

Diagnosis: Shell moderate in size; fold on pedicle valve moderately high, well rounded, continues back on to posterior third of shell; sinus on brachial valve shallow but produced into a high tongue anteriorly in adults; outer hinge plates narrow; inner hinge plates broad, forming a spondylium on a very low septum, or sessile, and extending to mid-point of valve; loop unknown.

Description: Shell moderate in size, largest individual a brachial valve about 28 mm. wide and 28 mm. long; in lateral profile pedicle valve moderately convex, and brachial valve very gently convex except at anterior margin, where its convexity is markedly increased; outline sub-pentagonal in adult, but much less distinctly so in juveniles; maximum width at about two-thirds the length; lateral commissure weakly sinuate; anterior commissure broadly and gently uniplicate till brachial valve is 6–8 mm. long, and thereafter sulciplicate; median fold on pedicle valve well rounded and bounded by flattened or slightly depressed areas on anterior half of shell; pedicle umbo sub-erect; foramen permesothyrid, large, about 3 mm. wide in a specimen about 27 mm. long; foramen margin thickened, but apparently no labrum developed; deltidial plates not observed; sinus in brachial valve shallow, rounded, and produced into a high rounded tongue anteriorly; brachial valves inflected only on lateral and anterior margins of shell, never on postero-lateral margins; inflexion takes place over a broadly rounded, never angular, zone; surface ornamented only with growth-lines; punctae number between 75 and 120 per sq. mm. on median part of shell, but reach 200–225 on anterior border.

Pedicle collar not preserved; dental lamellae robust but short (apparently about one-sixth of total shell length); other internal structures not preserved.

Inner socket ridges thick; outer hinge plates narrow; crural bases low and sharp; inner hinge plates broad, flat, with distinctly concave anterior outlines, and forming a septalium which is either sessile or on a very low septum; septalium reaches mid-point of valve; crural points, loop, muscle scars, and pallial markings unknown.

Remarks: The material available is not well preserved and consists entirely of dissociated valves, many of which are worn around the umbo. Only one moderately well preserved pedicle valve is available, but there are two others badly crushed. Such material does not allow a discussion of the range of variation, but it is clear that the width of the sinus on the brachial valve, the height of the tongue, and the amount of inflexion of the margins are all variable.

Y. stehlii can be easily distinguished from *Y. thomasi* by its larger size, less inflected margins, shallower sinus in the brachial valve, and relatively longer septalium.

Localities and Horizons: The species is known from only one locality in addition to the type, viz, KLD 65 in the Lightjack Member, base of the Liveringa Formation, 2·28 miles at 70° from Shore Range trig. point, where it is represented by one broken pedicle valve.

Genus Hoskingia nov.

Type species: Dielasma trigonopse Hosking from the Madeline Formation, Byro Basin, Western Australia.

Diagnosis: Shells of moderate to large size for subfamily; slightly to deeply sinuate, or sulciplicate; pedicle umbo prominent; deltidial plates conjunct; pedicle foramen large and labiate; umbonal ridges sub-angular to well rounded; dental lamellae and pedicle collar well developed; outer hinge plates confluent with inner socket ridges near umbo, but rapidly diverging onto floor in front; inner hinge plates uniting medially on floor of valve at all growth stages, and forming a long sessile septalium; crural bases well developed; crural points high; loop terebratuloid but without transverse band; punctae number 100–180 per sq. mm.

Remarks: The genus *Hoskingia* is erected to encompass a number of Western Australian Permian species which clearly form a homogeneous group. It is possible that such Russian Permian species as *Dielasma truncatum* Chernyshev, *D. curvatum* Chernyshev, and *D. giganteum* Waagen of Chernyshev, and the Pennsylvanian species *Beecheria patagonica* Amos from Argentina and *Terebratula itaitubensis* Derby from Brazil, ought to be included also. However, details of the arrangement of the hinge plates, loops, and punctae are lacking for all these forms and no definite conclusion can be reached.

Comparisons: This new genus is closely related to *Beecheria* Hall & Clarke, and in fact I have been dubious of the value of separating the two. For this reason a detailed discussion of *Beecheria* and its type species is included here.

Stehli (1956) has redescribed the genus, but it is not clear how much of his interpretation is based on *Terebratula bovidens* Morton and another unnamed Pennsylvanian species. His transverse sections do not appear to be based on the type species *B. davidsoni.* Through the courtesy of Dr D. J. McLaren I have been able to examine twenty-two specimens identified as *B. davidsoni* from the Windsor Group at Maxner Point, Windsor, Nova Scotia (Geol. Surv. Canada loc. 7497). Of these the interiors of eighteen have been examined by sectioning, or by calcining and developing with a needle to produce internal moulds. The external form of the species is adequately described by Bell (1929, p. 144), whose description of the interior is also quite accurate as far as it goes. The outer hinge plates are attached directly to the shell wall, not the inner socket ridges, and remain attached well forward of the inner hinge plates. The latter form a septalium which is ' medially and posteriorly . . . . . closely appressed to the valve, but it rises slightly anteriorly, as well as laterally to its union with the crural lamellae ' (Bell, p. 145). This is quite a remarkable and consistent feature. So close is the septalium to the floor of the valve that one gets the impression of the inner hinge plates uniting with the floor of the valve independently throughout growth. However, thin sections show clearly that this is not so. The inner hinge plates are attached to the valve wall towards the rear, but at the front they unite to form a septalium which is entirely free of the floor of the valve, though very close to it (Text-fig. 19). Another consistent feature is the presence of a low median ridge which runs almost the entire length of the septalium and continues forward to about the mid-point of the valve. The inner edges of the main trunks of the vascula media diverge from its anterior end. As shown by Bell, the crural points are high and develop directly from the crural bases; that is, in section they form part of a complex attached to the valve wall directly. The loop is short and in all the specimens examined by me shows no sign of a transverse band. The adductor muscle scars in the brachial valve are elongate, narrow, and widely separated. Detailed internal structures in the pedicle valve are extremely difficult to observe, though dental lamellae and a pedicle collar are clearly present. Punctae number 175–250 per sq. mm.

Several other Lower Carboniferous species which on current interpretations (Stehli, 1956; Armstrong, 1962) would be referred to *Beecheria* are well known, particularly those described from the Mississippi Valley by Weller (1914). They include *B. shumardana* (Miller), *B. sinuata* (Weller), *B. arkansana* (Weller). *B.*

chouteauensis (Weller), *B. formosa* (Hall), *B. illinoisensis* (Weller), and perhaps also *B. osceolensis* (Weller) and *B. fernglenensis* (Weller). These forms vary greatly in size (up to 52 mm. long), in convexity from lenticular to sub-spherical, and in outline from ovate to sub-triangular. Some are rectimarginate, others markedly sinuate. Internally the length of the septalium varies up to half the length of the brachial valve, and though this structure rises from the floor of the valve in front in some species, e.g., *B. chouteauensis* (Weller, 1914, p. 258), in others it apparently remains attached to the floor throughout. The anterior end of the septalium also seems to vary in outline from pointed to distinctly emarginate. Most of the species in which the septalium is figured show a distinct median ridge down its entire length. And finally, the only species in which the loop is known (by sectioning) has the high crural points developed from the outer hinge plates while they are still attached to the valve wall, in the same manner as *B. davidsoni*. Whether this extensive range of morphological types should be encompassed by the one generic name is open to question. Obviously the American species should be re-examined.

Since the limits of *Beecheria* cannot be satisfactorily set because of our inadequate knowledge, the distinguishing characters of *Hoskingia* cannot be stated with complete confidence. The following features are tentatively suggested, and taken together they appear to provide an adequate basis for the erection of the genus. In *Hoskingia* the septalium is formed by the union of the inner hinge plates along the mid-line of the valve, and it is never appressed to the floor of the valve; the septalium never rises above the floor of the valve in front, and its anterior termination is never emarginate; the crural points are developed in front of the point where the outer hinge plates become free of the valve wall; and finally the punctation density is less than that of *Beecheria*.

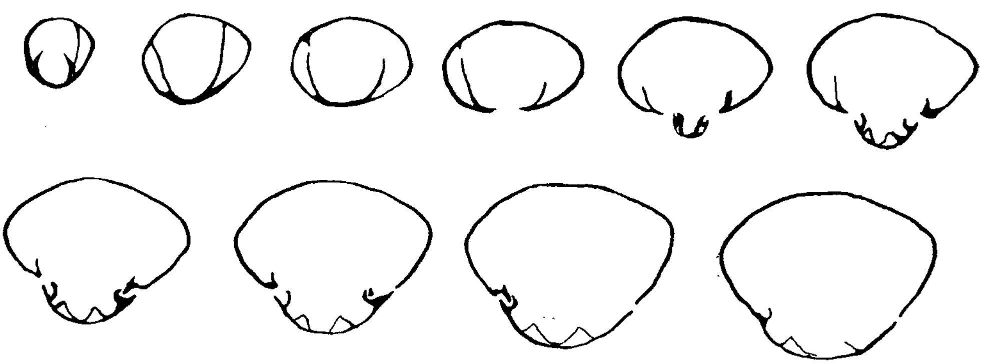

Fig. 19.—Serial sections of a specimen of *Beecheria davidsoni* (Hall & Clarke) from Nova Scotia, Canada. Intervals between sections are 0.5 mm. x 3.

HOSKINGIA TRIGONOPSIS (Hosking), 1933

(Pl. 13, Figs 1–8; Pl. 12, Fig. 14; Text-figs 20–22)

1931 *Dielasma cymbaeformis* Morris; *in* Hosking, *J. Roy. Soc. W.Aust.*, 17(15), 21, pl. 6, figs 1a–d.

1933 *Dielasma trigonopsis* Hosking, *J. Roy. Soc. W. Aust.*, 19(6), 44–46, pl. 3, figs 1a–e; pl. 4, figs 1a–b and 2.

Lectotope (here chosen); 1/4950 G.S.W.A., most probably from the Madeline Formation, two miles almost east of Survey Station R20, Wooramel River; specimen figured by Hosking (1933, pl. 3, figs 1a–e).

Diagnosis: Shell very large; trigonal in form; pedicle valve with a very broad, moderately deep sinus extending back almost to umbo; umbonal ridges angular and moderately sharp; foramen large, moderately labiate, and mesothyrid; brachial valve only slightly arched in longitudinal, and strongly domed in lateral profile; surface of both valves with weak variably developed and variably spaced discontinuous radial grooves; dental lamellae widely separated and one-fifth to one-quarter of total shell length; septalium sessile and extending somewhat less than half length of brachial valve; crural bases strong; anterior edges of septalium strongly concave; cardinal process a prominent strongly concave plate; crura very short and thick; crural points very high, slightly recurved posteriorly and strongly concave toward each other; descending lamellae comma-shaped in cross-section, extending to mid-length of valve, and without a transverse band.

Description: Shell very large for a terebratuloid, the largest individual being about 75 mm. long; in lateral profile pedicle valve more or less evenly and moderately convex, and brachial valve only gently convex; in anterior profile pedicle valve usually deeply and evenly concave, and brachial valve highly arched with its crest flattened; outline of shell triangular with maximum width close to anterior margin; lateral commissure moderately sinuate; anterior commissure very broadly sinuate; in most specimens, sinus extends back to within 10 mm. of umbo and occupies almost entire width of shell; umbonal ridges angular and extending to position of maximum width of shell; pedicle umbo sub-erect; foramen very large (up to 9 mm. in diameter), mesothyrid, and moderately labiate; deltidial plates conjunct and massive.

Surface showing traces of fine radial grooving with irregular spacing and distribution; punctae 100–150 per sq. mm.

Pedicle collar strong and entire; dental plates thick but extending only one-fifth to one-quarter of length of shell; teeth large; small denticula present; muscle field large, shield shaped and poorly defined; individual muscle scars almost indistinguishable, but thought to be arranged as in Text-figure 20; paired pedicle adjustor muscle scars very long and bound entire muscle field at sides; posterior end of muscle field about 5 mm. in front of pedicle collar, and anterior end just to rear of mid-length of shell; pallial markings not preserved.

Sockets large and non-denticulate, inner socket ridge high and rather sharp on its inner edge; cardinal process large, usually with concave myophores; outer hinge plates joining crural bases directly to shell wall; space between outer hinge plates and inner socket ridges filled with shell except at anterior edge, where shell rises from wall of valve to form a simulated outer hinge plate; crural bases very low and blunt posteriorly, very high and sharp anteriorly, inner hinge plates thick, united on floor of valve to form a sessile septalium reaching almost to mid-length of valve; edges of septalium deeply concave toward the front; crura up to 2 mm. long in adults, laterally compressed and robust; crural points very high, posteriorly recurved at their tips, and markedly flexed in section; descending lamellae merging into the crural processes, and deeply concave toward each other posteriorly but twisting to become deeply concave toward ventral valve anteriorly; no sign of a transverse band; loop extends to mid-length of valve; adductor scars large, distinctly paired, and fitting up into concavity in front of septalium; pallial markings not observed.

Remarks: Hoskingia trigonopsis is an unusually large species for a terebratuloid, and its very distinctive shape makes it easily recognisable. The depth and width of the sinus in the pedicle valve are somewhat variable; in some forms the sinus occupies less than half the width of the shell, whereas in the lectotype it occupies almost the entire width. Some specimens have a distinct furrow over almost the entire length of the brachial valve; the only sign of a modification on others is a slight flattening on the anterior half. The fine radial surface ornament is visible only on some specimens, and its position, depth, and spacing vary. There is insufficient material to describe its variation.

The simulated outer hinge plate is a feature of this species which has not been observed in any other. It is present in eight of the nine specimens from the Madeline Formation prepared to show the internal characters. No juvenile individuals from this formation are available, but the smaller specimens from the Bogadi Greywacke show no sign of it. Sections of large adults from the Madeline indicate that at the early stages of growth the space between the outer hinge plates and the inner socket ridges was the site of deposition of thick punctate shell tissue. Only in adults does the inner surface of this tissue become free of the shell wall and form an internal plate (see Text-fig. 21).

The description of the interior of this species given by Hosking (1933) is inaccurate, owing no doubt to the poor preservation of the specimen which she sectioned. I have examined the remains of this specimen (which has been very obliquely cut) and find that it is a typical member of the species, and shows one of the simulated outer hinge plates quite well. Presumably Hosking regarded it as a detached piece of shell. The median septum of the brachial valve is not as high as is indicated in her text-figure 1, and the inner socket ridges are not nearly so thick. Clearly she confused the inner socket ridges with the crural bases. She did not comment on the peculiar arrangement of the teeth and dental lamellae in text-figure 1 (3–6), but the pedicle valve must have been depressed in the vicinity of the articulation.

The specimen identified by Hosking (1931, p. 21), as *Dielasma cymbaeformis* (Morris), labelled 1/4644 G.S.W.A., probably comes from the same locality as the type of *H. trigonopsis*. As noted by Hosking the shell is crushed and it was also distorted during life, so that it is difficult to envisage its original form. From the

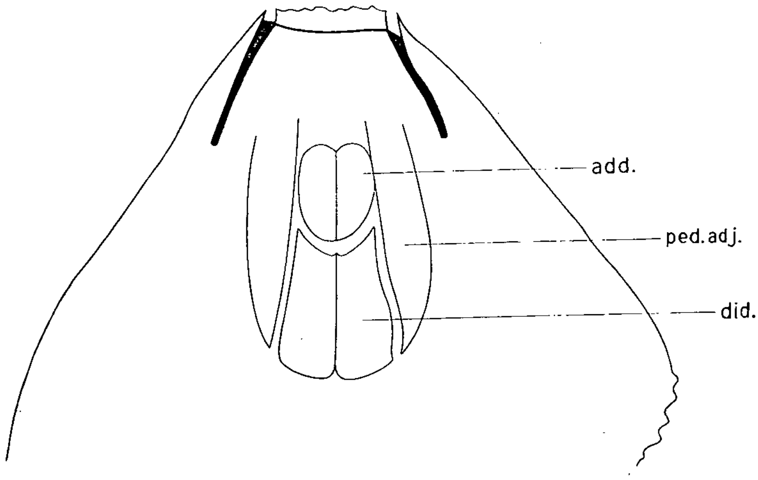

Fig. 20.—Muscle scars in pedicle valve of *Hoskingia trigonopsis* (Hosking), drawn from CPC 5247 from the Madeline Formation; adductor scars (add.), pedicle adjustor scars (ped. adj.), and diductor scars (did.). x 1.5.

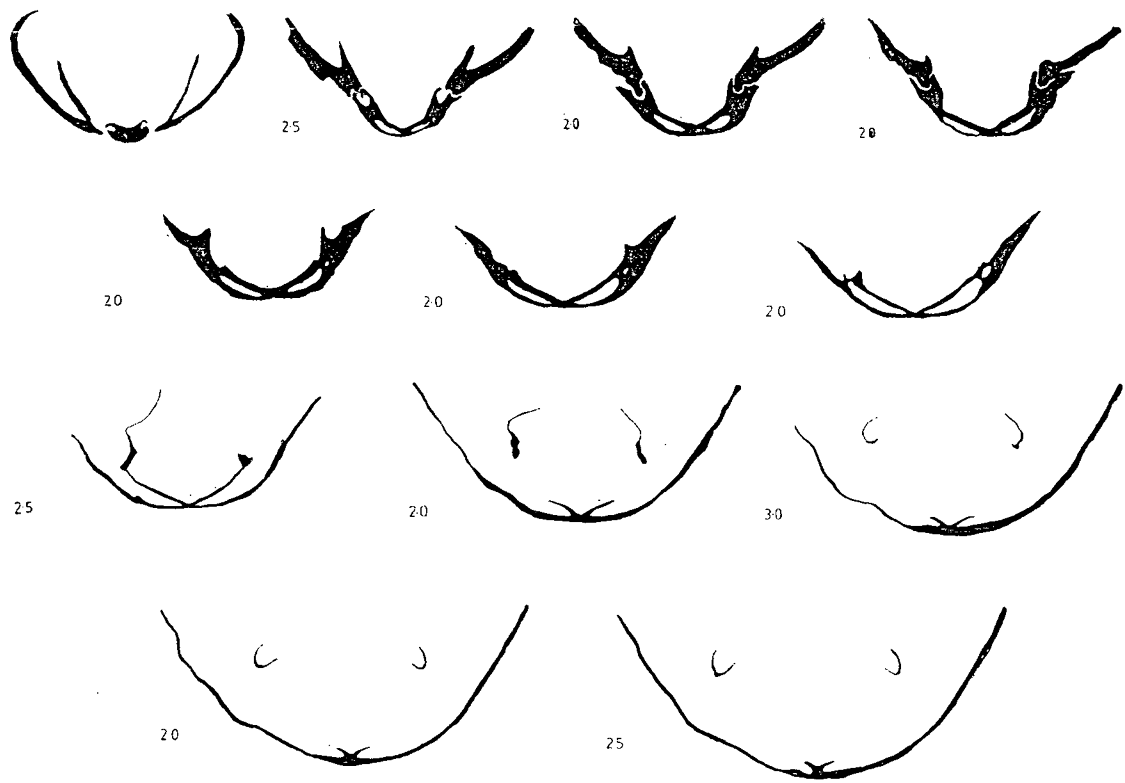

Fig. 21.—Serial sections of a specimen of *Hoskingsia trigonopsis* (Hosking) from the Madeline Formation; CPC 5252. Approximate intervals between sections are as shown. x 1.

small part of the brachial interior exposed it is possible to state categorically that it is not representative of *Gilledia cymbaeformis*, but on the other hand it is normal for *H. trigonopsis*. In fact I see no reason why it should not be regarded as a malformed member of this species.

Hosking made tentative comparisons between *H. trigonopsis* and *D. spatulatum* Girty from Texas on the one hand, and *D. latouchei* Diener from the Salt Range on the other. The internal structure of *D. spatulatum* has never been adequately described, but the similar *D. shafterense* King, which occurs with it in the Leonard of Texas, has the typical internal structures of *Hoskingia* (King, 1930, pl. 44, fig. 21b). Neither species reaches the size of *H. trigonopsis*, nor are they as markedly triangular in outline. *D. latouchei* on the other hand is a very difficult species to interpret owing to inadequate knowledge of its internal structures. However, it is clear that the species has a prominent median fold in the pedicle valve, and this can be used to distinguish it from *H. trigonopsis*.

Localities and Horizons: Hosking's specimen 1/5232 G.S.W.A. comes from 2 miles south-east of Madeline Hill, Wooramel River District, and 1/5241 from between Callytharra Road and No. 2 Bore Road, about 5 miles from Bogadi, Wooramel River District. Dr J. M. Dickins informs me that both these localities probably lie within the Madeline Formation.

New material from the Madeline Formation is as follows; CPC 5245–5249 from locality WB 81, $2\frac{3}{8}$ miles on bearing of 46° from Keogh Hill, Wooramel River District; CPC 5255–5256 from locality WB 76, $3\frac{1}{2}$ miles bearing 248° from Bogadi Outcamp; CPC 5258 from locality WB 135, $2\frac{1}{2}$ miles on bearing 102° from Mount Madeline, Wooramel River District; three specimens labelled CPC 5251, CPC 5259–60, catalogued as from the Byro Limestone (Madeline Formation), Wooramel River District; CPC 5252 and CPC 5254 from Oil Search localities 7 and 8 in the Byro Limestone (Madeline Formation).

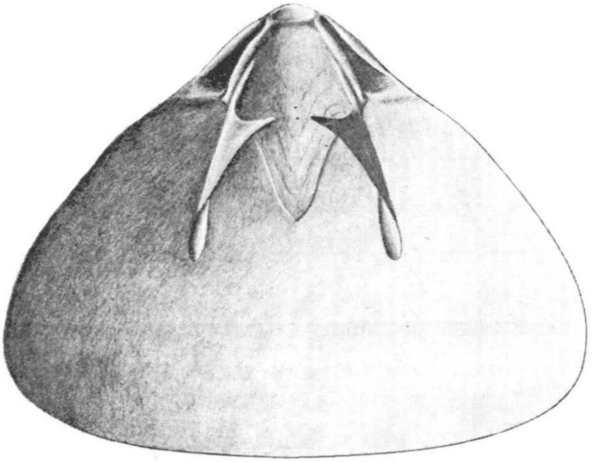

Fig. 22.—Reconstruction of interior of brachial valve of *Hoskingia trigonopsis* (Hosking), drawn from sections in Fig. 21, together with sections from two other individuals.

A single specimen, 23796 U.W.A. from the Bogadi Outcamp, Wooramel River District, is preserved as a ferruginous steinkern. It is smaller than the usual size for the species, but is otherwise closely comparable. There are ten specimens labelled CPC 5261 from the Bogadi Greywacke at locality WB 78, six miles bearing 323° from Bogadi Outcamp. These also are much smaller than the types, the largest being only about 55 mm. long. They have been considerably flattened during preservation and it is difficult to prepare their interiors for study. However, apart from the fact that the brachial valve bears an unusually deep median furrow, there seems to be no reason to distinguish them from *H. trigonopsis*.

HOSKINGIA NOBILIS (Etheridge, 1907)
(Pl. 12, Figs 9–13)

1907 *Dielasma nobilis* Etheridge, *Bull. geol. Surv. W.Aust.*, 27(3), 19, pl. 4, figs 2–4; pl. 6, figs 1–2.

Lectotype (Crespin, 1964, p. 65): F229A G.S.W.A. from the Mingenew Formation at Mingenew; other syntype F229B G.S.W.A. from same locality.

Diagnosis: Shell large, outline sub-triangular posteriorly but well rounded in front; anterior commissure strongly sulciplicate; pedicle valve moderately and evenly convex, fold on pedicle valve evenly rounded and reaching back almost to the umbo; foramen mesothyrid and moderately labiate; dental lamellae slender and widely spaced; outer hinge plates joined to wall of shell, and lying flat, almost in plane of commissure; inner hinge plates forming a sessile septalium reaching about three-eighths of length of valve; anterior edges of septalium almost straight but curved forward sharply close to crural bases; crural points high and recurved posteriorly at their tips; descending lamellae V-shaped in transverse section and extending almost to mid-length of valve; no transverse band.

Description: Largest specimen known 52 mm. long and 40 mm. wide; in lateral profile pedicle valve moderately and evenly convex, brachial valve very gently and evenly convex; maximum width at about two-thirds the length, and anterior outline well rounded at all growth stages; lateral commissure weakly sinuate; anterior commissure strongly sulciplicate; median fold on pedicle valve high, well rounded, extending back almost to umbo, and slightly less than half total width of shell at any growth stage; umbo sub-erect; umbonal ridges well rounded; foramen large (5 mm. internal diameter in large specimens), mesothyrid and moderately labiate; deltidial plates probably conjunct.

Surface characters and punctation density unknown.

Pedicle collar strong and entire; dental lamellae slender, very widely spaced, and extend about one-eighth of length of shell along outer shell wall; muscle field shape not clearly distinguishable; main trunks of vascula media long, straight, and run along edges of median fold; other pallial markings not observed.

Sockets of moderate size; cardinal process with slightly excavate myophores and sharp anterior edge; crural bases of moderate size; outer hinge plates narrow, lying more or less horizontally, slightly concave on their ventral face, and joining shell wall just inside inner socket ridges; inner hinge plates large, slightly concave

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ventrally in transverse section, and forming a sessile septalium which reaches about three-eighths of length of valve; anterior tip of septalium well rounded; adductor muscle scars elongate, each scar almost twice as long as wide, and situated just in front of septalium; crura 2–3 mm. long in adults, standing out ventrally from front edges of crural bases, and in transverse section convergent ventrally (Fig. 2); crural points high, with posteriorly recurved tips, which lie opposite tips of crural bases; ventral edge of crural points gradually decreasing in height and passing imperceptibly into the descending lamellae; immediately in front of crura descending lamellae become V-shaped in transverse section and remain so to their anterior tip; no transverse band.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Septalium	Width Median Fold	Height Median Fold
49	39	23	44	16	20	4
45	36	22	40	16	18	5
43	30	21	39	15	18	3

Remarks: Etheridge (1907, p. 19) commented that the median fold in the pedicle valve was traversed by a groove, but his specimens were internal moulds and the groove is the very low rounded internal median ridge common in terebratuloids. As he indicated (p. 20) the plication pattern of the shell is very distinctive.

The type specimens are rather badly broken, but the material now available is well preserved. No exteriors are present in the collections and so details of external ornament remain unknown, and such features as the size of the foraminal lip have to be inferred from the internal moulds.

Though the collection is small, it is clear that this is not a highly variable species. It does not overlap with any other form, and there is no difficulty in distinguishing it. Its nearest relative in Western Australia is *H. grandis* sp.nov., from which it can be distinguished by its characteristic plication, its less elongate outline, and by the orientation and position of its outer hinge plates.

The only comparable overseas species is *Dielasma latouchei* Diener from several Permian localities in the Himalayas, Kashmir, and Pakistan, but it is a flatter form with a much smaller pedicle foramen and a more definitely triangular outline.

Localities and Horizons: The precise locality of the types is in doubt, but they must have come from the Mingenew Formation.

Ten specimens labelled 29908 U.W.A. from the Mingenew Formation, 500 yards north-east of entrance to Eregulla Springs Station, 2 miles from Mingenew, form the basis of the description. Four specimens labelled CPC 5262 and one CPC 5264 from the same formation at locality PB 15, south side of Fossil Hill, Eregulla Springs Station, belong to the species.

One individual, F9457 A.M. from 1 mile east of Mingenew Railway Station, has a deeper median plication (about 7 mm. at the commissure) than the specimens described above, and it extends farther back toward the umbo.

HOSKINGIA WANDAGEENSIS sp.nov.

(Pl. 10, Figs 1–15; Pl. 12, Figs 5–7; Text-figs 23–25)

Holotype: F27301a U.W.A. from locality WC (29–32) 3, Wandagee Formation on west side of syncline, south of Minilya River; paratypes CPC 5189–5207 from locality ML 44, Wandagee Formation, south bank of Minilya River, 9 miles west of Wandagee Homestead and 1⅝ miles south-west of Coolkilya Pool; CPC 5214 from locality CC 98, same formation, Coolkilya Syncline; F27557a–c U.W.A. from locality WC (25–27) 3, slightly lower in the Wandagee Formation at the holotype locality.

Diagnosis: Shell of moderate size; outline sub-triangular; profiles flattened; broad shallow sinus in pedicle valve with weak median furrow; labrum short; foramen large; dental lamellae short; septalium sessile, very shallow, and between 0·30 and 0·45 the total length of the brachial valve.

Description: Shell of moderate size for genus, the largest one available being about 42 mm. long and 35 mm. wide; maximum width situated in the anterior quarter of the shell; in lateral profile pedicle valve only moderately convex, convexity increasing markedly toward the umbo; brachial valve very weakly convex; in anterior profile pedicle valve weakly convex and brachial valve domed but flattened or slightly depressed on the crest; outline sub-triangular in adults but much more rounded in juveniles; lateral commissure weakly sinuate; anterior commissure weakly sulciplicate in adults; pedicle umbo sub-erect; umbonal angle varies from 40°–60°; foramen large, about 3·2 mm. in diameter in the specimen 42 mm. long, permesothyrid; labrum short and not markedly overhanging umbo of brachial valve; umbonal ridges sub-angular toward umbo, much more rounded anteriorly, and extending forward to position of maximum shell width; deltidial plates conjunct; earliest growth stages rectimarginate, then broadly sinuate till shell is one-third to one-half grown, and finally weakly sulciplicate; punctae number 125–175 per sq. mm.

Pedicle collar strong and complete; dental lamellae widely separated and extending about one-seventh of length of valve; muscle and pallial markings not preserved.

Inner socket ridges slender; crural bases low and narrow; space between crural bases and inner socket ridges very variable and directly correlated with overall width of shell; septalium sessile at all growth stages, and tending to be a flat open structure in transverse section ; anterior edges of inner hinge plates swing back from crural bases for about 1 mm. and then forward to mid-line; anterior tip of septalium pointed in juveniles, tending to become rounded in adults; crura thick and projecting ventrally from anterior edges of crural bases; crural points high, slightly recurved at their tips, and concave toward each other; transverse band thin forming a postero-ventrally directed open V-shaped structure; loop reaches almost to mid-length of valve; adductor and pallial markings not observed.

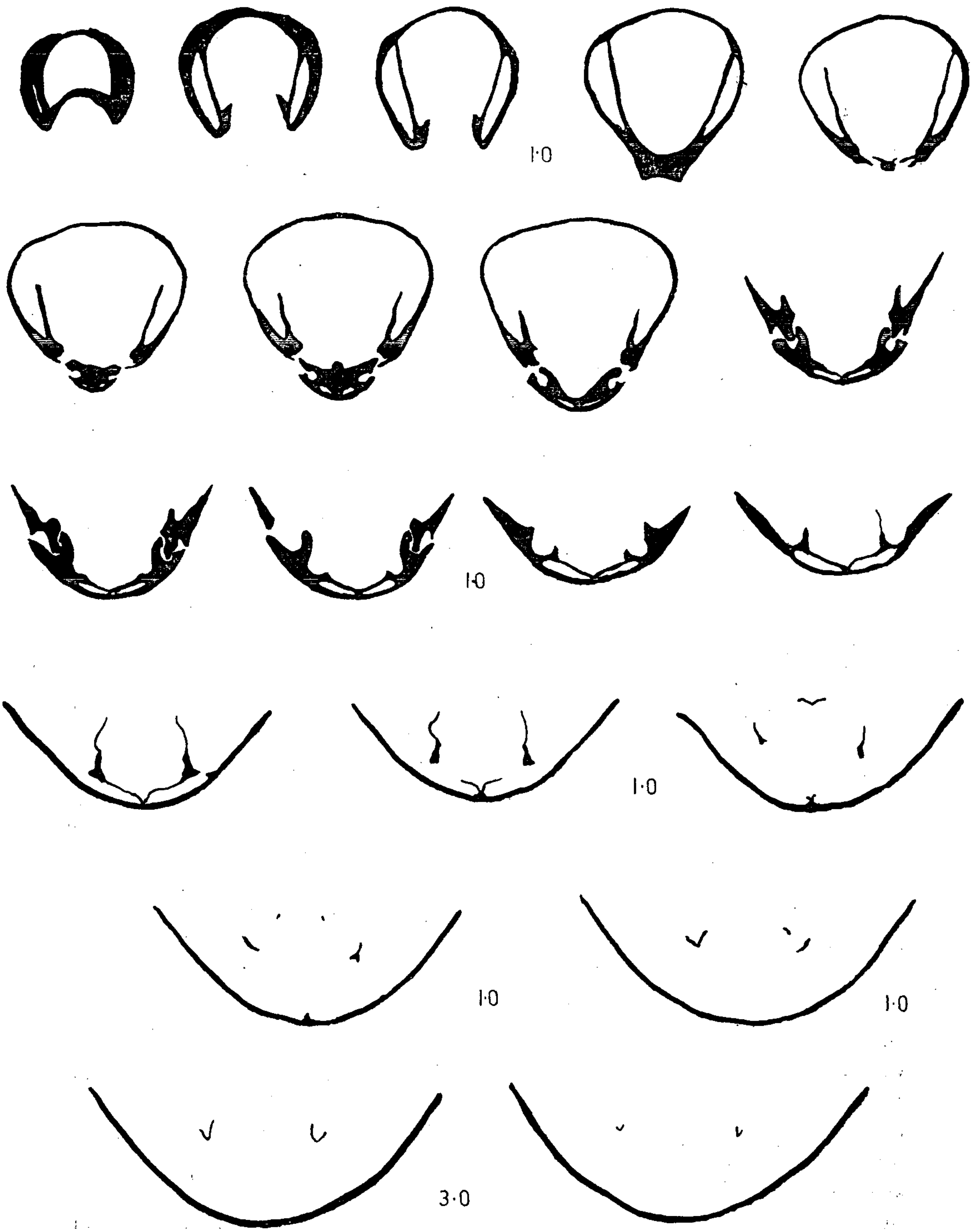


Fig. 23.—Serial sections of a specimen of *Hoskingia wandageensis* sp. nov. showing a loop with a transverse band; from the Wandagee Formation at ML 44. Intervals between sections 0.5 mm. unless otherwise shown. x 2.5.

Dimensions:

Length	Width	Height	Length Brachial Valve	Height Median Fold	Width Median Fold	Length Septalium
41	36	16	36	....	....	....
35	26	13	31	1·5	10	12
34	26	....	31	1·5	10	11
33	27	13	29	0·5	....	....
27	18·5	11	24	1·0	6	....
27	23	11	24	....	....	10·5

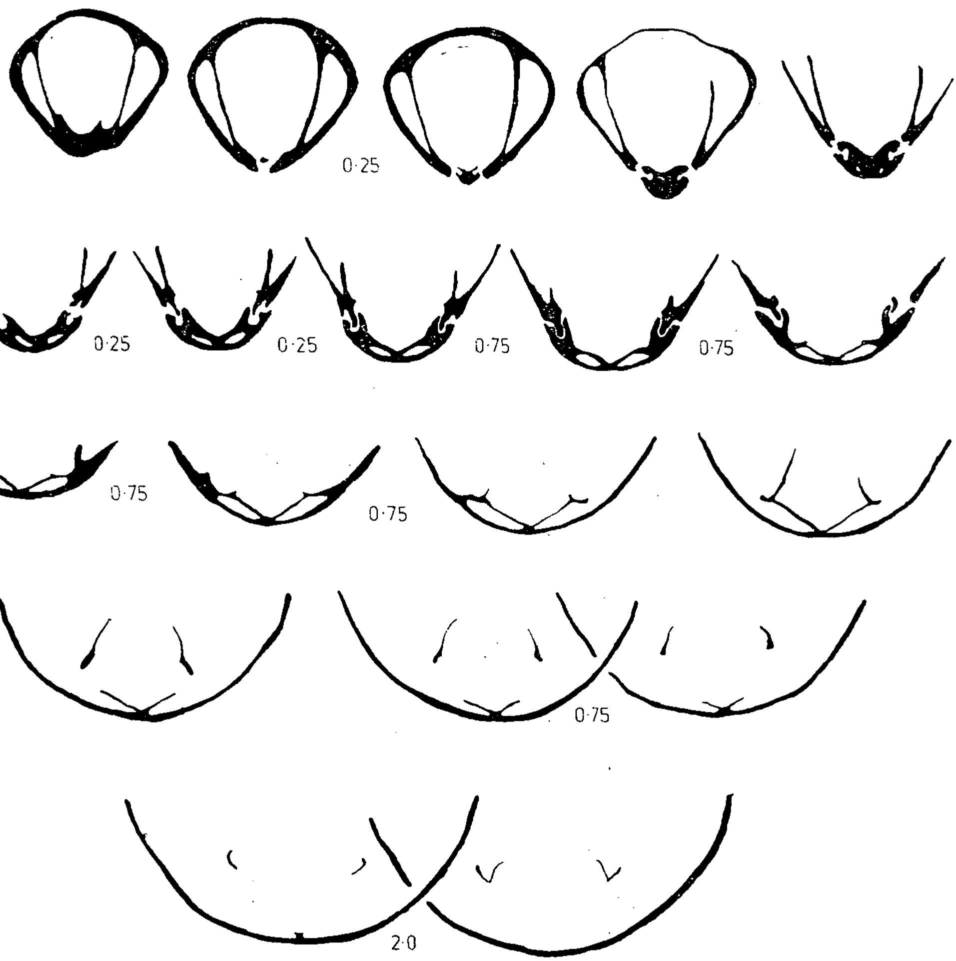


Fig. 24.—Serial sections of a specimen of *Hoskingia wandageensis* sp. nov. without a transverse band or a median boss on the cardinal process; from the Wandagee Formation at ML 44. Intervals between sections 0.5 mm. unless otherwise shown. x 2.

Remarks: Shape variability is considerable in this species and it can be analysed into the following components: (a) The umbonal angle ranges from 40° to 60°; some of the forms with the smaller angles have concave postero-lateral outlines. (b) Width/length ratios range from 0·60 to 0·83; the larger specimens usually lie between 0·74 and 0·80 and the adolescent ones between 0·60 and 0·74. The relatively wider specimens also have their position of maximum width farther forward than the narrow ones. (c) The narrower forms naturally have a narrower sinus and median plication, but the height of these structures is comparable throughout the series. This results in an apparently stronger sulciplication of the commissure in the narrower specimens. (d) In the broader forms the crural bases are well separated from the inner socket ridges, but this space is very much reduced in the narrower forms and is the site of much shell thickening.

The only forms with which *H. wandageensis* is likely to be confused are young individuals of *H. grandis* sp.nov., but plication of the shell begins much earlier in the ontogeny of *H. wandageensis*, its umbonal region is more strongly convex in lateral profile, and its outline much less distinctly triangular.

The Russian specimens figured as *Dielasma timanicum* Chernyshev (Chernyshev, 1902, pl. 1, figs 2a–d) and *Dielasma curvatum* (pl. 1, figs 5a–c) both have resemblances to this species. Both are said to be from the *Schwagerina* limestone.

Localities and Horizons: Almost all the specimens come from the Wandagee Formation, in which they occur in abundance. In addition to the holotype and paratype localities, specimens have been found as follows: CPC 5210–5212 from CC 87, 220 feet above the base of the formation at the type section; two specimens CPC 5213 from locality ML 82, north bank of Minilya River, about 1½ miles south-west of Coolkilya Pool; CPC 5216, from ML 59, Minilya Syncline, 155–165 feet above base of formation; seven specimens F33359/4 U.W.A. from about 3½ miles west of Binthabooka Creek, 5½ miles west of Lyons River Homestead; three specimens F27762 U.W.A. from locality WC (30–31) 12, Brandy's Horizon.

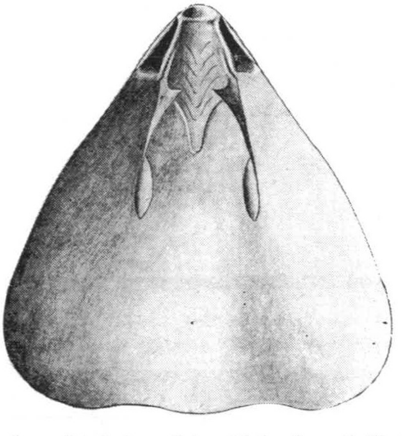


Fig. 25.—Reconstruction of interior of brachial valve of *Hoskingia wandageensis* sp. nov. based on several sectioned specimens.

CPC 5208–9 from KNA 36, 1860 feet above the base of the Noonkanbah Formation on the south of Grant Range, 8 miles at 120° from Mount Anderson Homestead, and CPC 5349 (two specimens) from G 24, the Wandagee or Nalbia Greywacke at 24° 12′ 51″, 114° 40′ 27″, Norton One Mile Sheet, are similar in outline but are rather flatter and slightly less plicate. The brachial valve is known from only one poor specimen. These specimens are best identified as *H.* cf. *wandageensis.*

A single specimen CPC 5215 from locality ML 87, probably the Coyrie Formation at 8½ miles bearing 82° from Mia Mia Homestead, north bank of Lyndon River, is badly crushed, but probably belongs to the species.

HOSKINGIA KENNEDIENSIS sp.nov.

(Pl. 12, Figs 1–3; Text-fig. 26)

Holotype: F17162a U.W.A. from the Bulgadoo Formation, ¾ mile south-east of CP 144; paratypes F17162b–d and F17616 U.W.A. from the same locality.

Diagnosis: Shell moderate size for genus; outline ovate; more or less equally biconvex; very broad shallow sinus in pedicle valve; foramen small, strongly labiate, and permesothyrid; dental lamellae short, about one-seventh of total shell length; outer hinge plates well separated from inner socket ridges; inner hinge plates forming a sessile septalium extending 0·25–0·30 of length of brachial valve.

Description: Largest specimen available about 39 mm. long and 30 mm. wide; in lateral profile pedicle valve gently convex over most of its length, more strongly convex toward umbo, and brachial valve weakly and evenly convex; in anterior profile pedicle valve moderately convex and brachial valve more highly domed, but with a slight flattening along its crest on anterior half of shell; outline triangular posteriorly, very well rounded in front; greatest shell width about mid-length of shell; lateral commissure weakly to moderately sinuate; anterior commissure broadly sinuate; umbo sub-erect to erect; foramen small (about 2·5 mm. wide in a specimen 37 mm. long), strongly labiate and permesothyrid; beak ridges subangular to rounded; surface crossed by growth-lines only; punctae number 100–125 per sq. mm.

Pedicle collar weak but entire; dental lamellae thin and short, extending only about one-seventh of total shell length; vascula media straight and parallel, and situated about 0·7 mm. apart in adults.

Sockets very slender and short; inner socket ridges thin; outer hinge plates joined directly to floor of valve throughout and leaving a gap of 1·5–4 mm. between their anterior edges and inner socket ridges; inner hinge plates broad and flat, with straight anterior edges at early growth stages, becoming progressively more curved during ontogeny; sessile septalium extends about one-quarter of length of valve; low sharp ridge extends about 4 mm. in front of septalium; crural bases thin and sharp; crura and loop unknown; adductor scars narrow and elongate, and forming a distinctive pattern; long straight vascula media diverge from ridge in front of septalium, their outer edges being inside muscle scars; angle of divergence about 35°; other vascular markings not preserved.

Dimensions:

Length	Width	Height	Length Brachial Valve	Length Septalium
37	28	c 14	34	10
c 35	26	....	31	7·5

Remarks: Only six specimens are available: one is a juvenile, three are separated broken valves, and two are partly crushed but with both valves present. Nevertheless it is clear that they do not belong to any previously described species. The distinctive adductor scars of the brachial valve have been observed in two specimens, and the septalium in three. It is possible that in one specimen the septalium is slightly less than one-quarter the total shell length, but the preservation is too poor to be certain.

Of the Australian species only young specimens of *H. grandis* are in any way comparable, and they are differentiated by their more sub-triangular outline, stronger and more divergent dental lamellae, larger pedicle foramen, and relatively longer septalium.

Terebratula itaitubensis Derby from the Pennsylvanian of the Tapajos River, Brazil, is more strongly biconvex, and has much longer dental lamellae and a longer septalium.

Localities and Horizons: Only one possible occurrence is known in addition to that of the type locality. This is CPC 5241 from the Cundlego Formation at locality MG 176, 300 yards west of Cundlego Crossing, south side of Minilya River, 9 miles west of Wandagee Homestead. The specimen is crushed, but the outline must have been very similar to that of *H. kennediensis*. The septalium is rather more than one-third of the length of the brachial valve, which is relatively longer than that of the types.

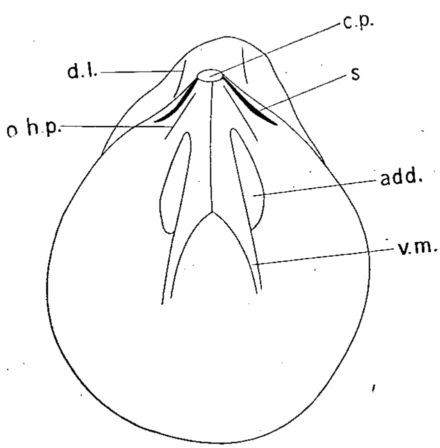


Fig. 26.—Outline diagram of dorsal view internal mould of *Hoskingia kennediensis* sp. nov. showing adductor scars (add.), vascula media (v.m.), sockets (s), outer hinge plates (o.h.p.), cardinal process (c.p.), and dental lamellae (d.l.). Drawn from the holotype. x 1.5.

Hoskingia grandis sp.nov.

(Pl. 10, Figs 16–21; Pl. 11, Figs 1–5)

1954, cf. " *Dielasma* " *latouchei* Diener, in Thomas, G. and Dickins, J. M., *Aust. J. Sci.*, 16(6), p. 221.

Holotype: CPC 5265 from 300 feet below the top of the Hardman Member at locality KLC 40, 4·9 miles bearing 339° from Moffatt's Bore, Nerrima Station, Fitzroy Basin; paratypes CPC 5266–5271 from the same locality.

Diagnosis: Shell very large; greatest width well forward of mid-length; pedicle valve with very broad sinus; much narrower well-rounded median fold, reaching almost to umbo; brachial valve with moderate median sinus; foramen mesothyrid; dental lamellae short, robust, and widely spaced; outer hinge plates joined to shell wall and widely divergent from base of inner socket ridges; inner hinge plates forming a sessile septalium almost to mid-point of valve; anterior edge of septalium deeply concave near crural bases, and drawn out in front.

Description: Largest specimen known in excess of 100 mm. long; length/width ratios highly variable—from 1·1 to 1·5; outline of posterior part sub-triangular; maximum width at about two-thirds the length; in lateral profile pedicle valve only weakly convex, with greatest curvature towards umbo; brachial valve even less convex; lateral commissure weakly sinuate; in anterior profile, pedicle valve rather flat, brachial valve moderately arched; anterior commissure broadly sulciplicate; sinus on pedicle valve broad, occupying two-thirds or more of total shell width, and usually extending to within 2·0 cm. of umbo; median fold low, well rounded, and between one-third and one-half total shell width at any growth stage; sinus on brachial valve evenly rounded and with moderately sharp bounding ridges; umbo sub-erect; umbonal ridges very well rounded; foramen mesothyrid to permesothyrid, and approximately 4–5 mm. in diameter in a specimen 80 mm. long; lip short and thick; deltidial plates short, covering only apex of large delthyrium; surface apparently crossed by growth-lines only; punctae 50–75 per sq. mm.

Pedicle collar prominent, dental lamellae short (rarely more than 10 mm. long) rather thick, and very close to lateral walls of shell; muscle scars and pallial markings not preserved.

Inner socket ridges thick; outer hinge plates joined directly to shell wall, leaving a gap of 5–6 mm. between their anterior edges and inner socket ridges in adults; anterior socket ridges weak or absent; shell wall in this gap often slightly thicker than elsewhere, with a sharp anterior edge on the thickening (Pl. 11, Fig. 1); outer hinge plates apparently not joined to inner socket ridges at any growth stage; outline of inner hinge plates deeply concave just inside outer hinge plates, and drawn out in front; septalium sessile and extending almost to mid-point of valve; adductor scars as in *H. trigonopsis*; pallial markings not preserved; crura about 3 mm. high in adults, with a concave posterior edge and a gradually tapering anterior edge; crural points 8–10 mm. high, short, slightly concave toward each other, slightly recurved posteriorly and gradually tapering anteriorly; crural points developed directly ventral to crura, the line of junction marked by thick ridge; descending lamellae gently concave on their ventral faces, twisted in front of crura so as to lie more or less in planes at right angles to planes of crural points, directed antero-ventrally and diverging from each other at angles of about 30°, tapering gradually at their tips and extending beyond mid-length of valve; no transverse band.

Dimensions:

Length	Width	Height	Length Brachial Valve	Height Fold	Width Fold	Length Septalium
89	62	36	84	5	30	40
77	68	32	71	....	....	35
71	51	27	64	3	20	29

Remarks: Almost all the available material is in the form of broken internal moulds with occasional fragments of external moulds. As a result such features as the structure of the deltidial plates and details of the umbonal ridges are unknown from topotype material. The preservation of the surfaces of the moulds does not permit the description of the muscle scars or pallial trunks.

The shape of this species is highly variable. The normal type is represented in Plate 11, Figures 3–4, and the squat type in Plate 11, Figures 1–2. There is also a wide range in height, but it is difficult to decide how much of this is due to distortion.

H. grandis can be easily distinguished from *H. nobilis* (Etheridge) by its flatter form, broader and deeper pedicle median sinus, less prominent pedicle median fold, more attenuate septalium, and more widely divergent outer hinge plates and inner socket ridges.

Dielasma latouchei Diener from the Zewan Beds of Kashmir and the Lissar Valley in the Himalayas has a sub-triangular outline and a similar style of plication. However, as noted previously, little is known of its internal structure apart from the fact that it has dental lamellae, and, to judge from Diener (1903, pl. V, fig. 9), a sessile septalium in the brachial valve. Its foramen is much smaller than that of *H. grandis*, plication of the shell begins much earlier in ontogeny, the umbo is more nearly straight, and the outline is more nearly triangular.

Localities and Horizons: Numerous specimens CPC 5276–77 from locality KLC 14, Hardman Member, about ¼ mile bearing 120° from Mount Cedric, Fitzroy Basin, clearly belong to the species. Several individuals show a much later onset of plication than do the types and are still simply sinuate at shell lengths of up to 50 mm. Also, occasional specimens show an extraordinarily short septalium. The most striking one of these, CPC 5275, is figured on Plate 8, Figure 43.

CPC 5294–5295 from locality KLB 57, Hardman Member, about 300 yards west of Mount Hardman windmill, on south side of hill, are the only specimens with shell present. One of them, CPC 5294, is figured on Plate 11, Figure 5.

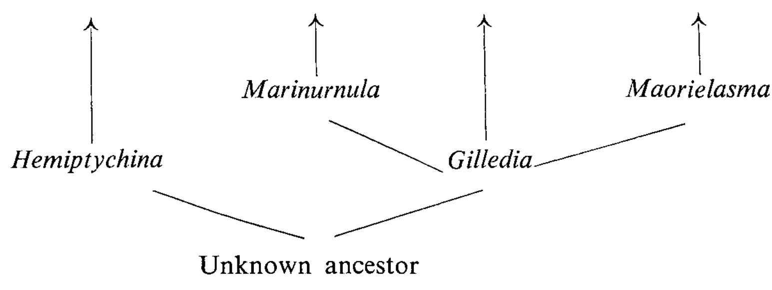
Other typical representatives of the species are known from the Hardman Member at locality M 3, in the central Millyit Range (CPC 5292); locality FL 192 (CPC 5278–81); and locality FL 2? (CPC 5290). Small individuals which probably belong to the species are known from locality CAL 2 (CPC 5282–89); locality H 3 (CPC 5291); and locality KLB 13, next to the fence 500 yards west of the mill, south of Mount Hardman (CPC 5293). Some of these smaller specimens are rather more inflated than normal, and another (CPC 5291a) is more triangular in outline, but otherwise they are normal (Pl. 10, Figs 17–21).

There are several fragments from the Noonkanbah Formation at KNF 73, 2·2 miles bearing 288° from Bruten's Old Yard (745 feet above the base of the formation) which must be compared with this species. All of them are flattened but it is clear that although they reached a size comparable with that of *H. grandis* and were similarly plicate, their outline was more markedly triangular and their position of maximum width farther forward. The interior of the brachial valve is normal for the species, but that of the pedicle valve is unknown. They are tentatively identified as *H.* cf. *grandis.*

Family Gilledidae nov.

Diagnosis: Shells biconvex in longitudinal profile, but pedicle valve either concave or convex in anterior profile; smooth or plicate; foramen mesothyrid to permesothyrid, and labiate; dental lamellae absent; outer hinge plates attached either to socket ridges or directly to floor of valve; inner hinge plates either absent, or small and joined directly to floor of valve along their inner edges, or broad and uniting to form a sessile septalium; loop in adult stages terebratuliform.

Remarks: This family is intended to include two subfamilies, Gillediinae nov. and Hemiptychininae nov. The origin of the group cannot be determined at present, but it is considered that the genera *Gilledia* Stehli and *Hemiptychina* Waagen must have developed from the one Upper Carboniferous group. *Gilledia* became isolated in the Australasian region and evolved there, while *Hemiptychina* became widespread throughout the Tethyan, Uralian, and Cathaysian provinces. The general scheme of evolution is indicated below.



Hemiptychina is usually grouped with the Dielasmatinae (Roger, 1952; Likharev, 1960), presumably simply because the inner hinge plates are joined directly to the floor of the valve. I put more emphasis on the absence of dental lamellae than on the shape of the hinge plates.

Subfamily GILLEDIINAE nov.

Diagnosis: Shells smooth or simply plicate—never multiplicate; shoulders of pedicle valve often with thick callus deposits; outer and inner hinge plates as for the family.

Remarks: Gilledia became established in the Australasian province in the Sakmarian and remained until late in the Permian. Morphologically *Maorielasma* developed from it by increasing the size of the inner hinge plates to form a sessile septalium, while *Marinurnula* evolved from it in the other direction, decreasing the size of the inner hinge plates until they were entirely absent. Both *Maorielasma* and *Marinurnula* first appear in the late Artinskian or Kungurian.

The internal structure of *Marinurnula* suggests affinities with the Heterelasminidae. However, shell shape and size, structure of the pedicle foramen, and palaeogeographic considerations, all indicate that it is related to *Gilledia*. The reduction of inner hinge plates must have occurred at least twice in the Upper Carboniferous and Permian.

Genus GILLEDIA Stehli, 1961

Type species (by original designation): *Terebratula cymbaeformis* Morris, from the Muree Formation near Raymond Terrace, New South Wales.

Diagnosis: Shells of small to large size; pedicle valve tending to become flattened or slightly sinuate on anterior half of shell but strongly convex posteriorly; brachial valve highly arched transversely; pedicle umbo sub-erect or erect; foramen weakly to strongly labiate and mesothyrid to permesothyrid; cardinal margin sub-terebratulid; deltidial plates conjunct; beak ridges well rounded to sub-angular; surface sometimes ornamented with fine, irregular radial furrows; dental plates absent; pedicle collar weak to strong; cardinal process normal for family; outer hinge plates usually fused to inner socket ridges in the umbo but sometimes joined to shell wall anteriorly; inner hinge plates always discrete and joined to shell wall; crural points long; loop short and terebratuliform but often with incomplete transverse band.

Remarks: When erecting this genus Stehli apparently did not see the type specimen of *T. cymbaeformis*, but based his discussion on material from Wyro, near Ulladulla. It is my opinion that specimens from that locality are not conspecific with *T. cymbaeformis*. The above diagnosis differs from the original in three main points—the absence of dental lamellae, the union of the outer hinge plates with the inner socket ridges, and the variation in the surface ornament. No true dental lamellae have been observed in species belonging to this group. Some species, including *G. culburrensis* sp.nov., include within their range of variation forms with thickened shoulders. Such thickenings sometimes have sharp edges which simulate the edges of dental plates, and the impression is that the plates themselves are joined to the shell wall by callus infilling the umbonal cavities. Other specimens of the same species from the same localities show no sign of such thickening (cf. Pl. 3, Figs 9 and 10). Such structures are well known among other terebratulaceans, e.g. *Magadina* and *Bouchardia*. The problem of the union between the outer hinge plate and the socket plate will be discussed more fully when dealing with *G. cymbaeformis* and *G. woolagensis*, but it should be noted here that there is considerable variation in the form of the junction between these two plates within certain species. As regards the surface ornament, it can scarcely be called carinate since that term refers to structures raised above the general level of a surface, whereas those under discussion are very delicate, irregular, and discontinuous furrows. The surface is not capillate as is that of *Terebratulina.* Terebratellaceans exhibit a variety of fine wavy surface structures, most of which are poorly described (Jackson, 1918; Thomson, 1927). Buckman (1910, p. 24; pl. 2, fig. 1d) has described and figured ornament superficially similar to that of *Gilledia* in the Recent *Terebratula lecta* Guppy—'. . . . . . in the older specimens particularly, there is a *sort of outer layer of test* which is radially grooved—the grooves waved and irregular . . . . .' (my italics). It is clear that the grooves of *G. homevalensis*, *G. culburrensis*, and *G. ulladullensis* are not structures belonging to the superficial shell layer alone, since they are frequently present in decorticated specimens, and occasionally traces of their presence can be detected on the inner surface of the shell. Transverse sections show that although the primary layer is thinner in the furrows than in the intermediate spaces, the whole of the layer is folded inwards slightly at the furrows, and the secondary layer fibres of course show a corresponding folding which becomes progressively weaker towards the inside of the shell. I am not convinced that this character is of generic significance, since it is widely variable in several populations, and it is not developed at all on certain species which are otherwise very closely comparable with species in which it is present; compare, for example, *G. oakiensis* and *G. homevalensis.*

Comparisons: *Hemiptychina* is similar internally, but is easily distinguished by the multiplicate commissure and the more closely placed inner hinge plates. Although some species of *Hemiptychina* such as *H. sublaevis* do develop almost rectimarginate commissures, in practice there is never any difficulty in referring them to that genus since all populations apparently include some plicate individuals.

A similar type of internal structure appeared in the Triassic (or perhaps uppermost Permian) with *Rhaetina* Waagen, but that genus appears to have the inner hinge plates joining the shell wall near the median line, and commonly exhibits a median keel, which is never present in *Gilledia* (Zugmeyer, 1882; Dubar, 1934). The genus is also biplicate, usually in the fashion of *G. ulladullensis* sp.nov., though in many species the biplication is weak. According to recent work by Dagis (1958), the loop structure also is fundamentally different, since it passes through a centronelloid stage with a marked median plate.

Distribution: The genus is common in New Zealand, Queensland, New South Wales, Tasmania, and Western Australia. It ranges through the entire marine Permian sequence in eastern Australia.

GILLEDIA CYMBAEFORMIS (Morris)

(Pl. 5, Figs 1–4)

1845 *Terebratula cymbaeformis* Morris *in* Strzelecki, 278, Pl. 17, Figs 4–5.

non 1877 *Terebratula sacculus* var. *cymbaeformis* (Morris); *in* de Koninck, *Mém. Soc. Sci. nat. Liège*, Ser. 2, 6–7, 255, Pl. 15, Figs 4–4a.

non 1892 *Dielasma cymbaeformis* (Morris); *in* Etheridge, *Publ. geol. Surv. Qld*, 92, 225, Pl. 9, Figs 10–11.

non 1961a *Gilledia cymbaeformis* (Morris); *in* Stehli, *J. Paleont.*, 35(3), 451, Pl. 61, Figs 1–6.

Remarks: This species was based on a single internal mould from Raymond Terrace, now labelled B 96872 B.M.N.H. The original figure is accurate apart from the rather exaggerated emphasis given to the flattening along the crest of the brachial valve. The pedicle valve is transversely convex in the posterior half of the shell, flattened at the mid-length and slightly sinuate in front. A slight swelling in the sinus is probably due to distortion. The brachial valve is only slightly arched along the crest, but it is very deeply convex in anterior profile. The lateral commissure is strongly sinuate. The inner socket ridges and inner and outer hinge plates are surprisingly short. There is no junction between the inner socket ridges and the outer hinge plates, the latter being joined directly to the wall of the valve. A distinct cavity is present between the two myophore surfaces of the cardinal process. The foramen, muscle scars, and surface ornament are not preserved.

The fact that the outer hinge plates do not join the inner socket ridges is not considered to be of generic significance. In most species assigned to the genus these two sets of plates are invariably joined. In *G. woolagensis* sp.nov., however, the outer hinge plates are joined directly to the wall of the valve in all known specimens, and in *G. culburrensis* sp.nov. both arrangements are known even in the collection from the type locality. It is not possible therefore to decide whether *G. cymbaeformis* is characterized by the structure exhibited by the type specimen or whether both arrangements of the outer hinge plates occur.

I have been unable to find further specimens in the Raymond Terrace area. The type locality, however, is not accurately specified. No topotypes have been described, and I can find none in museum collections. Further, no closely comparable material is available from anywhere else in eastern Australia. The specimens referred to the species by de Koninck (1877) and Stehli (1961a, Pl. 61, Figs 1, 2, 5, 6) have been placed in *G. culburrensis* sp.nov., and can be easily distinguished by the more convex pedicle valve, less sinuate lateral and anterior commissures, and less angular umbonal ridges. Those identified by Etheridge (1892) and Hosking (1931) are now identified as *G. pelicanensis* sp.nov. and *Hoskingia trigonopsis* (Hosking) respectively, the latter having practically no similarities with *G. cymbaeformis*, and the former having a much longer pedicle umbo, more convex pedicle valve, and less sinuate lateral and anterior commissures. So far as external shape is concerned, the nearest species is *G. oakiensis* sp.nov., but it has much longer inner socket ridges and hinge plates, and in none of the specimens seen to date do the outer hinge plates join directly to the wall of the valve.

Three overseas species have been compared with *G. cymbaeformis*, viz. *Dielasma truncatum* Waagen from Timan (Chernyshev, 1902), *Dielasma tolmachoffi* Likharev from the Kolyma Peninsula (Likharev, 1934), and *Dielasma lidarense* Diener from the Himalayas (Diener, 1915). The first and second of these species possibly belong to the genus *Hoskingia* as herein interpreted. The third is more difficult to place, but it has dental lamellae and broad hinge plates, so that it is certainly not a species of *Gilledia*.. It possibly belongs to *Hoskingia* also.

'RHYNCHONELLA' INVERSA (de Koninck, 1877)

1877 *Rhynchonella inversa* de Koninck, *Mém. Soc. Sci. nat. Liège*, Ser. 2, 6–7, 171, pl. 11, figs 11–11b.

non 1898 *Dielasma inversa* (de Koninck); *in* Etheridge, *Rec. geol. Surv. N.S.W.*, 5(4), 175–176, pl. 19, figs 1–13.

non 1919 *Dielasma inversa* (de Koninck); *in* Etheridge, *Rec. Aust. Mus.*, 12(9), 183–184, pl. 29, figs 3–4.

non 1961 *Fletcherina inversa* (de Koninck); *in* Stehli, *J. Paleont.*, 35(3), 453–454, pl. 61, figs 8, 9, 12, 13, 16, 26.

Remarks: The original description of this species was based on a single specimen from 'Muree Quarry, Raymond Terrace, near the junction of the Williams and Hunter Rivers.' The figures leave no doubt that the specimen was an internal mould, so that the reference to nearly equidistant lines of growth on the external surface must have been an inference. De Koninck's collection was destroyed by fire in 1882. I have been unable to collect any further specimens at the Muree Quarry and there appear to be none in the museums in Sydney.

The following points are apparent from the descriptions and figures: shell elongate, with a prominent, acute, almost erect pedicle umbo; dorsal furrow extended almost to the umbo; lateral commissure deeply sinuate, and anterior strongly episulcate.

No hinge plates are shown, and this could be due to faulty drawing, or to the fact that they were not preserved, as is sometimes the case with specimens of *Gilledia* preserved in sandstone, or to the absence of such plates in the original specimen. It seems clear, however, that no hinge plates of the *Fletcherithyris* type were present as were inferred by Stehli (1961a). Though de Koninck's figure 11 shows no sign of dental lamellae, figure 11a does. There is no description of the internal structure in the text.

Etheridge (1898) was the next author to use the name. He grouped under it a wide variety of forms, none of which came from the type locality, and it is clear that two genera and probably three species are represented. These specimens are now preserved in the Australian Museum. The one from Harper's Hill figured on plate 19, figures 1–3, catalogued as F35797 A.M., has the shell preserved, and without etching or sectioning it is not possible to decide its generic position. The broken umbo of the pedicle valve shows no dental lamellae. The specimen of figures 4–6 is almost identical with the Gerringong material assigned to *Fletcher-*

ithyris parkesi (see below). The drawings of figures 7–9 are slightly inaccurate in that the median furrow on the brachial valve does not terminate so abruptly at its posterior end, and the lateral commissure is more deeply sinuate. This specimen, now F35682 A.M., has the narrow outer hinge plates attached to the base of the inner socket ridges. It is discussed below under the genus *Jisuina*. Apart from the fact that the septalium is rather closer to the floor of the valve than normal, the specimen of figures 10–11, now F35679 A.M., is very similar to *F. parkesi* n.sp. The original of figures 12–13 is missing.

Although the name has become well established in Australian literature through its frequent use in faunal lists, specimens so named have been described and figured on only two other occasions, by Etheridge (1919) and Stehli (1961a). In neither case are the specimens from the type locality, nor even from the same region. Etheridge's came from Wollongong and Stehli's from Wyro, both of which localities are on the south coast of New South Wales. Those from Wollongong are here dealt with as *Gilledia ulladullensis alta* sp.nov. and those from Wyro as *Fletcherithyris parkesi* sp.nov.

Since no topotypes can be found at present, a neotype would have to be selected from somewhere other than the type locality. This would be unwise in view of the difficulty of establishing the detailed structure of the hinge plates or the presence of dental lamellae in the original specimen. The alternative is to suppress the name. This course would result in no nomenclatorial upheaval, and would on the contrary clarify the situation considerably since up till now specimens belonging to three genera and probably five species have been covered by the name.

GILLEDIA HOMEVALENSIS sp.nov.

(Pl. 1, Figs 1–27; Pl. 9, Figs 33–41; Text-figs 27–29)

Holotype: F20825 U.Q. from the Homevale Beds, Mount Britton; paratypes F16075, F16187, F20825, F20934, F21092 U.Q. and 11927–11935 A.N.U., all from the Homevale Beds, Mount Britton.

Diagnosis: Shells of moderate size for genus; pedicle valve flattened posteriorly, deeply and broadly sinuate anteriorly; brachial valve highly arched in anterior profile; lateral commissure strongly sinuate; foramen strongly labiate; outer surface of shell with fine furrows; inner and outer hinge plates very narrow; dorsal pedicle adjustor scars short.

Description: Shells of moderate size; in lateral profile, pedicle valve strongly and more or less evenly convex, and brachial valve only very gently arched or flat along crest; in anterior profile pedicle valve gently convex, flattened, or gently concave, and brachial valve highly vaulted and rounded on top; in outline, posterior of shell sub-triangular, maximum width posterior to mid-length and gradually tapering to rounded anterior; lateral and anterior commissures strongly sinuate; sinus in pedicle valve very variable, in some specimens scarcely present at all and in others very broad, extending back well on to posterior half of shell; in some specimens sinus smooth in transverse sections, but in others a slight break in slope present at its margins near front of valve; pedicle umbo moderately developed and sub-erect to erect; foramen mesothyrid to permesothyrid, oval, strongly labiate; deltidial plates conjunct with a distinct line of division between them; beak ridges well rounded to sub-angular.

Surface of both valves ornamented with fine, irregular, linear, discontinuous furrows; furrows on median parts of valve straight but lateral ones become progressively more concave outwards; furrows almost always increase by intercalation, though occasional ones bifurcate; on lateral parts of pedicle valve furrows reach to margins of foramen, but medially a smooth area present for a short distance (5–10 mm.) forward of foramen; smooth patch also on and about 5 mm. forward of umbo of brachial valve; punctae 75–150 per sq. mm.

Pedicle collar strong and entire; complete dental plates never present but some specimens with thickenings forming dental ridges; pedicle adjustor tracks begin just forward of pedicle collar and run one-third length of valve; pedicle adjustor scars themselves well impressed and ranging between sausage-shaped and elongate rhombic in outline; adductor scars ill-defined and elongate cordate in outline; anterior diductor scars ill-defined, lacrymate in outline, wedged in between the adductors and pedicle adjustor, but extending well forward of both; no posterior diductor scars or unpaired pedicle muscle scars observed; vascula media strongly impressed, arise at outer anterior edge of diductor scars, run parallel to within 3–5 mm. of anterior edge of shell and then divide (two or three times?); vascula genitalia very indistinct but almost certainly of lemniscate type (Williams, 1956); very low rounded median ridge runs from mid-length of scars for about two-thirds length of valve.

Sockets non-denticulate; inner socket ridge strong, with anterior part of ventral edge projecting into a cavity on inner face of tooth; denticula and accessory sockets well developed, but loosely interlocking; cardinal process sometimes V-shaped in transverse section, and defined in front by a sharp to moderately sharp change in slope; outer hinge plates very narrow, attached to inner socket ridges at all growth stages and separated from them by a furrow which develops only from about their mid-length; inner hinge plates widely divergent and very low; dorsal pedicle adjustor scars clear, longitudinally ridged or irregularly knobbled; in some specimens pairing of these scars very vague; adductor scars usually well impressed; posterior edge of scars 1–2 mm. in front of anterior edge of inner hinge plates; posterior scar small and more or less oval in outline, with posterior end sometimes slightly pointed; anterior scar slightly longer and up to twice as wide as the posterior, and its inner edge swinging backwards so as to embrace the posterior one; anterior edge of adductor scars at or slightly beyond mid-length of valve; anterior edge of pedicle adjustor scars at any point between front and back limits of anterior adductor scars; vascula media separate immediately in front of pedicle adjustor scars and either run parallel courses almost to margin or continue to diverge slightly; other pallial markings obscured by traces of radial furrows but almost certainly lemniscate; crural bases small; crura short; crural points long, narrow, very acute and curved slightly backwards; descending branches of loop sub-parallel to moderately divergent and directed slightly ventrally with respect to surface of brachial valve; transverse band highly arched in a dorso-ventral sense, and arched weakly posteriorly; length of loop (measured from tip of umbo) approximately two-fifths to one-half length of valve.

Dimensions:

Length	Width	Height	Length Brachial Valve	Height Lateral Commissure	Height Anterior Commissure
33	23	17	30	15	13
30	20	16	27	14	12
30	21	14	27	13	11
27	19	14	24·5	12	10
27	18	13	25	11	9
20	14	10·5	18	7	5·5

Remarks: The surface furrows are very variably developed. In one relatively young specimen they do not appear to occur on the median part of the valve at all, whereas in one well preserved adult they are strongly developed all over. Even among adults, however, there is much variation, particularly in the continuity of individual furrows and in the strength of their development.

In the pedicle valve, the vascula media are very strongly impressed, and since the muscle field has to grow forward over these strong furrows it is often difficult to detect the limits of the various muscle scars.

The sockets are rarely preserved in these specimens. In one small individual in which they are preserved there is no sign of denticulation, but in another larger specimen the crest of the outer socket ridge shows numerous scale-like structures which could be interpreted as very weak denticles.

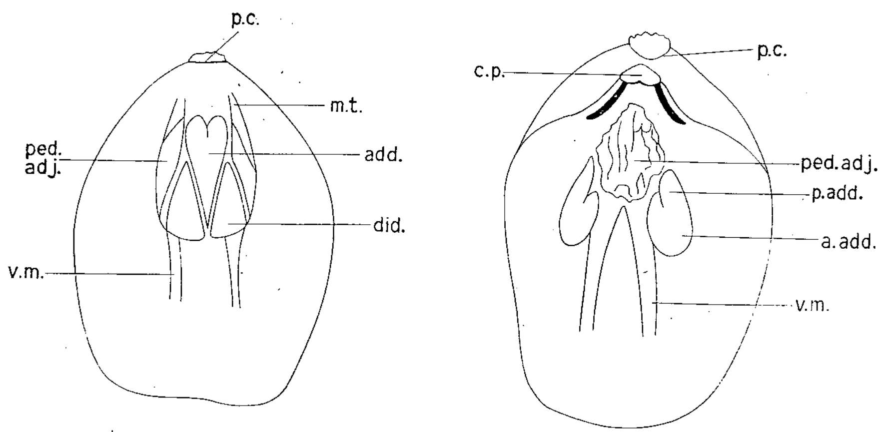


Fig. 27.—Outline diagram of muscle scars of pedicle and brachial valves of *Gilledia homevalensis* sp. nov. drawn mainly from specimens F20825 U.Q. and 11934 A.N.U., both from the Homevale Beds. Pedicle adjustor scars (ped. adj.), muscle tracks (m.t.), adductor carsa (add.), anterior and posterior adductor scars (a.add. and p.add.), pedicle collar (p.c.), vascula media (v.m.) and cardinal process (c.p.).

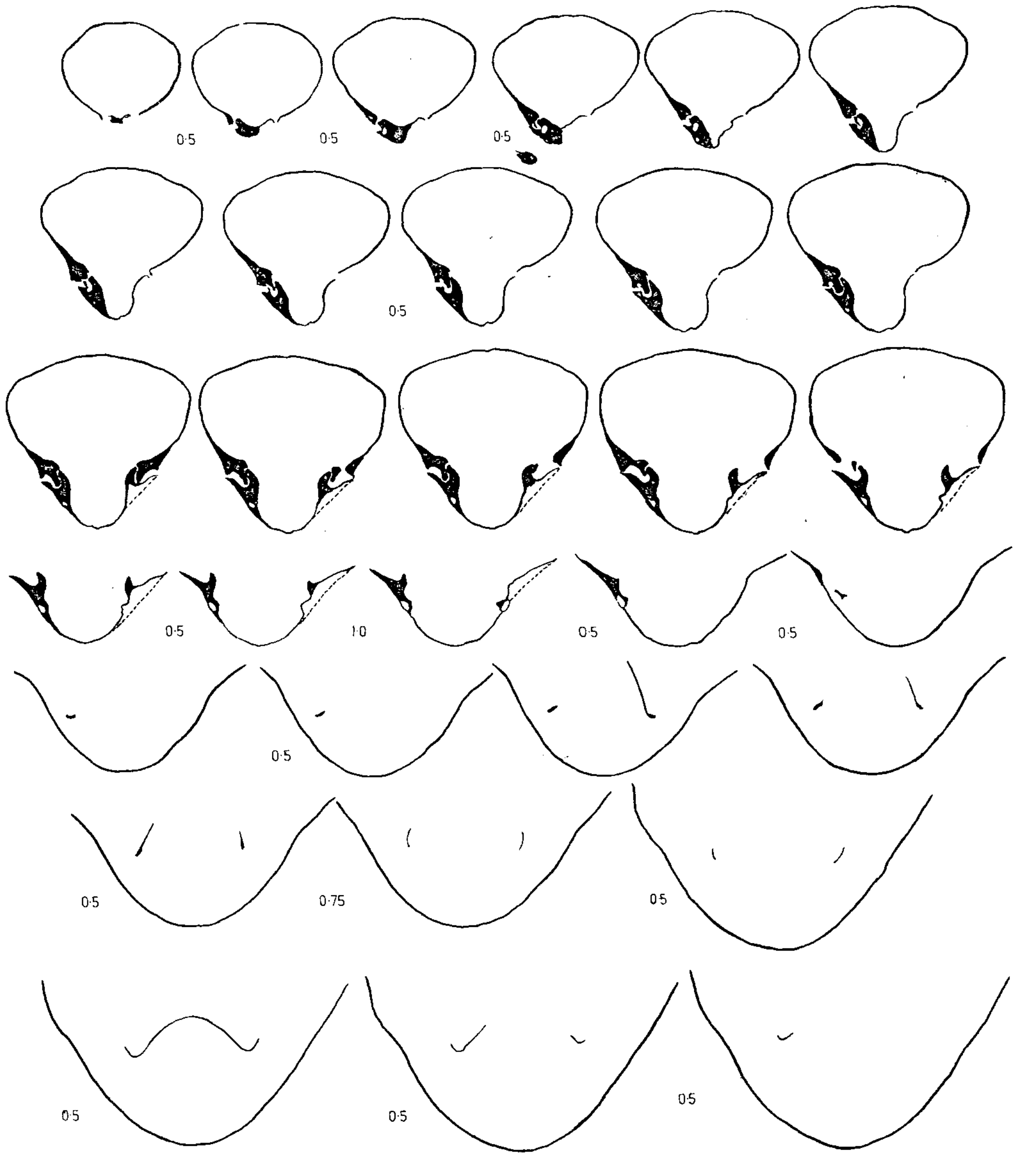


Fig. 28.—Serial sections of a specimen of *Gilledia homevalensis* sp. nov. from the Homevale Beds. Intervals between sections 0.25 mm. unless otherwise stated. x 1.5.

Localities and Horizons: Numerous specimens of *G. homevalensis* have been obtained from several localities both north and south of Homevale in association with the typical Homevale fauna. The most profuse collections come from the Bureau of Mineral Resources '*Dielasma*' bed, locality MC 485 Diel., 1½ miles south-east of Lizzie Creek road crossing of Hazelwood Creek, and M412a about 1 mile south-east of Carinyah Homestead.

Specimens from the latter locality are very similar to the topotypes except that their surface grooves are deeper and somewhat more widely spaced. One individual (CPC 5243a) has a well preserved mould of the loop which has been exposed by excavation. Specimens from the former locality generally have a shallower sinus in the pedicle valve, and a less highly arched lateral commissure than is usual in the topotypes, and in these characters they resemble *G. oakiensis*. They also have relatively longer dorsal pedicle adjustor scars than the topotypes. In this species at least, this character seems to be closely correlated with shell shape, individuals with more convex pedicle valves and only moderately arched lateral commissures having long adjustor scars.

The specimen F2261 G.S.Q. from Turrawalla, near Nebo, belongs to the species. The locality is probably near the base of the Middle Bowen Beds. F2274 G.S.Q. from Dilly, near Springsure (Pl. 1, Figs 25–27), is related to *G. homevalensis* but not conspecific with it. The specimen is proportionately narrower, with a shallower sinus and apparently no fine radial ornament. It has no dental lamellae, and its hinge plates are of the type normal for the species. Two small and one large specimens (F45567–45569 U.Q.) from the Cattle Creek Shale in Cattle Creek are also closely related to the species, but it is not possible to say whether they are conspecific. Three specimens of *Gilledia* are known from the Farley Formation at

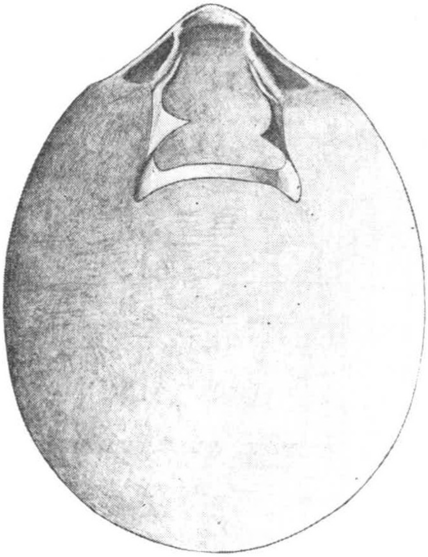


Fig. 29.—Reconstruction of interior of brachial valve of *Gilledia homevalensis* **sp. nov. based on Fig. 28.**

Farley, N.S.W. Of these, F19491 S.U. (Pl. 1, Figs 1–4) is distinguishable from the type *G. homevalensis* by its narrower outline, larger hinge plates and crural bases, and paired dorsal pedicle adjustor scars—a large anterior and much smaller posterior pair. This specimen almost certainly belongs to an undescribed species. The other two specimens are too poorly preserved to contribute any definite information on relationships. One of them, however, shows well developed radial markings even though it is an internal mould.

In Western Australia there are several possible occurrences. From the Wandagee Formation there are two specimens labelled F33359/4 U.W.A. from about $3\frac{1}{2}$ miles west of Binthabooka Creek and $5\frac{1}{2}$ miles west of Lyons River Homestead; three juveniles labelled F27557 from locality WC (25–27) 3 on the west side of the syncline south of Minilya River, and one specimen labelled CPC 5311 from locality ML 83, 217 feet above base of Wandagee Formation, north bank of Minilya River, all of which are very similar in form to *G. homevalensis*. In addition there are seven similar specimens labelled CPC 5304 and one CPC 5305 from G 317 in the Upper Cundlego (? Quinnanie Shale), $5\frac{3}{4}$ miles at 027° from Walbarune Peak. However, they all differ in having hinge plates which are rather larger than is normal for the species, and in lacking fine radial ornament on the shell surface. The muscle scars are not clearly preserved on any specimen. Probably a new species is represented, but for the present they are identified as *G.* cf. *homevalensis*.

Specimens of the same type as those from the Wandagee are known from the Coyrie and Mingenew Formations. From the former there are eight specimens labelled CPC 5306 at locality GW 55, 2 miles south-west of Boolirdi Well, Jimba Jimba, and two labelled CPC 5307–08 at locality GW 48, half a mile north of GW 55. All these specimens are preserved as internal moulds in a hard ferruginous matrix. From the Mingenew Formation there is a single specimen F29908K at a locality 500 yards north-east of the entrance to Eregulla Springs Station, 2 miles from Mingenew.

Finally from the Noonkanbah Formation there are five small specimens labelled CPC 5357 from locality PR 288, near KNF 85, and one labelled CPC 5310 from locality KNF 85, 2 miles at 255° from Bruten's Old Yard, Cherrabun Station, 700 feet above base of formation. These are more transverse than those described above, and I am doubtful whether they belong to the same species.

GILLEDIA OAKIENSIS sp.nov.

(Pl. 8, Figs 32–41; Text-figs 30–32)

Holotype: F21269 U.Q.; paratypes F21270, F21312–14, F24060–64 U.Q.; all from the Middle Bowen Beds in Oakey Creek, 3–$3\frac{1}{2}$ miles south-south-west from Homevale Homestead, near north-west corner of Portion 17, Parish Mount Britton.

Diagnosis: Large pedicle valve convex toward umbo, flattened or slightly sinuate anteriorly; lateral commissure moderately arched; surface smooth, without fine irregular furrows; foramen large; labrum broad; little thickening in umbo of pedicle valve; pedicle collar weak; loop incomplete; both inner and outer hinge plates relatively large.

Dimensions:

Length	Width	Height	Length Brachial Valve	Height Lateral Commissure	Height Anterior Commissure
55	38	29	49	c 23	c 17
48	35	24	42	c 17	c 11
c 45	28	21	41	19	15
42	32	c 20	37	16	....
31	21	13	28	11	c 8
23	16	10	21	7·5	4·5

Remarks: Topotypes are particularly variable in the shape of the anterior part of the pedicle valve (see Text-fig. 30). Many specimens are distorted and the range may be greater than illustrated. Muscle scars are poorly defined in both valves, and individual muscle scars cannot be detected. This species is obviously derived from *G. homevalensis*, which it replaced. The two species show some overlap in the degree of sinuation of the pedicle valve and in the arching of the lateral commissure, and in overall shape they are very similar. However, they can be easily distinguished by the presence of radial surface furrows in *G. homevalensis*, which also has a smaller pedicle foramen and a stronger pedicle collar. Further, it never reaches the large size of *G. oakiensis*. *G. pelicanensis* differs in its more convex and highly arched pedicle valve and its much smaller inner and outer hinge plates.

Localities and Horizons: The type locality is in the Middle Bowen Beds at an indefinite interval above the Homevale Beds. Slight structural disturbance and alluvial cover obscure the relationship. Recent measurements by the Bureau of Mineral Resources suggest an interval of approximately 1200 feet. Here it is in association with *Notospirifer extensus tweedalei* and a large species of *Terrakea*, and it forms part of Fauna IIIa of Dickins (1964). The species also occurs in the equivalent of the Glendoo Member on the western side of the Bowen Basin at locality B634, lat. 20° 56′ 30″ S, long. 147° 41′ 15″ E. Here the specimens are larger than the types, but otherwise are entirely similar.

Three specimens (F45570–F45572 U.Q.) and several labelled CPC 6710 from the Stanleigh Formation 3 miles east of Crystal Hill Homestead in the Springsure area are confidently assigned to the species. They occur with *Notospirifer extensus.*

From the Dabool Formation, Weston Creek, near Poatina, Cressy, Tasmania, there are numerous specimens, 25229–37, 25240–42, 22544, 22548 and 22550 U.T., which doubtfully are placed here. They are not well preserved, and several of them have a boss between the myophores, which is unknown in the Queensland specimens. It is possible that the Dabool specimens are more closely related to *G. cymbaeformis*, but that species is too poorly known to enable a definite statement to be made.

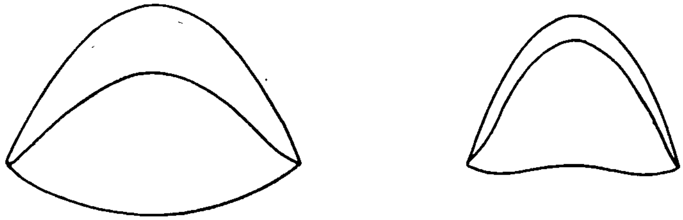


Fig. 30.—Reconstructed anterior profiles of two specimens, F21313 U.Q. and 11916 A.N.U., of *Gilledia oakiensis* sp. nov. showing wide variation in size of sinus in pedicle valve and height of fold in commissure.

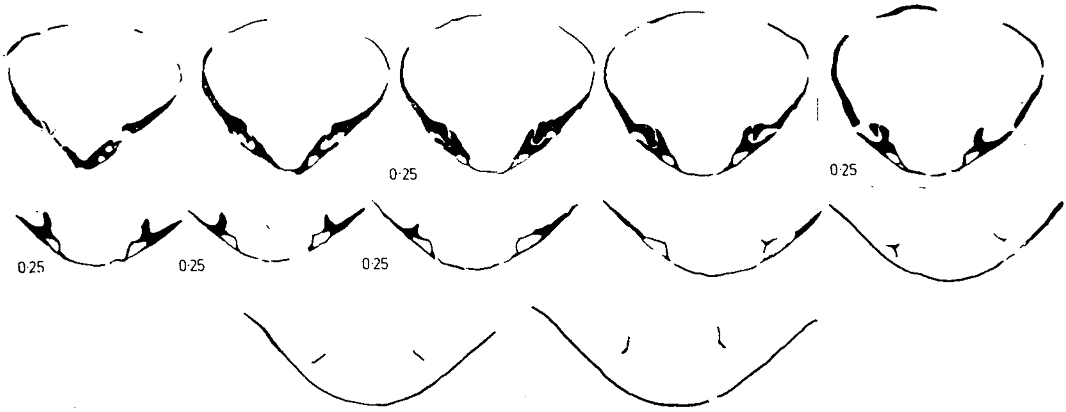


Fig. 31.—Serial sections of a young individual of *Gilledia oakiensis* sp. nov. from the type locality. Intervals between sections 0.5 mm. except when otherwise stated. x 3.

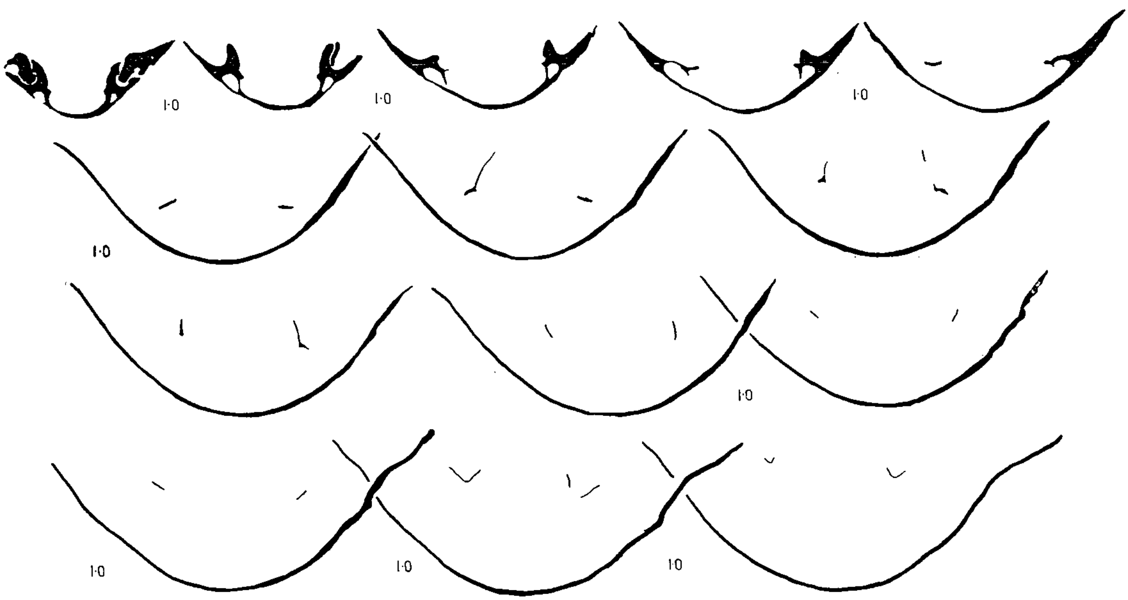


Fig. 32.—Serial sections of an adult individual of *Gilledia oakiensis* sp. nov. clearly showing the loop shape. Intervals between sections 0.5 mm. unless otherwise stated. x 2.5.

Gilledia woolagensis sp.nov.

(Pl. 9, Figs 42–47)

Holotype: F31563a U.W.A.; paratypes F31563b–h and F31564a–j U.W.A.; all from the basal part of the High Cliff Sandstone, Woolaga Creek, Mingenew District, Western Australia.

Diagnosis: Externally very similar to *G. homevalensis*; interior of umbo of pedicle valve unthickened; pedicle collar strong and entire; outer hinge plates joined to socket plates only at their posterior extremity, and joined directly to wall of valve in front of this; inner hinge plates close to, and usually shorter than, outer hinge plates; socket plates slender and invariably shorter than the hinge plates; adductor scars in the brachial valve as for the genus; dorsal pedicle adjustors coarsely ridged and extending approximately to the front edge of the adductors.

Dimensions: The specimens are too badly crushed to provide unequivocal measurements. The two specimens below have been partly reconstructed.

Length	Width	Height	Length Brachial Valve	Height Lateral Commissure	Height Anterior Commissure
33	22	15	30	13	11
32	21	14	29	13·5	12

Remarks: Almost all the available specimens are broken, but they are well enough preserved to show that on external shape and umbonal characters they could not be distinguished from *G. homevalensis.* Well preserved exteriors, however, show no sign of fine radial grooving. The arrangement of the hinge plates is remarkably constant and provides a ready means for distinguishing the two species. In this feature *G. woolagensis* resembles the lectotype of *G. cymbaeformis.* One remarkable feature is the small size of the sockets and socket plates in such a large species. This is probably to be correlated with the general absence of shell thickening posterior to the teeth in the pedicle valve. The muscle and pallial scars in the pedicle valve are not clearly defined.

Localities and Horizons: G. woolagensis is abundant at the type locality. It is rare in the Mingenew Formation at locality PB 15, south side of Fossil Hill, Eregulla Springs, specimen CPC 5312; and 500 yards north-east of entrance to Eregulla Springs Station, 2 miles from Mingenew, specimen F29008R U.W.A.

GILLEDIA ULLADULLENSIS sp.nov.

(Pl. 7, Figs 1–23; Pl. 15, Figs 8–11; Text-figs 33–34)

1961 *Fletcherina inversa* (de Koninck) (in part); *in* Stehli, *J. Paleont.*, 35(3), 453, pl. 61, figs 8, 9, 12, 16, 26; *non* pl. 61, fig. 13.

Holotype: F20779 A.M.; paratypes F6041–6045 U.N.E.; F20703, F20818, F21828, F22828, F24126, F24129–30, F24269, F24270, F39491 A.M.; all from Wyro (Lagoon Head), south of Ulladulla, New South Wales.

Diagnosis: Moderate size; adults distinctly episulcate; fold in anterior commissure very high, and median plication in fold prominent; surface partly covered by fine radial furrows which have a fan-like arrangement in the median plications; outer hinge plates strong and attached directly to inner socket ridges; cardinal process with a variable median boss.

Description: Shell of moderate size, largest individual about 42 mm. long; outline elongate; width between two thirds and five-sixths of length; height about half length, though rather variable; juvenile stages simply biconvex and rectimarginate up to about 8 mm. in length, followed by very short uniplicate and sulciplicate stages; adult shells episulcate; in lateral profile pedicle valve strongly arched, especially toward umbo, and brachial valve more gently and evenly arched, or tending to flatten out or increase in convexity anteriorly; in anterior profile brachial valve much more convex than pedicle valve; pedicle umbo rather prominent and suberect; foramen moderately to strongly labiate and permesothyrid; beak ridges rounded; deltidial plates short, conjunct, and usually hidden beneath labrum; plication in sinus and depression in fold of variable strength, and usually well rounded, but tending in some specimens to be sub-angular; margins of sinus divergent at angles between 15° and 20°; furrows bordering fold deepen rapidly in some specimens, but become scarcely more than flattened regions in others; surface with fine discontinuous radial furrows.

Pedicle collar strong; umbonal thickening very weak; muscle scars very indistinct save for elongate pedicle adjustors of usual pattern for *Gilledia*; vascula media running down, or just on outer sides of, axes of depressions bordering median plication; low median ridge commences a few millimetres forward of edge of foramen and runs from half to almost entire length of shell.

Inner socket ridges thick; whole length of outer hinge plates attached directly to the inner socket ridges and not extending forward of their front edges; both hinge plates and inner socket ridges almost coplanar over most of their length; crural bases very weak, developing only near anterior end of hinge plates; crura slender and short; crural points long, slightly recurved at tips; loop short and without transverse band; myophores variable in size, flattened or slightly excavate, lacrymate to sub-rhombic in outline, with tips near mid-line and axes directed antero-laterally; rounded or slightly bilobed boss of variable size between myophores; floor of valve between inner hinge plates and up to 10 mm. forward of umbo in adults, occupied by poorly impressed dorsal pedicle adjustor scars; adductor scars poorly known but lying on flanks of fold and encroaching onto axes of bordering furrows; vascula media on, or just beside, crests of fold plicae.

Dimensions:

Length	Width	Height	Height Fold	Height Median Plication	Width Median Plication	Angle of Fold
42	28	28	18	5	10	15°
c 35	22	21	c 11	....	c 7	14°
34	25	20	17	4	11	20°
32	23	17	9	3·5	10	....
32	26	17	12	3	8	18°
29	21	14	8	2	7	....
25	20	14	10	4	8	17°
25	18	15	10	3	5	11°
17	12	9	5	....	4	14°

Remarks: The external features of the specimen figured by Stehli (1961a, pl. 61, figs 8, 9, 12, 16, 26), as *Fletcherina inversa* (de Koninck) suggest that it is a *Gilledia ulladullensis.* The specimen is from Wyro, and judging from the illustrations it must be about 30 mm. long. *Fletcherithyris parkesi* is the only plicate species of *Fletcherithyris* known from Wyro and it is generally very much smaller than this, the largest specimen being only 20 mm. long. Specimens of *G. ulladullensis,* however, are commonly of this size. The episulcate plication of Stehli's specimen, too, is typical of *G. ulladullensis* and is unknown in *F. parkesi.*

Among the topotypes there is considerable variation in both the degree and form of the plication, as well as its time of development during ontogeny. This is well shown in the illustrations and dimensions. In only one of the topotypes (F39486 A.M.) is there any indication of a uniplicate or sulciplicate initial stage: all the others are rectimarginate and pass through the stages outlined in the description. The degree of episulcation varies from individual to individual, but in most it increases rapidly with increasing age.

Overall shell proportions are variable at all stages of growth.

The details of external ornament are known only from three incomplete specimens. The fine furrows are curved and radially arranged on the lateral slopes of both valves, and have a fan-like arrangement in the deep furrows of the sinus and the fold. They are absent along the crests of the plicae in both valves, and this does not appear to be due to wear during preservation. The boss between the myophores on the cardinal process is very small on some specimens and very pronounced on others. The sectioned specimen (Text-fig. 34) has a bilobed boss.

Localities and Horizons: G. ulladullensis is relatively abundant and well preserved at the type locality, but exteriors are difficult to prepare because of the brittle calcareous matrix.

From a horizon ' over 18 inch coal seam, Bowen River Coalfield,' is a single specimen (F2231 G.S.Q., Pl. 7, Figs 4–6) similar in form to young specimens of this species, but it has no boss between the myophores of the cardinal process and the furrow on the fold extends further toward the umbo than normal. The horizon is near or just above the top of the Collinsville Coal Measures. Another individual

(14093 A.N.U., Pl. 7, Figs 1–3) collected by E. Webb from a similar horizon in a gully 20 chains north-west of No. 25 Bore, and 3–4 miles west of Scottville, Bowen River, is much narrower than F2231 G.S.Q., but compares very closely with some of the topotypes.

A single pedicle valve, CPC 5325, from locality B683, lat. 20° 56′ 45″ S, long. 148° 08′ 00″ E, near Exmoor Homestead, which is in the Middle Bowen Beds about 500 feet below the Big *Strophalosia* Zone, probably belongs to the species. Associated with it are several specimens of *Fletcherithyris parkesi* sp. nov.

Gilledia ulladullensis alta subsp. nov.

(Pl. 7, Figs 24–32; Text-fig. 33)

1919 *Dielasma inversa* (de Koninck); *in* Etheridge, *Rec. geol. Surv. N.S.W.*, 12(9), 183, pl. 29, figs 3–4.

Holotype: F49647 A.M.; paratypes F45314–21 A.M.; all from the Capertee Group at Rylstone, New South Wales.

Diagnosis: Shell similar to *G. ulladullensis*, but with less convex valves, less marked episulcation, a larger foramen with a more massive labrum, and a greater overall size.

Dimensions:

Length	Width	Height	Height Fold	Height Median Plication	Width Median Plication	Angle of Fold
55	c 38	c 30	19	5	16	15°
c 50	.4	24	17	4	12	14°
47		2	8	1	10	10°
46	28	4	16	2·5	9	11°
36	c 26	16	c 11	3	11	14°

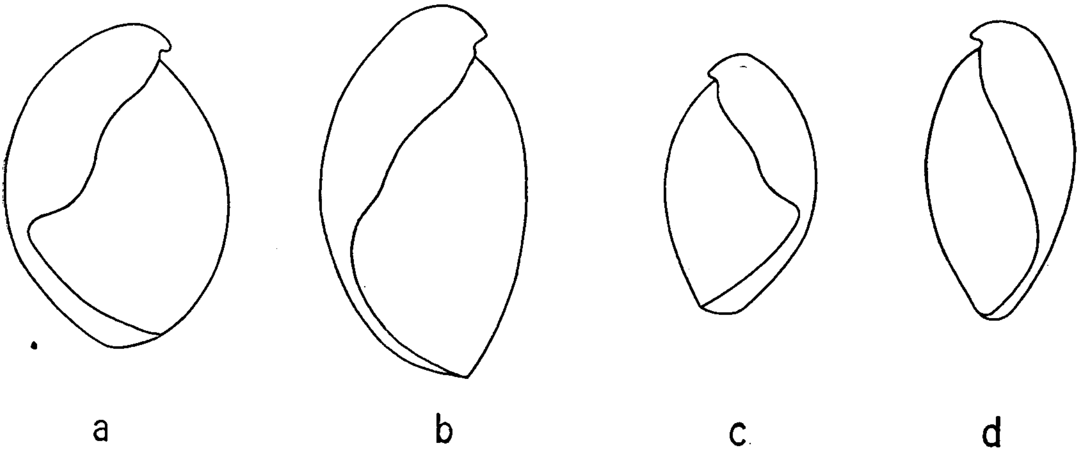


Fig. 33.—Lateral profiles of *Gilledia ulladullensis* sp. nov. (a, c) and *G. ulladullensis alta* sub sp. nov. (b, d), showing differences in plication. x 1.

Remarks: The largest individual available is about 55 mm. long. The convexity of both valves is distinctly less than that of *G. ulladullensis,* as can be seen by comparing the profiles of specimens of similar sizes in Text-figure 33, as well as from the tables of dimensions. Episulcate commissures are developed on all adult specimens of *G. ulladullensis,* and the resulting furrows bordering the median plication in the brachial valve are often quite sharp. Some large individuals of this new subspecies never reach the episulcate stage but remain sulciplicate, and in those individuals which become episulcate, that stage is usually reached relatively late in the ontogeny. Because of the greater episulcation, the height of the fold is relatively greater in the parent species, as can be seen from the tables of dimensions.

No external moulds are available, but some of the internal moulds show evidence of the presence of fine radial surface furrows. Several specimens (but not all) have a small boss between the myophores of the cardinal process.

Two highly variable features among the types are the depth of the median plication in the fold of the brachial valve, and the overall width of the fold itself. The two features are clearly correlated, the broader plications having the deeper median plication. This is well illustrated on Plate 7, Figures 26 and 27.

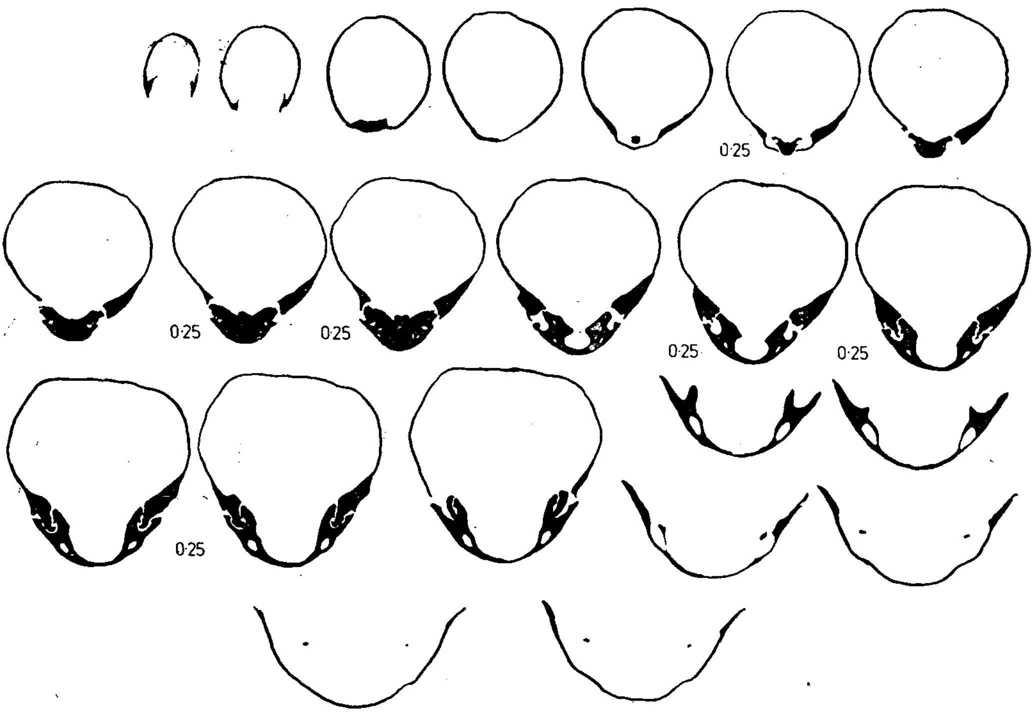


Fig. 34.—Serial sections of a young adult specimen of *Gilledia ulladullensis* sp. nov., F24269 A.M. Note boss between myophores of cardinal process. Intervals between sections 0.5 mm. unless otherwise stated. x 2.

Localities and Horizons: The type locality is just recorded as Rylstone, and the specimens are almost certainly not from the one point. The probability is, however, that they all come from the Megalong Conglomerate at the base of the Capertee Group.

The species is also known from the Gerringong Volcanics on the south coast of New South Wales. Three specimens, F22832, and the two figured by Etheridge (1919), F7951 and F16879 A.M., come from Wollongong, and one, F22831 A.M., from Black Head, Gerringong.

GILLEDIA JERVISENSIS (Etheridge), 1919

(Pl. 15, Fig. 12)

1919 *Dielasma jervisensis* Etheridge, *Rec. geol. Surv. N.S.W.*, 12(9), 183, pl. 28, fig. 4.

Material: F268 A.M. from Cabbage Tree, north side of Jervis Bay. This is possibly in the Nowra Sandstone, but may be as low as the Upper Conjola Formation.

Remarks: Only the type specimen is known, but it is particularly well preserved. It suggests comparison with *G. culburrensis*, but as Etheridge pointed out the low convexity and the almost circular outline of the brachial valve are quite distinctive. It is unlikely that these features are the result of distortion. Other unusual characters are the broad outer hinge plates and the strong growth halts. It is impossible at present to decide whether any or all of these characters are of systematic significance, or are merely individual modifications.

GILLEDIA PELICANENSIS sp.nov.

(Pl. 5, Figs 5–9; Pl. 15, Figs. 5–7)

1892 *Dielasma cymbaeformis* (Morris); *in* Jack & Etheridge, *Geol. Surv. Qld Publ.*, 92, 225, pl. 9, figs 10–11.

Holotype: F1485 G.S.Q. from the *Streptorhynchus pelicanensis* Bed, Bowen River Coalfield.

Diagnosis: Shell large for genus; pedicle valve strongly convex posteriorly, flattened or slightly plicate anteriorly; umbo of pedicle valve long and narrow; lateral commissures slightly sinuate; inner and outer hinge plates narrow; dorsal pedicle adjustor scars long.

Description: Shell large, maximum length observed about 70 mm.; in anterior profile valves rather strongly convex; in lateral profile pedicle valve strongly and evenly convex, brachial valve much flatter; both lateral and anterior commissure slightly sinuate; maximum width at about anterior third; anterior well rounded; outline elongate and narrow with a long protuberant pedicle umbo; cardinal margin terebratulid to sub-terebratulid; pedicle umbo sub-erect; beak ridges very well rounded; foramen large (about 7 mm. wide in a specimen about 70 mm. long), strongly labiate, and permesothyrid; pedicle valve apparently developing slight median fold on anterior part of valve.

Pedicle collar strongly developed and complete; shell thickening supporting teeth not very strong; muscle scars poorly defined except for lateral pedicle adjustors, which are very long and lie outside lines of vascula media; the latter parallel, close together, and slightly raised on middle of shell.

Cardinal process in some specimens with slight median boss between myophores; outer and inner hinge plates very narrow and barely separating from floor of valve (Pl. 5, Fig. 6); crural bases variably developed; crura and loop unknown; dorsal pedicle adjustor scars corrugated, very broad and long, extending to mid-length of valve, and in width equal to about one-third total width of valve; adductor scars large, with posterior edges well forward of, and medial to, front edge of inner hinge plates, and anterior edges slightly behind those of pedicle adjustors; punctae irregularly arranged or in irregular rows, and number 120–150 per sq. mm.

Dimensions:

Length	Width	Height	Length Brachial Valve	Height Lateral Commissure	Height Anterior Commissure
c 68	47	33	c 58	23	....
c 52	36	23	41	12	7

Remarks: G. pelicanensis is based on rather scanty material, but since sufficient detail can be determined to permit a ready separation from the other described forms, and since it comes from a stratigraphic position much higher than any other members of the genus in Queensland, it warrants a new name. Previously it has commonly been used by overseas workers as a basis for comparison with *G. cymbaeformis*. However, it is readily separated from that species by its very elongate pedicle umbo, narrow outline, unflattened pedicle valve, much larger ventral pedicle adjustor scars, and smaller inner and outer hinge plates. It is separated from *G. culburrensis* by its elongate outline, longer dorsal pedicle adjustor scars, and the absence of fine radial surface ornament.

The material is too scanty to give much idea of the variability, but the holotype is wider, and flatter across the anterior part of the pedicle valve, than the other specimens. Etheridge (1892, p. 225; pl. 9, figs 10–11) described and figured the holotype as *Dielasma cymbaeformis.* His comments on the well displayed ' impressions of the strong dental plates ' obviously refer to the inner socket ridges of the present terminology.

Localities and Horizons: The type specimen is labelled ' Mouth of Coral Creek, Bowen River Coal Field'. This locality is probably on the outcrop of the *Streptorhynchus pelicanensis* Bed, or slightly above it. A further specimen, F5252 G.S.Q., is labelled ' ? Coral Creek, *Derbyia* Bed'. This is the *S. pelicanensis* Bed. Another individual, CPC 5299 from 15 feet below the *S. pelicanensis* Bed near Collinsville, in Corduroy Creek, 6400 feet south of the railway viaduct, is typical of the species.

A single specimen, F2269 G.S.Q., from Pelican Creek, CPA 21, half a mile from the eastern boundary of the Bowen River Coalfield, is in a similar matrix to the types, and the locality is known to be on a similar horizon. This specimen is narrower than the holotype, and closer to F5252 G.S.Q. mentioned above.

The pedicle valves, F2243–2244 G.S.Q., labelled Gully Head, 20 chains north-north-west No. 3 Camp, CPA 21, Bowen River Coalfield, are from a similar horizon. F2243 is more highly curved longitudinally than is normal, but is otherwise characteristic. It shows well the very long labrum on the foramen, and the long deltidial plates. F2244 has been heavily thickened in the umbo, and has a different appearance from all other specimens. Since it is also in a different matrix, I am doubtful of the accuracy of its locality label.

From the *S. pelicanensis* Bed in Rosella Creek, 2½ miles south-east of Havilah Homestead, Bowen Basin, Isbell has collected several small specimens, F24065–7, F24069 U.Q., which probably belong to this species. From the same locality there is also a large specimen, F24068 U.Q., with the pedicle umbo missing. It has a rounded fold on the pedicle valve, a shallow sinus in the brachial valve, rather broad outer hinge plates and high inner hinge plates, all of which distinguish it from the types of *G. pelicanensis.* However, it does have the long, broad dorsal pedicle adjustor scars and very large dorsal adductor scars of that species and there is probably a close relationship between the two.

Numerous specimens from the Nowra Sandstone at Tianjarra, F19262, 19312–3, 20286, 20301, 22278, 22742, 22747 A.M., and Jerrawangala, South Coast, N.S.W., F2766 A.M., are also probably best compared with this species. They do not reach the size of the largest of the types, and they tend to become gently sulciplicate much earlier in their ontogenies. In addition none of the specimens has the brachial valve sufficiently well preserved to show the long dorsal pedicle adjustor scars clearly. On the other hand the pedicle umbo is long and narrow in the manner of *G. pelicanensis,* and the inner socket ridges are longer and finer than they are in any other species. The differences are not sufficient to outweigh the similarities, and the specimens are identified as *Gilledia* cf. *pelicanensis.*

GILLEDIA CULBURRENSIS sp.nov.

(Pl. 3, Figs 7–21; Pl. 17, Figs 3–5; Text-figs 35–39)

1961a *Gilledia cymbaeformis* (Morris); *in* Stehli, *J. Paleont.*, 35(3), 451, pl. 61, figs 1, 2, 5, 6.

Holotype: CPC 5337; paratypes CPC 5338–5342, and 14000–14022 A.N.U., all from the ? Nowra Sandstone, Culburra Headland (Wheeler's Point), east of Nowra, New South Wales.

Diagnosis: Shell large; pedicle valve not sinuate anteriorly and highly convex posteriorly; surface of both valves covered with fine radial furrows; lateral commissure weakly sinuate; umbo of pedicle valve thickened internally in many specimens; inner and outer hinge plates relatively broad.

Description: Shell large, maximum length observed about 70 mm.; in anterior profile valves sub-equally and strongly biconvex; in lateral profile pedicle valve evenly convex, and more strongly so than brachial; maximum width of shell well forward of mid-length; anterior well rounded; commissure weakly arched in both lateral and anterior profiles; cardinal margin terebratulid in juveniles and markedly sub-terebratulid in adults; pedicle umbo generally sub-erect, but occasionally erect; beak ridges moderately rounded; foramen large (4–5 mm. diameter in specimens 50–60 mm. long), mesothyrid to permesothyrid, and labiate with the lip of moderate length; pedicle valve without sinus, but some specimens with very slight rounded median fold on anterior quarter; brachial valve in such specimens with corresponding flattening; surface with fine radial furrows generally almost completely covering both valves, those on the median parts tending to be straight and the lateral ones being strongly curved.

Pedicle collar moderately to strongly developed, and complete; dental lamellae absent, but umbonal shoulders of pedicle valve commonly strongly thickened in adults to produce pseudo-dental lamellae (Pl. 3, Figs 10 and 20); teeth supported on thickened platforms bordering the delthyrium, even in young specimens; muscle field long and narrow often depressed into the shell, and with its margins diverging at angles of 12–15°; outlines of individual scars faint, arrangement as in Text-figure 35; vascula media running parallel and close together, but pattern of other pallial trunks obscured by development of radial furrows through all layers of test and on internal surface; small denticula fit loosely into shallow sockets.

Cardinal process open V-shaped in transverse section, but sometimes with a small boss between the myophores; inner socket ridges thick, strongly curved and extending well forward of the teeth; in juveniles, outer hinge plates relatively wide for genus and attached to inner socket ridges well up from floor of valve, but in some adults attached directly to floor of valve near anterior extremities (cf. Pl. 3, Figs 7 and 10); junction between inner and outer hinge plates angular at all except early growth stages; crural bases strong and sharp; crura very short; crural points high but short, slightly concave toward each other and slightly hooked backwards at their ventral tips; in transverse section general plane of crus at 130°–150° to general plane of crural point; descending lamellae short and parallel; transverse band incomplete; distance between brachial umbo and anterior edge of brachidium between 0·3 and 0·4 of total length of brachial valve; adductor scars lightly impressed, and relatively small—about 8 mm. long and 3 mm. wide in a valve about 42 mm. long; pedicle adjustor scars long and narrow, terminating about 3 mm. behind the front edge of the adductors.

Dimensions:

Length	Width	Height	Length Brachial Valve	Height Lateral Commissure	Height Anterior Commissure
52	38	28	48	17	9
49	37	28	44	16	8
46	33	22	41	15	8
36	26	17	32	10	6·5
21	16	9·5	19	5·5	3·5

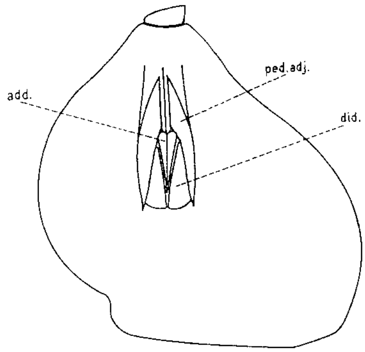


Fig. 35.—Reconstruction of muscle field on an internal mould, CPC 5342, of *Gilledia culburrensis* sp. nov. add = adductor scars; ped. adj. = pedicle adjustor scars; did = diductor scars.

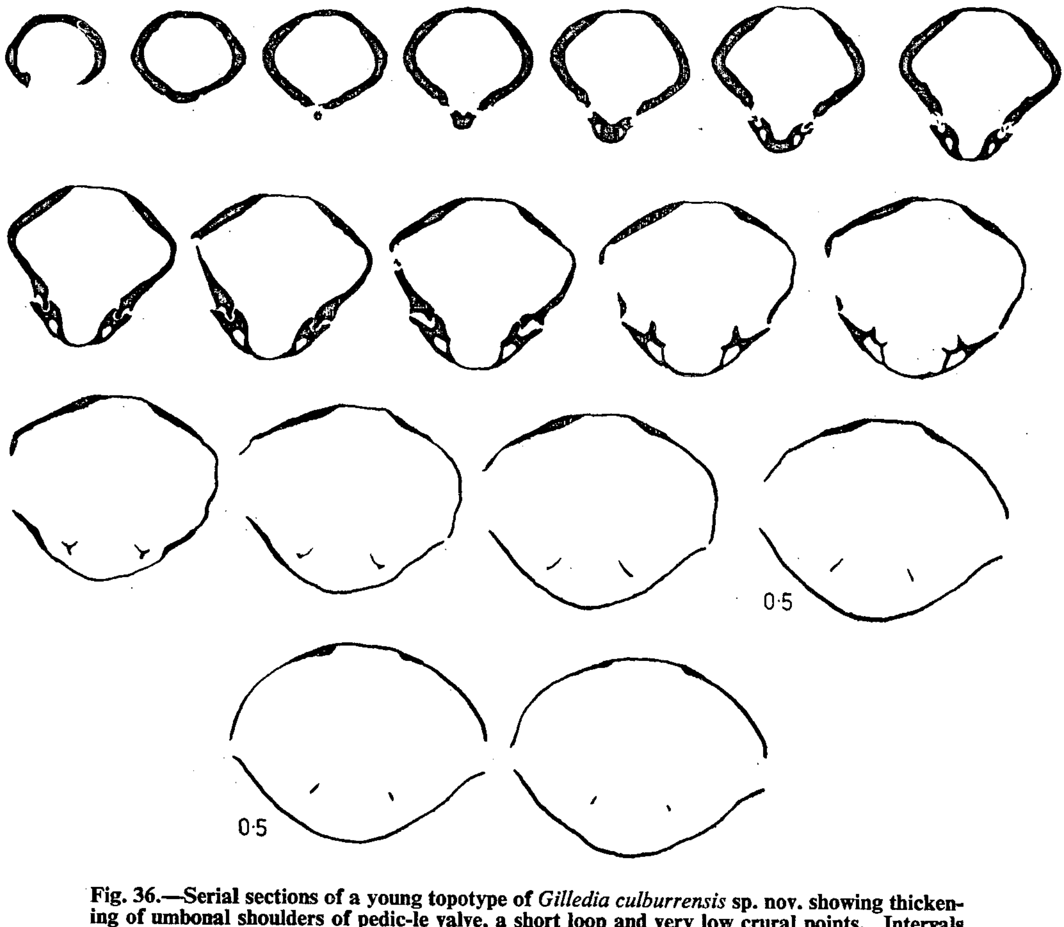


Fig. 36.—Serial sections of a young topotype of *Gilledia culburrensis* sp. nov. showing thickening of umbonal shoulders of pedic-le valve, a short loop and very low crural points. Intervals between sections are 0.25 mm. unless otherwise stated. x 2.

86074—(4)

Remarks: At the type locality, *G. culburrensis* is well preserved from the point of view of detail, but many specimens are broken or distorted. The range of variation in the shape is not so great as it may first appear to be.

The amount of shell thickening in the umbo of the pedicle valve varies widely. In CPC 5342 (Pl. 3, Fig. 9) it is negligible, and the muscle scars are almost flush with the general shell surface. In CPC 5336, 14004 A.N.U., and 14002 A.N.U. (Pl. 3, Figs 7–8, 10, 20), there is marked thickening and, especially in CPC 5336, pseudo-dental lamellae are developed. The muscle scars are situated in depressions which are bounded laterally in CPC 5342 by sharp ridges. The surface of the thickening of the umbonal shoulders in CPC 5339 is coarsely pitted, suggesting the presence of genital trunks of the saccate type.

The arrangement of the outer hinge plates also varies. In most specimens they are attached to the inner socket ridges throughout ontogeny, but in a few they migrate on to the wall of the valve in the adult stage; 14004 A.N.U. (Pl. 3, Fig. 10) is a specimen in which the plates migrated early in the ontogeny. CPC 5336 is an aberrant specimen in which a second plate in addition to the inner hinge plate joins the outer hinge plate to the wall of the valve.

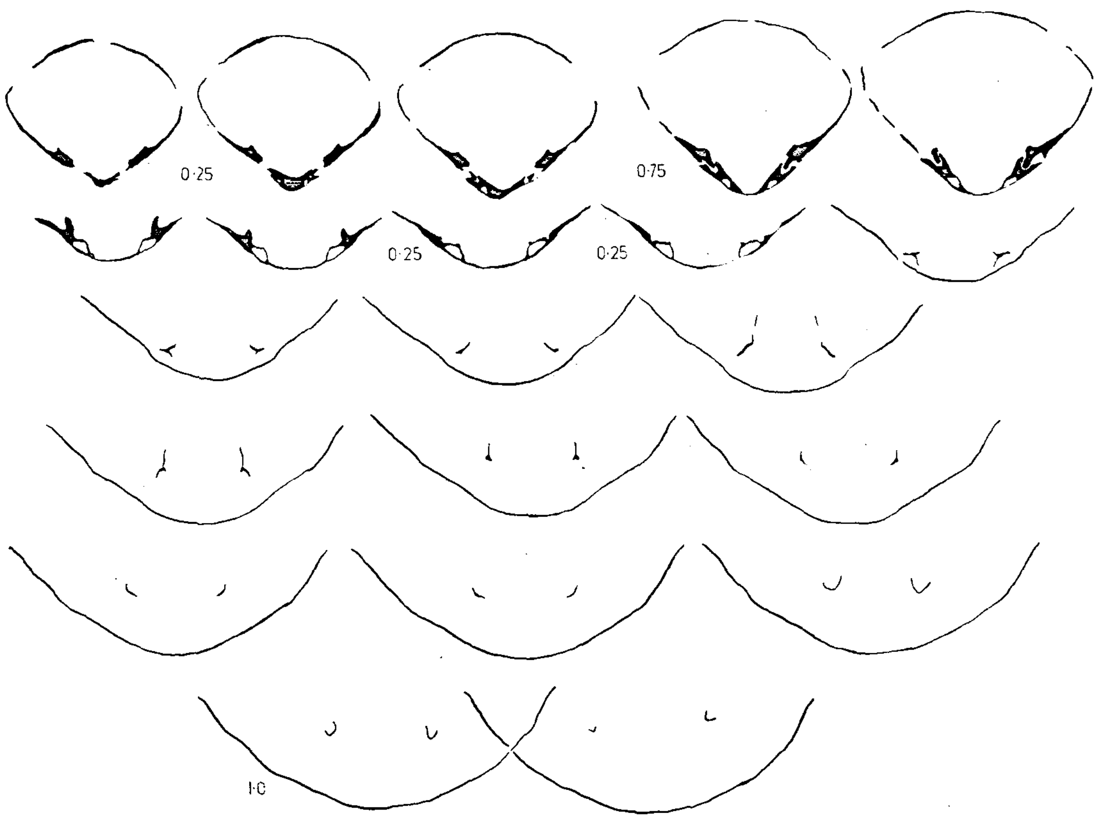


Fig. 37.—Serial sections of a young adult topotype of *Gilledia culburrensis* sp. nov. with outer hinge plates attached to base of the inner socket ridges throughout. Intervals between sections 0.5 mm. unless otherwise stated. x 2.

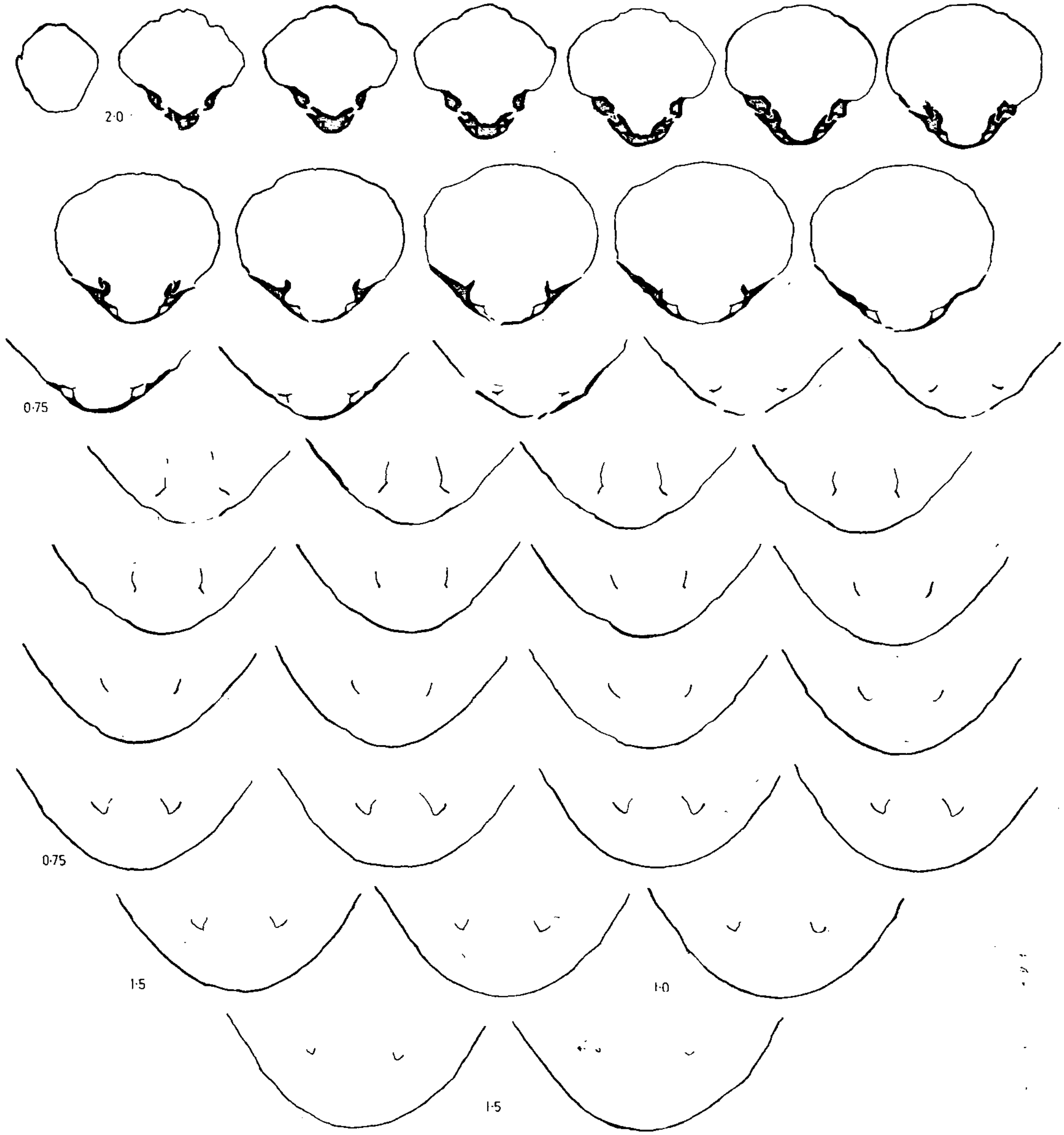


Fig. 38.—Serial sections of a large adult topotype of *Gilledia culburrensis* sp. nov. showing massive thickening of pseudo-dental lamellae, outer hinge plates joined to valve wall in front, recurved tips on crural points, and incomplete transverse band. Intervals between sections 0.25 mm. unless otherwise stated. x 1.

G. culburrensis could be confused with *G. oakiensis* sp.nov., but can be distinguished by its non-sinuate pedicle valve, more strongly labiate foramen, stronger pedicle collar, thickened umbo in some adult specimens, little impressed muscle field, and surface with fine radial furrows. *G. pelicanensis* sp.nov. has a longer and narrower umbo in the pedicle valve, longer dorsal pedicle adjustor scars, and, so far as I can determine, no radial ornament.

Localities and Horizons: The type locality is Culburra Headland (also called Wheeler's Point), which is probably in or just below the Nowra Sandstone. Specimens from the Conjola Formation at Wyro (also called Wairo or Lagoon Head), near Ulladulla, cannot be clearly distinguished from those from the type locality (F20734–20736, F20769–20773, F20654, F20362, F39483, F39491, all A.M.). The muscle field of the brachial valve is better preserved in one of these specimens than on any of the types (F20770 A.M., Pl. 3, Fig. 21). The dorsal pedicle adjustor scars are long and broad, well separated at their anterior edge, and strongly ridged. They reach a point slightly more than two-fifths of the length of the valve from the umbo. The adductors also are broad structures, somewhat club-shaped, and reach a point only about 3 mm. farther forward than the pedicle adjustors in a valve some 48 mm. long.

The species is also relatively common at Warden's Head, Ulladulla (F45143 A.M. and numerous specimens A.N.U.), and at North Head, Ulladulla (F22110, 22115, 22130, 22085 A.M.). The specimens from these localities are almost all

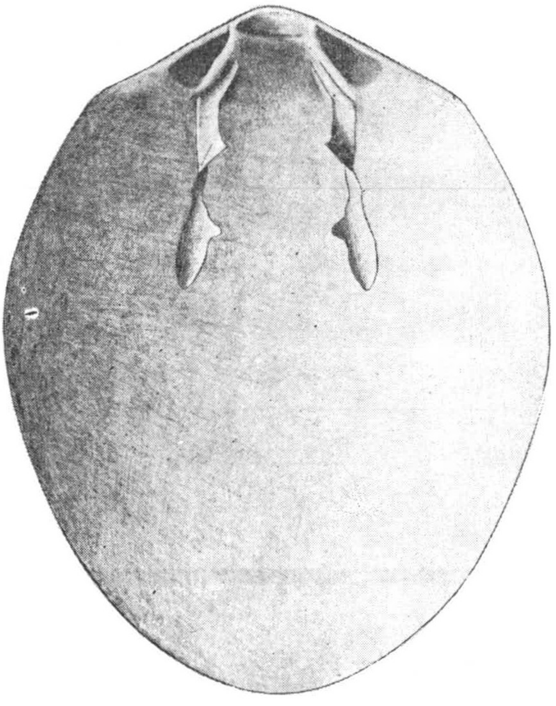


Fig. 39.—Reconstruction of interior of brachial valve of *Gilledia culburrensis* sp. nov. based on Fig. 38.

badly crushed, and as a result some of the internal moulds seem to show hinge-plate arrangements comparable with *Marinurnula* Waterhouse; but no unquestionable examples of *Marinurnula* have been found at these localities.

The Ulladulla and Wyro localities have recently been mapped as near the top of the Ulladulla Mudstone (Fletcher, 1958). Officers of the Geological Survey of New South Wales now include it in the Conjola Formation and define that formation to embrace all the sediments from the base of the Permian sequence near Bateman's Bay up to the base of the Wandrawandian Siltstone.

There are several specimens of the species in the B.M.R. collections from JB 38, Tomerong-Braidwood Road, about 1 mile north-west of Tomerong, which is near the top of the Wandrawandian Siltstone or the base of the Nowra Sandstone.

Genus MAORIELASMA Waterhouse, 1964

Type species (by original designation): *M. imperatum* Waterhouse from the Mangarewa Formation (Kungurian) of New Zealand.

Diagnosis: Shells of small to large size for terebratuloids; pedicle valve strongly convex in both profiles; brachial valve strongly convex transversely, weakly convex laterally; pedicle umbo sub-erect to erect; foramen strongly labiate and mesothyrid to permesothyrid; deltidial plates conjunct; beak ridges well rounded; pedicle collar strong; dental lamellae absent; cardinal process as for family; a pedicle adjustor muscle scar just inside the delthyrium on each side of the shell; sockets not denticulate; outer hinge plates narrow; inner hinge plates broad and long and meeting on the shell wall to form a sessile septalium with a V-shaped anterior outline; crural bases sharp and widely divergent; loop incomplete.

Remarks: The group of species included in *Maorielasma* is readily recognisable on the basis of internal structures. Two important features are the constancy of the union of the inner hinge plates almost on the shell floor without the formation of a median septum (or in rare cases with the formation of a low septum at the front of the septalium), and the development in certain species of a thickening of the pedicle umbo to produce structures simulating dental lamellae which have been joined to the lateral walls of the shell by callus deposits. The constant arrangement of the inner hinge plates is rather remarkable in view of the wide variability of this character in many other genera. The pseudo-dental lamellae are of the same type as those described for *Gilledia.*

Maorielasma is unlikely to be confused with any of the established genera. *Hemiptychina* Waagen is much smaller, has an erect produced umbo in the pedicle valve, inner hinge plates which usually meet the floor of the valve independently, and an anterior commissure which is usually multiplicate. Waagen (1882) certainly records that the hinge plates *do* rarely meet to form a septum and that an occasional smooth individual is found in some populations, but since the union of the hinge plates is so constant in *Maorielasma* and no sign of multiplication of the commissure has been observed in the genus, it can only be assumed that overlap in this character is not taxonomically significant. *Rhaetina* Waagen has a similar hinge-plate arrangement but is much smaller and has an entirely different loop development.

Distribution: The genus is known only from New Zealand and Queensland. In New Zealand it occurs only in the Mangarewa Formation (Kungurian); in Queensland it occurs in the Ingelara Shale, the Catherine Sandstone, the Mantuan Formation, and at the northern end of the Bowen Basin almost as high as the *Streptorhynchus pelicanensis* Bed, all of which are thought to be either Kungurian or Kazanian in age.

MAORIELASMA CALLOSUM sp.nov.

(Pl. 4, Figs 20–25; Pl. 14, Figs 1–8)

Holotype: CPC 5941 from the Ingelara Shale at SP 115, 7.2 miles at 287° from Springwood Homestead in Sandy Creek, Springsure 1 : 250,000 Sheet Area; paratypes CPC 5942–5946 from the same locality.

Diagnosis: Shell large; globose; foramen relatively small; labrum short; callus supporting the teeth in most specimens; septalium V-shaped in most specimens and extending 0·24–0·32 of length of brachial valve.

Description: Shell large, largest observed about 50 mm. long; biconvex; in lateral profile pedicle valve much more strongly convex than brachial; in anterior profile both valves highly convex; umbo of pedicle valve inflated; lateral commissure weakly sinuate; no sinus in pedicle valve; labrum on foramen short.

Pedicle collar strong; callus deposits forming pseudo-dental lamellae often present; muscle scars not distinguishable apart from pair of pedicle adjustor scars on inner face of pseudo-dental lamellae 2–3 mm. in front of pedicle collar; teeth small and slender.

Inner socket ridges short but thick; no anterior socket ridges; outer hinge plates narrow, and with growth-lines directed sharply forwards; inner hinge plates forming a sessile septalium with V-shaped anterior outline; crural bases thick and high; remainder of brachidium unknown; septalium extending from 0·22 to 0·30 of length of brachial valve; a very short and low median ridge present in some specimens in front of septalium; adductor muscle scars large, clearly divisible into anterior and posterior pairs and with their anterior edges 5–6 mm. in front of edge of septalium; vascula media long and straight and diverge at about 25° from end of a short ridge in front of septalium.

Remarks: None of the type specimens is completely undistorted, but it is clear that the posterior part of the valve must have been highly globose, and the anterior part did not develop a sinus. The amount of callus in the umbo of the pedicle valve varies considerably: in some specimens it is almost negligible, whereas in others strong pseudo-dental lamellae are present. This is presumably a function of age. The septalium is variable in length (see p. 100) and in shape. In some individuals the growth-lines on the inner hinge plates form a broad arc between the crural bases and the mid-line of the shell; while in others they curve back in a narrow zone up against the crural bases and then run straight to the mid-line.

The specimen F2268 G.S.Q. shows the paired pedicle adjustor scars particularly well. They lie in the excavated inner faces of the pseudo-dental lamellae and are just inside the delthyrium. They are oval in outline with their long axes parallel with the height of the shell (Pl. 4, Fig. 23).

M. imperatum, the type species, is a smaller form with a narrower outline, a slighter callus in the pedicle umbo, and a more delicate septalium.

Localities and Horizons: A single individual, F14259 A.N.U. from Dry Creek, Ingelara, lacks the umbonal thickening but is otherwise normal (Pl. 4, Figs 24–25). Two specimens, F24088–89 U.Q., from the Flat Top Formation at 315945 Monto Four-Mile Sheet area, are rather poorly preserved in a siltstone, but they almost certainly belong to the species (Pl. 4, Fig. 20). Specimens CPC 5975 from the Flat Top are in a similar matrix, and come from locality BA 806, Baralaba-Rannes Road, 5 miles east of Baralaba. They are entirely comparable. Other Flat Top specimens are F5955 G.S.Q., from east of the Banana-Barfield road, 7 miles south east of Banana, and F2267–68 G.S.Q., labelled only 'Banana.' These have a similar mode of preservation and could well be from the same locality. They are more transverse in outline than the types and have more massive crural bases. However, they show the characteristic pseudo-dental lamellae and short septalium particularly well, and hence they are probably best regarded as members of this species. The specimen F42504 U.Q. (Pl. 15, Figs 3–4) from the Orange Creek Formation, 0·7 miles west of the Theodore road, 5 miles north of Cracow, is well preserved, has only slight thickening in the umbo of the pedicle valve, and a septalium that extends more than one-third the length of the brachial valve, rather longer than in the types. It is therefore intermediate between *M. callosum* and *M. globosum* in this character, but the foramen appears to be small and the umbonal angle is 80°–85°, and hence it is referred to *M. callosum*. Another specimen, F31214 U.Q. (Pl. 4, Fig. 21) from 2·75 miles west of Walhalla Homestead, via Barfield, is badly broken and is doubtfully referred to the species. CPC 5348 from the ? Barfield Formation, 10 miles north-north-west of Banana, in a creek 100 yards west of the Banana-Baralaba road, has had the two valves pushed together so that the specimen now appears to be smaller than it was originally. It has heavily thickened shoulders in the pedicle valve and the usual septalium of the species.

MAORIELASMA GLOBOSUM sp.nov.

(Pl. 4, Figs 1–19 and 26–28; Pl. 14, Figs 9–16; Text-fig. 40)

Holotype: F2253 G.S.Q., from the Mantuan Formation, Consuelo Creek, Serocold Anticline, Queensland: paratypes F25687 U.Q. and CPC 5962–63 from the Mantuan Formation at Tanderra (Nardoo) SP 649, 2 miles south of the Station homestead; F24059 U.Q. from the same unit, 1½ miles north-west of Consuelo Homestead, Serocold Anticline; and CPC 5951–5960 from SP 391, 4½ miles south-west of Wealwandangie Homestead; all Springsure 1 : 250,000 Sheet Area.

Diagnosis: Large; outline elongate; strongly biconvex; foramen large; umbonal angle averages 65° over a range of 55–70°; lateral and anterior commissures weakly sinuate; sessile septalium averages 0·35 of length of brachial valve.

Description: Shell large, largest observed about 50 mm. long; test thick; outline elongated ovate; greatest width at about two-thirds the length; in lateral profile pedicle valve highly arched, especially towards umbo, brachial valve gently convex; in anterior profile valves highly and sub-equally convex; commissures broadly and evenly sinuate; pedicle umbo prominent, sub-erect; umbonal angle approximately 65°; foramen large, strongly labiate, with labrum hanging well over brachial umbo; permesothyrid; beak ridges well rounded; deltidial plates broad and conjunct; sinus and fold absent; punctae number 120–160 per sq. mm.

Pedicle collar strong and complete; lateral shell wall in umbonal region slightly to highly thickened; pseudo-dental lamellae present in some specimens; muscle field and pallial trunks not observed apart from coarse irregular pitting on the front face of the callus in the shoulders, probably indicative of pouch-like vascula genitalia; very low rounded median ridge on middle part of valve.

Outer hinge plates clearly separated from inner socket ridges by change of slope; inner socket ridges low; inner hinge plates uniting on floor of valve forming a sessile septalium; septalium V-shaped in transverse section toward the rear, but

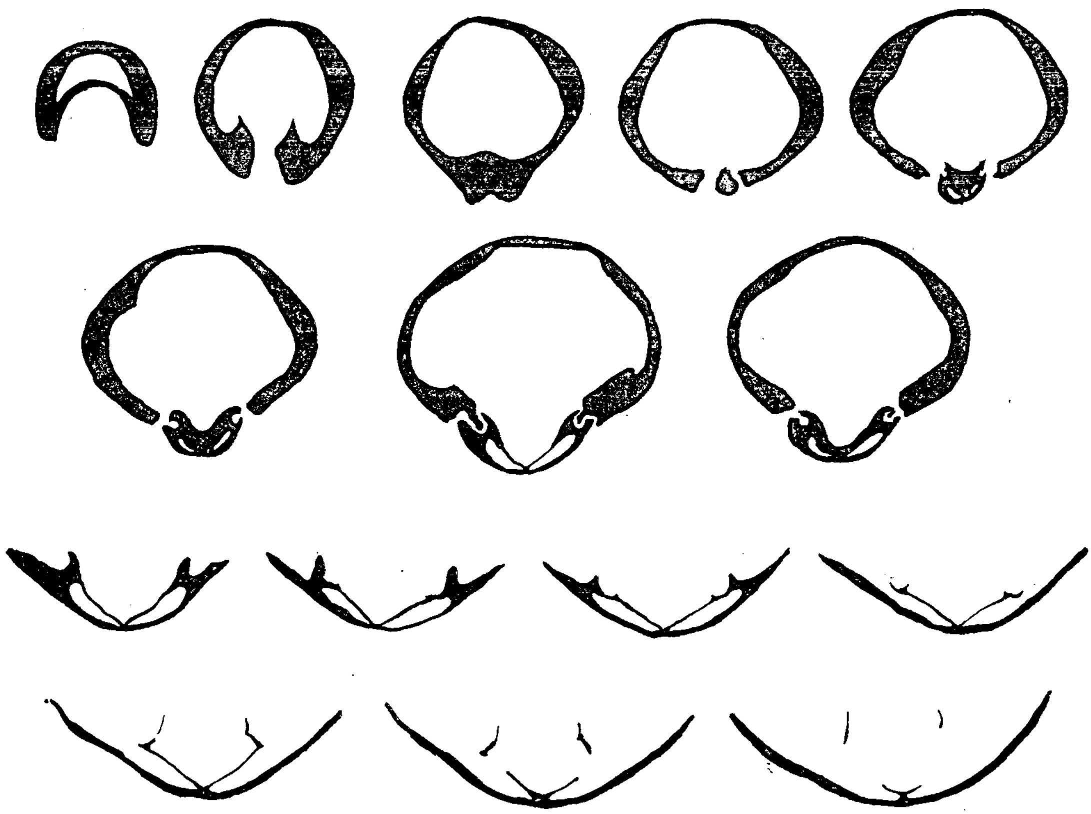


Fig. 40.—Composite serial sections drawn from two individuals of umbonal part of *Maorielasma globosum* sp. nov. showing thickened umbonal shoulders, pseudo-dental lamellae, and distinctive hinge plates; note that the crural points are probably incomplete. From locality SP649. Sections cut at intervals of approximately 1 mm. x 2.5

slightly rounded on axis toward the front; growth-lines on inner hinge plates run back in straight lines from median plane almost to crural bases, where they are deflected forward sharply; anterior edge of crural trough bluntly rounded in outline; crural bases high on anterior half of outer hinge plate and not visible on posterior half; muscular facets of cardinal process often separated by low rounded boss; adductor scars well impressed posteriorly but ill-defined anteriorly, large, and ovate in outline with the posterior end slightly pointed; differentiation into pairs not detected; pallial trunks not distinguished; crural points low; loop extending almost to middle of valve; no transverse band.

Dimensions:

Length	Width.	Height	Length Brachial Valve	Length Septalium
57	c 38	c 29	51	14·5
55	37	32	49	20
50	36	26	45	c 17
48	36	24	44	15
44·5	31	24·5	38	....
Specimens from C.P.A. 21				
21	16	10	18	....
19	15	9	16	7
13·5	10	....	12	4
8·5	7	3·5	7	3

Remarks: M. globosum is known from about twenty specimens from the Mantuan Formation. Interiors or parts of interiors are known from twelve of these. As with *M. callosum* there is a wide range of variation in the amount of callus in the shoulders of the pedicle valve, and this is not always dependent on age. Specimen F24059 U.Q., figured on Plate 4, Figures 18–19, is one of the largest specimens, and yet it has one of the smallest calluses. The largest callus observed is in CPC 5952, figured on Plate 14, Figure 16. As with *M. callosum* there are pedicle adjustor scars in embayments in the callus inside the delthyrium.

The pedicle collar is particularly thick and long. In CPC 5952 its anterior edge is more than 5 mm. in front of the posterior edge of the foramen.

In most specimens the shape of the septalium is as described above. However, in occasional specimens from SP 391, particularly CPC 5955, the growth-lines of the inner hinge plates are directed straight inwards from the crural bases to the mid-line, and not forwards at all. This of course results in a very short septalium comparable in all respects with that of many specimens of *M. callosum.* Another unusual feature of some individuals from this locality is that the septalium is supported on a septum up to 2 mm. high at its anterior edge.

The loop is known from a single adult specimen, CPC 5959. The descending lamellae are short, straight, and almost parallel. Toward the front they are V-shaped in cross section. There is no transverse band.

The species is considered to differ from *M. callosum* in its relatively longer septalium, its smaller umbonal angle, its larger pedicle foramen, and its thicker and longer labrum; though, as pointed out above, there is some overlap in the dimensions of the septalium. The basis for comparison is set out below. All measured specimens of *M. callosum* are from the type locality, and those of *M. globosum* are all from the Mantuan Formation, though from different localities.

	M. callosum	*M. globosum*
No. of individuals	9	10
Range in length, brachial valve	30–40 mm.	24–51 mm.
Average length of brachial valve	34 mm.	43.5 mm.
Mean of $\left\{\frac{\text{length septalium}}{\text{length brachial valve}}\right\}$	0.28	0.35
Range of values of $\left\{\frac{\text{length septalium}}{\text{length brachial valve}}\right\}$	0.24–0.32	0.24–0.42
Standard deviation	0.023	0.050

It can be shown that the means differ significantly at the 1% level.

It is noted that the *M. callosum* sample consists of individuals of smaller mean size than that of *M. globosum*. However, neither sample shows any correlation between size and the ratio discussed, and hence this is of no importance. Another point is that although there is a large overlap in the range of values of this ratio, only two of the twelve individuals of *M. globosum* fall in the *M. callosum* range. Therefore a single specimen cannot be assigned to either species with any assurance on this character alone unless it falls outside the upper limit of *M. callosum*; but in conjunction with the magnitude of the umbonal angle and the size of the labrum, the ratio provides an adequate basis for the assignment of all specimens encountered to date.

M. imperatum is a smaller species with a narrower outline, a relatively smaller mean septalial length, and less thickened umbonal shoulders in the pedicle valve.

Localities and Horizons: Other specimens from the Mantuan Formation are CPC 5965 from locality SP 435, 1½ miles north-west of Consuelo Homestead.

The specimen F2270 G.S.Q. (Pl. 4, Figs 26–28) is stated to be from the Mantuan Formation at Consuelo Creek. Its mode of preservation is unusual, however, and for that reason I have not included it among the paratypes.

From the Big *Strophalosia* Zone at locality MC 553, creek crossing on the Homevale-Elphinstone road, come three specimens labelled F5946–47 G.S.Q. These have weakly developed pseudo-dental lamellae (Pl. 14, Figs 13–15), and one has a length septalium/length brachial valve ratio of 0·31. The umbonal angles are not easily measured, but seem to be in the 55°–65° range.

Seven specimens, F2234–2240 G.S.Q., labelled gully head 10 chains north of No. 3 camp, CPA 21, Bowen River Coalfield, are all much smaller than the types. The dimensions of four of them are given above, and they are illustrated on Plate 4, Figures 1–12. Apart from size and a slightly greater length septalium/length brachial valve ratio, there is no feature by which they can be distinguished from other members of the species, and I regard them as juveniles. According to Mr E. Webb (in litt.) the locality is not far below the *Streptorhynchus pelicanensis* Bed just north of Pelican Creek, on the eastern boundary of CPA 21.

A single specimen, F2232 G.S.Q., labelled Pelican Creek, CPA 21, $\frac{1}{2}$ mile from eastern boundary, Bowen River Coalfield, is related to this species, but its septalium is relatively shorter. The horizon is similar to that of the other specimen from CPA 21.

Genus MARINURNULA Waterhouse, 1964

Type species (by original designation): *Marinurnula rugulata* Waterhouse from the AG 4 limestone, Arthurton Group (Kazanian) of New Zealand.

Diagnosis: Shell medium to large; pedicle valve convex in longitudinal sections, tending to become flattened on the anterior half on transverse sections; brachial valve highly arched in transverse and gently arched in longitudinal sections; deltidial plates conjunct; dental lamellae absent; outer hinge plates small, diverging from socket plates and attached directly to shell wall in adolescents and adults; loop unknown.

Remarks: In addition to the type species, this genus includes *M. mantuanensis* sp.nov., and an unnamed species from Tomerong, near Nowra, N.S.W. It is readily distinguished by the complete absence of inner hinge plates, and it has probably been derived from *Gilledia* Stehli by the reduction of these structures.

Pseudodielasma Brill has a similar simple dorsal cardinal region, but in that genus the crura are given off from very narrow outer hinge plates attached high up on the inner socket ridges, and not from a separate crural base on the base of the inner socket ridge or the outer shell wall as in *Marinurnula.*

Jisuina Grabau as defined by Stehli (1962) has internal structures very similar to those of *Marinurnula.* The internal structures of the type species, *J. elegantula* Grabau from the Permian of Mongolia, remain unknown, and Stehli's interpretation of the genus is founded on the interiors of externally similar species from Sicily and Pakistan which have previously been placed in *Heterelasmina* Likharev. All these forms, however, can be distinguished from *Marinurnula* by their plicate commissures, short broad pedicle umbones, and transversely flattened pedicle valves.

Distribution: The genus is known only from the Arthurton Group (Kazanian) of New Zealand, the Ingelara Shale, Catherine Sandstone, Mantuan Formation, Upper Oxtrack Formation, and Flat Top Formation of Queensland, and the Nowra Sandstone and Mulbring Formation of New South Wales, all of which are thought to be either Kungurian or Kazanian in age.

Marinurnula mantuanensis sp.nov.

(Pl. 5, Figs 10–14; Pl. 14, Figs 20–21; Text fig. 41)

Holotype: F25686 U.Q. from the Mantuan Formation at Tanderra (Nardoo), Central Queensland; paratypes F2254–2260 G.S.Q. probably same formation at the western base of Mount Serocold; and CPC 5964a–c from the same formation at SP 719, west flank of Reid's Dome, 1.4 miles at 312° from Mount Serocold.

Description: Shell large; pedicle valve highly convex in lateral profile, and brachial valve much less so; in anterior profile pedicle valve broadly convex and brachial valve highly vaulted; pedicle umbo high and probably sub-erect to erect; foramen labiate, permesothyrid?; deltidial plates conjunct; pedicle valve tending to flatten out towards the front and in the holotype developing a shallow sinus with a broad low median fold; cardinal margin sub-terebratulid; lateral and anterior commissures moderately sinuate.

Shell wall in region of pedicle umbo relatively unthickened; pedicle collar strong and complete; muscle scars indistinct, a pair of long straight pallial trunks extending along edges of sinus.

Cardinal process open U-shaped in transverse section, sharply defined in front by an angular change in slope, and without a median boss; inner socket ridges thick; sockets sometimes denticulate; outer hinge plates very narrow, joined to inner socket ridges in umbo, but diverging on to floor of valve in front; no inner hinge plates; crural bases thin, lying in a horizontal plane and diverging from base of sockets directly on to wall of valve; crura flattened, ribbon-like, and lying in a horizontal plane; remainder of loop unknown; muscle scars very faintly impressed and outlines indeterminable; punctae irregularly arranged or in irregular rows parallel with growth-lines and numbering 125–175 per sq. mm.

Remarks: The holotype is the only specimen from the type locality and it has the umbo of the pedicle valve badly crushed; also the only information on its

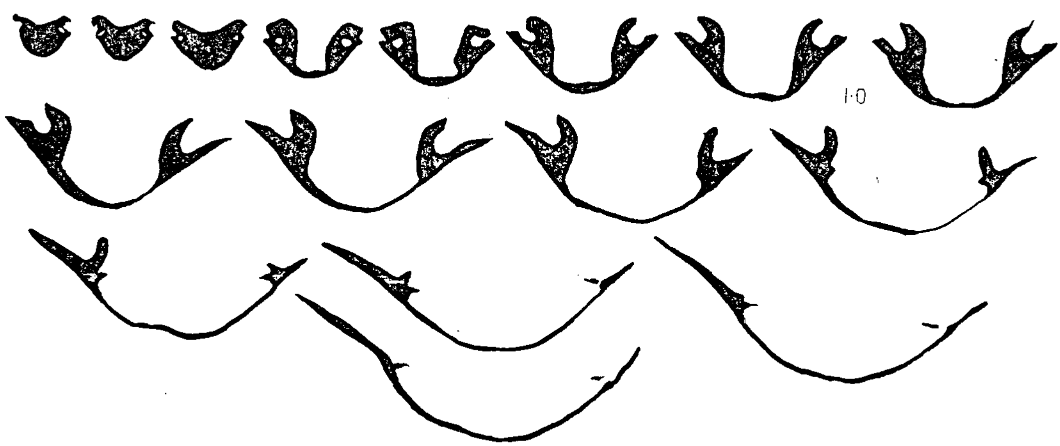


Fig. 41.—Serial sections of brachial valve of an adult topotype of *Marinurnula mantuanensis* sp. nov. Showing outer hinge plates diverging on to valve wall anteriorly; F2256 G.S.Q. Intervals between sections 0.5 mm. unless otherwise stated. x 1.5.

internal structure has been obtained by cutting a section through it. Almost all the descriptions of these features have been obtained from the paratypes. These all come from the same vicinity, but they are preserved in two different matrices and may be from slightly different horizons. All the available material is somewhat distorted, but the main features of shell morphology are easily distinguishable.

The outer hinge plates vary in strength and position; in some specimens they are close up to the socket floors, but in others they diverge from the socket floors at angles of up to 15° (Pl. 5, Fig. 13). One paratype (F2258 G.S.Q.) shows what appear to be very fine flat crescentic denticles along the outer socket ridge, and vestiges of somewhat similar structures are visible on other specimens. If denticles were present in the species they must have been very small and not invariably present.

M. mantuanensis reached more than double the linear size of *M. rugulata* Waterhouse, and its brachial valve appears to be relatively more highly vaulted; but the specimens of *M. rugulata* are much deformed and it is difficult to reconstruct their profiles.

Localities and Horizons: A single specimen from the Shell Development Collection now in the Sedgwick Museum from locality M1173X, south of Rocky Creek near Mount Serocold, comes from the same general area as the paratypes. Two specimens CPC 5966 from the lower part of the Catherine Sandstone at locality SP 383/3, 4½ miles north-north-west of Croydon Hills Homestead, Springsure 1 : 250,000 Sheet Area, and another from the upper Ingelara Shale at locality SP 115 (CPC 5948), are indistinguishable from the paratypes.

In the Dawson Valley the species is known from the upper Oxtrack Formation and the upper Barfield Formation or lower Flat Top Formation. From the former is F5948 G.S.Q., which is from the ridge north of Oxtrack Creek, Theodore-Cracow district. This specimen is squashed almost flat. From the latter formation is CPC 5359, on the Lonesome Creek road, about 7·6 miles from Theodore. It is undistorted, though a large part of the shell is missing. It shows a more pronounced flattening on the anterior half of the brachial valve, and a deeper, somewhat longer and steeper-sided sinus on the pedicle valve than does the holotype.

In the British Museum (Natural History) are two specimens labelled B58213–4, from 'Quarry near Tomerong, 10 miles south of Nowra.' One of these specimens is very similar to *F. amygdala*; the other is clearly a *Marinurnula*, but it differs from *M. mantuanensis* in its stronger outer hinge plates. I have searched in the area for further specimens without success. The locality is probably in the Nowra Sandstone.

The individual F1152 A.M. labelled 'Mulbring' is clearly a specimen of *Marinurnula*, but it is too badly distorted to give an opinion on its specific affinities.

Subfamily HEMIPTYCHININAE nov.

Diagnosis: Shells small and biconvex; anterior margins usually multiplicate; inner hinge plates joining the floor of the valve independently along their inner edges.

Remarks: At present this subfamily is monotypic.

Genus HEMIPTYCHINA Waagen, 1882

Type species (by original designation): *Terebratula himalayensis* Davidson, from the *Productus* Limestone of the Salt Range.

HEMIPTYCHINA ? sp.

(Pl. 16, Fig. 1)

Material: CPC 5969 from the Noonkanbah Formation at locality KNF 73, 2·2 miles bearing 288° from Bruten's Old Yard, 745 feet above the base of the formation.

Description: Most of a brachial valve is represented. It is somewhat distorted, but was probably gently convex with an inflected margin. The surface is smooth except on the anterior third, where it is thrown into about eight low rounded folds. Internally the hinge plates join the floor of the valve independently about 1 mm. from the mid-line, and do not form a septalium. Punctae number 220–320 per sq. mm.

Remarks: Since no pedicle valve is known this specimen cannot be placed with certainty in either *Hemiptychina* or *Dielasmina*. Moreover, there is very little authoritative information about the latter genus, particularly the internal structure of its brachial valve. On the slender data available, I consider that the hinge plates of the present specimen are indicative of *Hemiptychina* rather than *Dielasmina*.

There is a superficial comparison in shape and folding with *H. inflata* Waagen, figured by Waagen (1882, Pl. 27, Fig. 8), though our specimen has one or two less folds and they are not so angular.

Family HETERELASMINIDAE Likharev, 1956

Diagnosis: Shells small; pedicle valve flattened or convex in anterior profile; anterior commissure plicate; dental lamellae and inner hinge plates absent; outer hinge plates reduced and attached to floor of valve or to inner faces of socket ridges.

Remarks: I include two subfamilies in this group—the Heterelasmininae and the Labaiinae (pro Labaiidae Likharev, 1960). The former contains those genera in which the outer hinge plates are attached to the valve floor, and the latter those in which they are attached to the socket ridges. Whether this division is a natural one or not is a matter for further research; at the present time I do not consider the difference to be of family rank.

The relationships of *Jisuina* Grabau and *Heterelasmina* Likharev are discussed below and it is tentatively accepted that *Heterelasmina* is a synonym of *Jisuina*. However, under the 1961 International Code of Zoological Nomenclature, Article 40, the name Heterelasminidae is valid.

Subfamily HETERELASMININAE Likharev, 1956

Diagnosis: Heterelasminidae with the outer hinge plates attached to the floor of the valve.

Remarks: The only genus recognised is *Jisuina* Grabau, 1931.

Genus JISUINA Grabau, 1931

Type species (by original designation): *Jisuina elegantula* Grabau from the Permian Jisu Honguer Limestone of Mongolia.

Remarks: Jisuina at the present time cannot be interpreted accurately since the type species is represented by a single individual and nothing is known of its internals. Stehli (1961b) has suggested an interpretation based on the external similarity between *J. elegantula* and certain Sicilian species, including *Hemiptychina dieneri* Gemmellaro, which is the type species of *Heterelasmina* Likharev. Until more specimens of *J. elegantula* become available the relations of these two genera can only be regarded as unresolved. However, for present purposes Stehli's views are accepted.

Likharev (1956) has discussed *Heterelasmina* again and proposed a new species *H. schucherti* Likharev as type species. I can find no warrant for this substitution. However, *H. schucherti* appears to belong to the genus as originally defined.

Distribution: Mongolia (Jisu Honguer Limestone); Sicily (Sosio Beds); Caucasus and Samara (U.S.S.R.); possibly the Karakorum Range, the Salt Range, and New South Wales.

JISUINA sp.

(Pl. 15, Figs 13–15; Text-fig. 42)

Material: F35682 A.M. from West Maitland (possibly the Muree Formation); specimen figured by Etheridge (1898, Pl. 19, Figs 7–9).

Remarks: This specimen was well illustrated by Etheridge, although the furrow in the brachial valve does not have such a sharp posterior termination and the lateral commissure is more markedly sinuate than his illustration suggested. There are no dental lamellae. Considerable callus is deposited against the floors of the sockets, and embedded in this are the crural bases (Text-fig. 42). This, together with the depressed pedicle valve, flattened pedicle umbo, and plicate commissure, suggests that the specimen may have affinities with such species as *J. lepton* (Gemmellaro) and *J. schucherti* (Likharev). The loop shape in *Jisuina* is rather distinctive, and until further specimens showing this structure become available, this assignment must be considered to be tentative only.

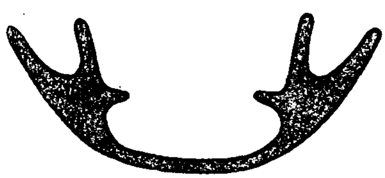


Fig. 42.—Reconstructed transverse section of a specimen of ?*Jisuina* sp. F.35682 A.M.

Subfamily LABAIINAE Likharev, 1960

Diagnosis: Heterelasminidae with the outer hinge plates attached directly to the socket ridges.

Remarks: Genera included here are *Labaia* Likharev, *Pseudodielasma* Brill, and *Oligothyrina* Cooper.

Genus PSEUDODIELASMA Brill, 1940

Type species (by original designation): *Pseudodielasma perplexum* Brill from the late Permian Whitehorse Sandstone of central U.S.A.

Diagnosis: Shell small; biconvex; pedicle valve with moderately high umbo; sinus weak or absent; no dental lamellae; very narrow outer hinge plates attached directly to the inner socket ridges; loop very short.

Remarks: It is difficult to be sure of all the characters of the type species since the specimen sectioned by Brill was imperfect. However, the above diagnosis does seem to be both accurate and adequate.

Distribution: The type formation is thought to be of Capitan (Kazanian) age. It also possibly occurs in New Zealand (Tartarian) and Queensland (Kungurian).

? PSEUDODIELASMA sp.

(Pl. 16, Figs 10–14)

Material: CPC 5301 from the Flat Top Formation, Lonesome Creek road, 7·6 miles from Theodore Post Office, and CPC 5300 from locality CL 142, beds associated with the Big *Strophalosia* Zone midway between Mount Lebanon and Logan Downs Homesteads, Clermont area.

Remarks: Both these specimens are characterized internally by an absence of dental lamellae, and by very narrow outer hinge plates which come directly off the inner socket ridges.

Their generic identification is in doubt. It is possible that they are young specimens of *Marinurnula mantuanensis*, or a new species developed from *Marinurnula* by migration of the outer hinge plates. If the former is true they are aberrant specimens, since young individuals of *M. mantuanensis* not much larger than those under discussion show the outer hinge plates attached to the shell wall. But in this context, some species of *Gilledia* are variable in the position of the outer hinge plates, and since it has been postulated that *Marinurnula* evolved from *Gilledia* the occurrence of specimens of *Marinurnula* with outer hinge plates attached to the inner socket ridges is not a morphological impossibility.

On the other hand there is an established group of genera with brachial cardinalia similar to those of these specimens, and while zoogeographical considerations and differences in size may suggest otherwise, there is no definite reason why they should not be included with this group. The answer to the problem lies in a study of the loop structure, but material adequate for this purpose is not available. Until such a study can be undertaken, the specimens are very doubtfully placed in *Pseudodielasma* Brill, and it is noted that they are much larger than the type species of the genus.

Superfamily CENTRONELLACEA Stehli, 1956

Genus GLOSSOTHYROPSIS Girty, 1934

Type species (by monotypy): *Cryptacanthia? robusta* Girty from the Permian of Texas. Stehli (1954) expressed doubt as to the validity of *Glossothyropsis*, but under Article 17(8) of the 1961 International Code of Zoological Nomenclature it is accepted as available.

Remarks: In my interpretation of this genus I follow the diagnoses given by Cooper (1953, p. 73) and Stehli (1954, p. 356).

Distribution: To date it has been recorded only from Texas and Mexico, where, according to Stehli, it seems to range throughout the Permian section. Only three species are so far described—the type species from the Delaware Mountain Formation (Guadalupian), *G. magna* Cooper from rocks equivalent to the Word Formation in Western Sonora, Mexico, and *G. sinuata* Stehli of the Leonardian of the Sierra Diablo, Texas.

? GLOSSOTHYROPSIS sp.

(Text-figs 43–44)

Material: 14454 A.N.U., from the Ingelara Shale, Dry Creek, Ingelara.

Description: Shell of average size; pedicle valve highly convex in both lateral and anterior profiles; brachial valve flattened in lateral profile and flattened and slightly sulcate in anterior profile; no indication of sinus or fold at any stage on pedicle valve; sinus on brachial valve beginning almost at umbo, becoming very broad toward the front; lateral and anterior commissures sulcate; structures of umbonal regions unknown; punctae 75–100 per sq. mm. Dental lamellae present.

Median septum of brachial valve high, thick, extending about one-third of total length of valve, and supporting a very short shallow septalium extending only about 2 mm. from umbo; crural bases forming slight swellings on dorsal side of hinge plate; crura robust and developed from very narrow outer hinge plates; crural points present, and of unknown size, lying in almost vertical planes; descending lamellae almost straight, sub-parallel, and close together; short distance forward of crural points, descending lamellae twist around so as to lie in an almost horizontal plane; near anterior extremity descending lamellae converge and unite to form an open W-shape in transverse section; lamellae very abruptly recurved at anterior extremity; ascending branches high, strongly concave toward each other in both transverse and longitudinal section, and joined by a short transverse band situated just in front of crural points; no evidence of spines on loop.

Remarks: The above description is based on a single specimen, probably adult, from which the umbo had been broken and in which the brachial valve had been pushed slightly into the pedicle valve during preservation. The flange of pedicle valve thus formed around the specimen was broken off during preparation, so that the whole shell is now smaller than the original. Part of the interior is filled with mud, but most of it is occupied by translucent calcite through which it is possible to make out most of the details of the loop.

The median septum is very high and much thickened, so that in sections through the septalium the so-called true median septum forms the main part of that structure. The sections also show a pair of thickenings (not crural bases) on the ventral face of the septalium. Their structure cannot be properly determined owing to the scarcity of material, but it seems most likely that they formed a partial ventral covering for the septalium.

Though the external shape, dental lamellae, dorsal median septum, and septalium are all consistent with an assignment to *Glossothyropsis*, the form of the loop is quite different from that said to be characteristic of the genus by Stehli (1954, fig. 55) in that the lamellae join near the anterior extremity. However, the descending lamellae are very broad and long and have a shape very similar to that figured by Cooper (1953, pl. 23, fig. 26) for *G. magna* Cooper.

Locality and Horizon: Known only from the Ingelara Shale, Dry Creek, Ingelara.

Two very small specimens (length 8–9 mm.) from Dry Creek, Ingelara, one of which was figured by Campbell (1953, pl. 6, figs 7–8), are probably juveniles of this species. They are numbered F14276–7 U.Q.

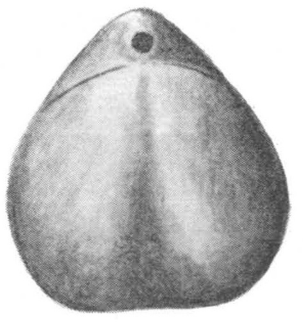


Fig. 43.—Reconstructed dorsal view of specimen of ? *Glossothyropsis* **sp. based on . . . . A.N.U.**

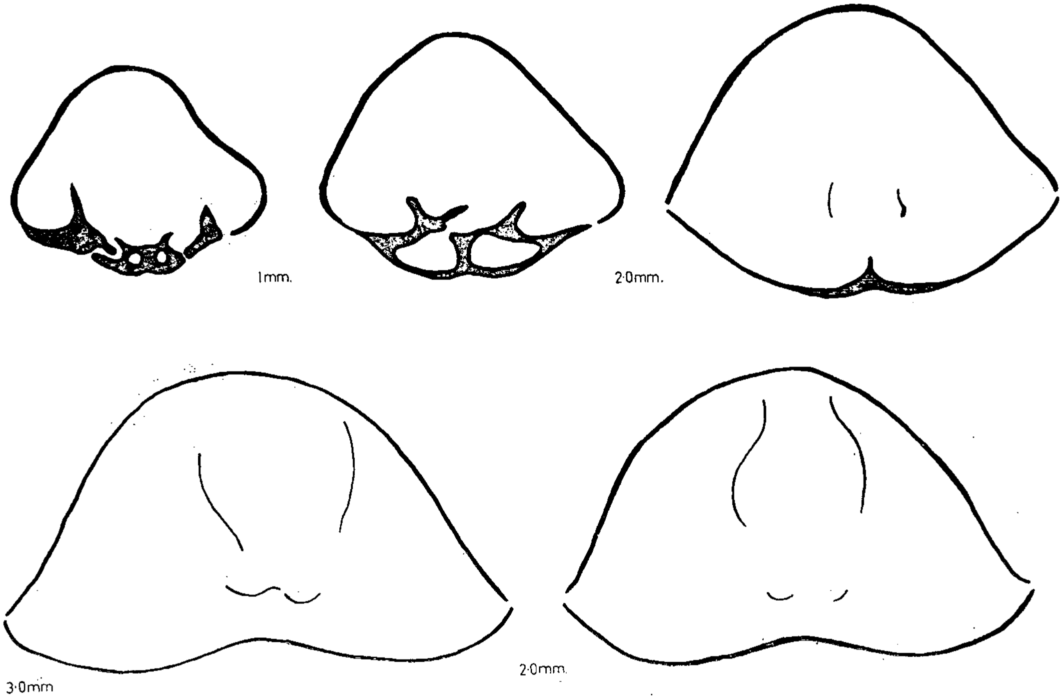


Fig. 44.—Sections cut from same specimen as in Fig. 43. Intervals between sections as shown. x 5.

GLOSSARY OF NEW NAMES

callosum (*Maorielasma*): referring to the umbonal callus.
canni (*Fletcherithyris*): in honour of Mr J. Cann, who brought the species to my notice.
culburrensis (*Gilledia*): from Culburra Headland, south coast, New South Wales.
farleyensis (*Fletcherithyris*): from Farley, Hunter Valley, New South Wales.
globosum (*Maorielasma*): referring to the globose shape of the species.
grandis (*Hoskingia*): referring to the size of the species.
hardmani (*Fletcherithyris*): in honour of Mr E. T. Hardman, pioneer geologist in Western Australia.
homevalensis (*Gilledia*): from Homevale Station, Bowen Basin, Queensland.
Hoskingia, f.: in honour of Miss L. F. V. Hosking (Mrs Hartigan), who has pioneered work on Western Australian brachiopods.
illawarrensis (*Fletcherithyris*): from the Illawarra District, New South Wales.
kennediensis (*Hoskingia*): from the Kennedy Range, Carnarvon Basin, Western Australia.
mantuanensis (*Marinurnula*): from Mantuan Downs Station, Central Queensland.
oakiensis (*Gilledia*): from Oaky Creek, Homevale Station, Queensland.
parkesi (*Fletcherithyris*): in honour of the late Mr V. Parkes, who collected much of the Permian material from the Conjola Formation, and arranged for it to be housed in the Australian Museum.
reidi (*Fletcherithyris*): in honour of the late Mr J. H. Reid, pioneer Queensland geologist.
scotti (*Fletcherithyris*): in honour of the late Mr Scott, pioneer on the Collinsville Coalfield, Bowen Basin.
stehlii (*Yochelsonia*): in honour of Dr F. G. Stehli, who has described many new terebratuloids from the Upper Palaeozoic.
ulladullensis (*Gilledia*): from Ulladulla, south coast, New South Wales.
wandageensis (*Hoskingia*): from Wandagee Station, Carnarvon Basin, Western Australia.
woolagensis (*Gilledia*): from Woolaga Creek, Mingenew, Perth Basin, Western Australia.

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PLATE 1

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Gilledia sp. cf. *G. homevalensis* sp.nov. 79

1–4. Ventral, lateral, dorsal, and anterior views of an internal mould; F19491 S.U., Farley Formation, Farley, N.S.W.

Gilledia homevalensis sp.nov. 74

5–8. Latex cast of pedicle valve, and ventral, lateral, and dorsal views of an internal mould; note pseudo-dental lamellae; 11929 A.N.U., Homevale Beds.

9–10. Ventral and anterior views of an internal mould; F20934 U.Q., Homevale Beds.

11–13. Ventral, dorsal, and anterior views of the internal mould of a juvenile, 11933 A.N.U., Homevale Beds.

14. Latex cast of pedicle valve showing ornament ; Homevale Beds.

15–19. Latex cast of anterior part of pedicle valve, and lateral, dorsal, ventral, and anterior views of F20825 U.Q., **holotype,** Homevale Beds.

20–21. Dorso-lateral view of latex cast of whole shell to show the ornament, and antero-dorsal view of the umbo to show the delthyrium; F21092 U.Q., Homevale Beds.

22–24. Dorsal, lateral, and anterior views of an interna lmould showing a more convex pedicle valve than normal; CPC5257, from the same horizon as the Homevale Beds at MC485 diel.

25–27. Same of F2274 G.S.Q., from the Dilly Formation, Dilly, Qld.

Gilledia sp. ....

28–33. Ventral, dorsal, and lateral views of two specimens F2271 and F2775 G.S.Q., from the Dilly Formation, Dilly.

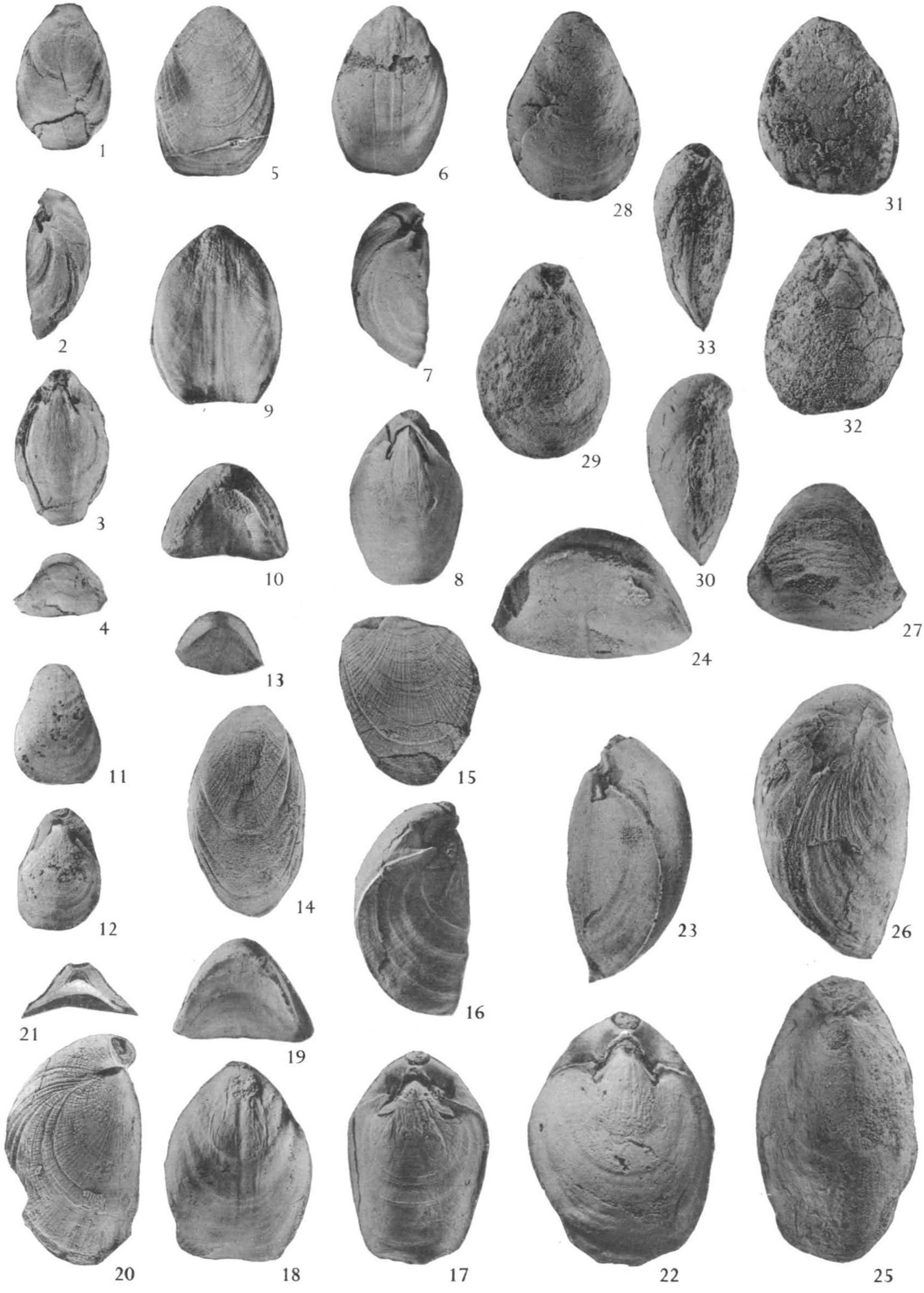
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PLATE 2

All figures natural size unless otherwise stated. Page

Fletcherithyris reidi sp.nov. 36

1–3. Ventral, anterior, and dorsal views; specimen destroyed by sectioning; Cattle Creek Shale, Cattle Creek.

4–6. Ventral, dorsal, and anterior views; note the high fold in the anterior commissure; 11979 A.N.U., same locality.

7–10. Ventral, dorsal, and anterior views; 11981 A.N.U., **holotype;** 9 is x 2; same locality.

12. Latex cast of exterior of part of 11981 A.N.U.; note the labrum; x 1·9.

11, 13. Ventral and dorsal views of two internal moulds; 11978, 11982 A.N.U., same locality.

Fletcherithyris illawarrensis sp.nov. 40

14–16, 19. Dorsal, ventral, anterior, and lateral views of a small specimen with a 'pinched' anterior commissure; F6053 U.N.E., Conjola Formation, Wyro.

17–18. Ventral and anterior views of a normal small specimen; F6063 U.N.E., same locality.

20–23. Ventral, dorsal, lateral, and anterior views of a typical specimen; F6064B U.N.E., same locality.

24–25. Dorsal view of a dissected specimen showing the long sockets and the form of the septalium; F6055 U.N.E., same locality; 25 is x 2.

Fletcherithyris scotti sp.nov. 38

26, 28–29. Anterior, ventral, and dorsal views of an internal mould; F5755 G.S.Q., x 2, Glendoo Member, Collinsville.

30–33. Lateral, anterior, ventral, and dorsal views of an internal mould; F5756 G.S.Q., x 2, same locality.

34–36. Lateral, ventral, and dorsal views; note how the septalium is sessile posteriorly in 36 and 39; F5757 G.S.Q., x 2, same locality.

37–40. F5758 G.S.Q., x 2, **holotype,** same locality.

41, 42, 44. Dorsal views of three internal moulds; note the sharp edges on the cardinal process and the shapes of the septalium; F5759, F5760, F5762 G.S.Q., x 3, same locality.

43. Latex cast showing the foramen; F5761 G.S.Q., x 3, same locality.

Fletcherithyris farleyensis faba subsp.nov. 34

45, 54. Dorsal and anterior views of a small internal mould; note the posteriorly sessile septalium and the long narrow adductor scars; 14095 A.N.U., x 2, Homevale Beds.

46, 47, 52, 53. Ventral, anterior, lateral, and dorsal views of another internal mould; note the pallial markings in 46 and 53; 14097 A.N.U., x 2, same locality.

48–51. Lateral, ventral, dorsal, and anterior views of a well preserved internal mould; 14096 A.N.U., x 2, same locality.

55. Dorsal view of an internal mould showing the shape of the sockets and the septalium; 14098 A.N.U., x 2, same locality.

56–57. Ventral and dorsal views of a larger internal mould; note the parallel vascula media and vague radial vascula genitalia in 56, and the septalium, adductor scars, and radial pallial markings in 57; F15710 U.Q., x 2, same locality.

58–59. Internal mould and latex cast of brachial valve of same; CPC5319, x 1·5, **holotype,** same horizon, locality MC485 diel.

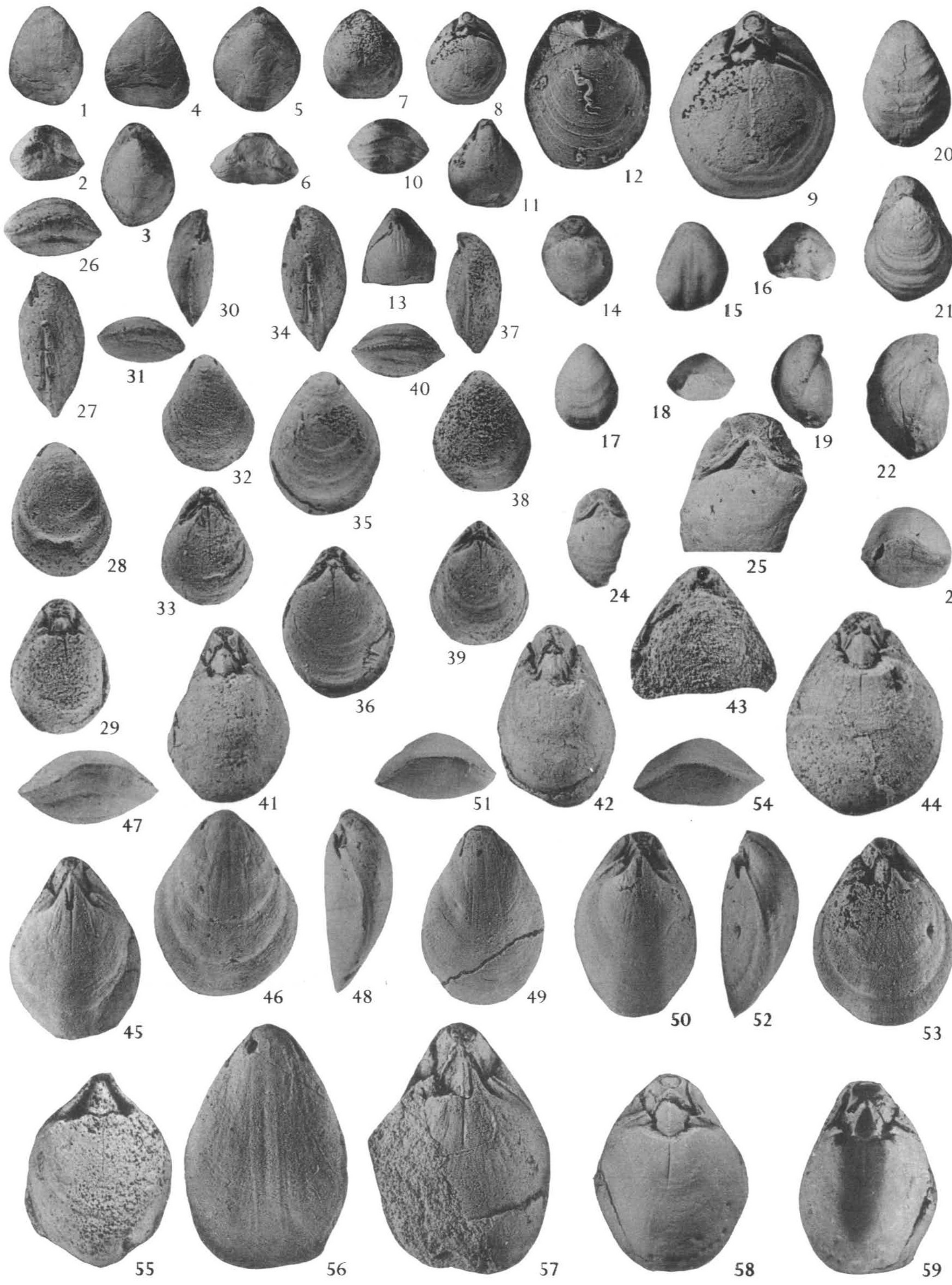
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PLATE 3

All figures natural size. Page

Fletcherithyris amygdala (Dana) 26

1. Dorsal view of an internal mould showing septalium and unusually long narrow adductor scars; 11943 A.N.U., Muree Formation, Hunter River, Glendon Homestead.

2. Ventral view of an internal mould showing pallial markings; 14094 A.N.U., same locality.

3–6. Anterior, dorsal and two ventral views; 3 and 6 photographed prior to preparation of internal mould with acid; note slight plication of the shell, and pallial markings particularly in 4; 11937b A.N.U., same locality.

Gilledia culburrensis sp.nov. 89

7–8. Dorsal and ventral views of an internal mould; note normal arrangement of hinge plates in 7 and sharp edge on muscle field and pallial markings in 8; CPC 5336, ? Nowra Sandstone, Culburra Headland, N.S.W.

9. Umbonal parts of a broken pedicle valve; note pedicle collar and muscle field; CPC 5342, same locality.

10, 20. Dorsal and ventral views of two specimens; note pseudo-dental lamellae in each, arrangement of hinge plates in 10, and muscle field in 20; 14004 and 14002 A.N.U., same locality.

11. Posterior view of latex cast of foramen; note short labrum; 14005 A.N.U., same locality.

12–15. Anterior, lateral, ventral, and dorsal views of a specimen partly stripped of shell; F39491 A.M., Conjola Formation, Wyro, N.S.W.

16–19. Same views of slightly broken specimen; CPC 5337, **holotype,** ? Nowra Sandstone, Culburra Headland, N.S.W.

21. Dorsal view of a crushed specimen; note adductor and dorsal pedicle adjustor scars, F20770 A.M., Conjola Formation, Wyro, N.S.W.

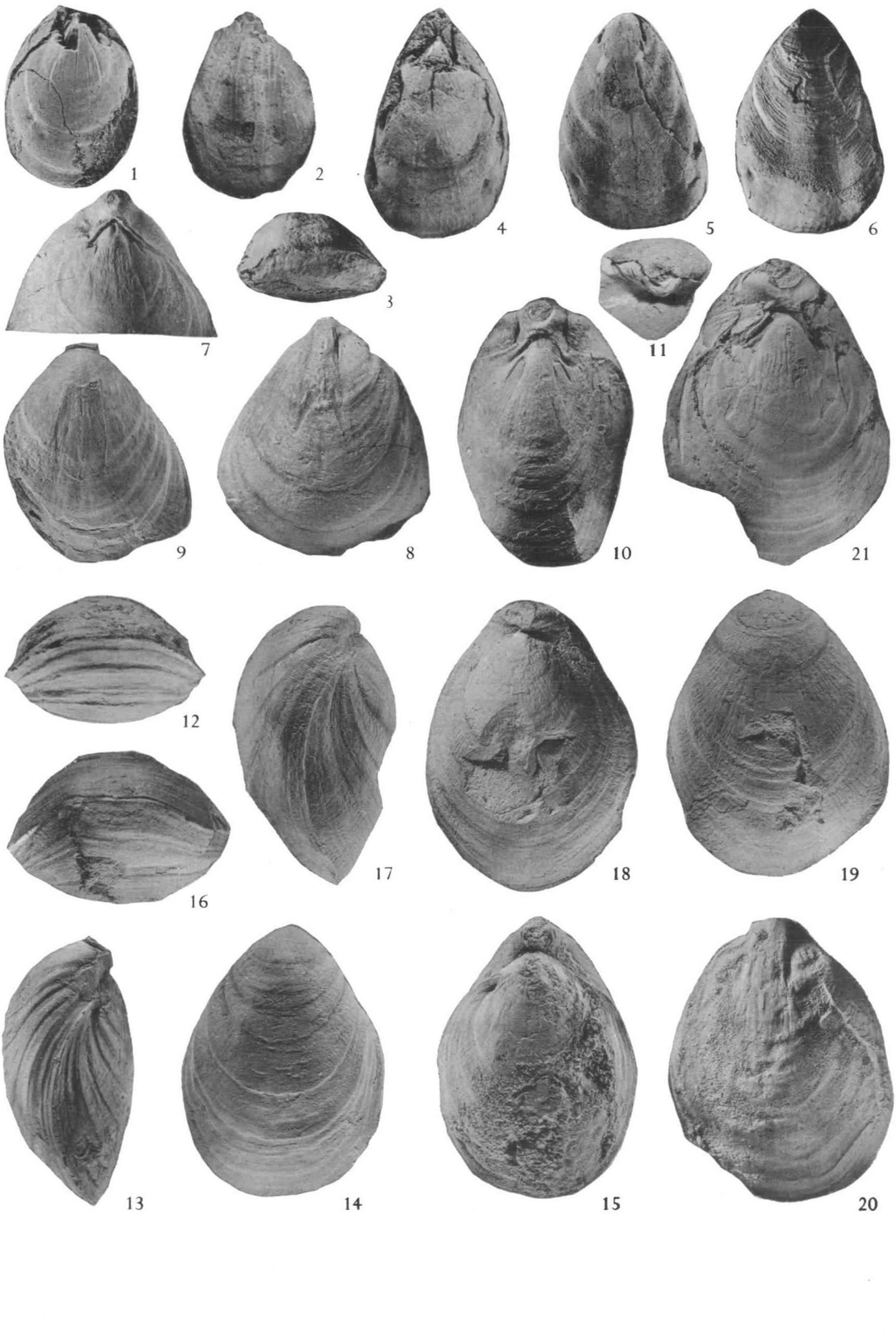

PLATE 4

All figures natural size unless otherwise stated. Page

Maorielasma globosum sp.nov. 97

1–4, 12. Ventral, dorsal, lateral, and anterior views of internal mould of a small specimen; 12 is x 2; F2236 G.S.Q., from near Collinsville.

5–6. Dorsal view of F2235 G.S.Q.; note adductor scars; same locality.

7–11. Ventral, lateral, dorsal, and anterior view of a testiferous specimen; 10 is x 2; F2234 G.S.Q., same locality.

13–16. Anterior, ventral, dorsal, and lateral views of a testiferous specimen; pedicle foramen slightly worn; F2253 G.S.Q., **holotype,** Mantuan Formation, Consuelo Creek, Qld.

17–19. Anterior, ventral, and dorsal views of an internal mould; note shape of septalium and adductor muscle scars in 19; F25687 U.Q., same horizon, near Tanderra (Nardoo) Homestead.

26–28. Dorsal, ventral and lateral views; note long labrum on foramen; F2270 G.S.Q., same horizon, Consuelo Creek, Qld.

Maorielasma callosum sp.nov. 96

20. Internal mould of umbonal part of a brachial valve; F24089 U.Q., Flat Top Formation, locality Cz.

21. Broken internal mould; note pseudo-dental lamellae and short septalium; F31214 U.Q., same horizon.

22–23. Ventral and dorsal views of umbonal part of a broken internal mould; note pseudo-dental lamallae, site of large ventral pedicle adjustor scars, strong pedicle collar, and pallial trunks diverging in front of septalium; F2268 G.S.Q., Flat Top Formation, Barfield, Qld.

24–25. Ventral and dorsal views of a partly crushed specimen; 14259 A.N.U., Ingelara Shale, Dry Creek, Ingelara, Qld.

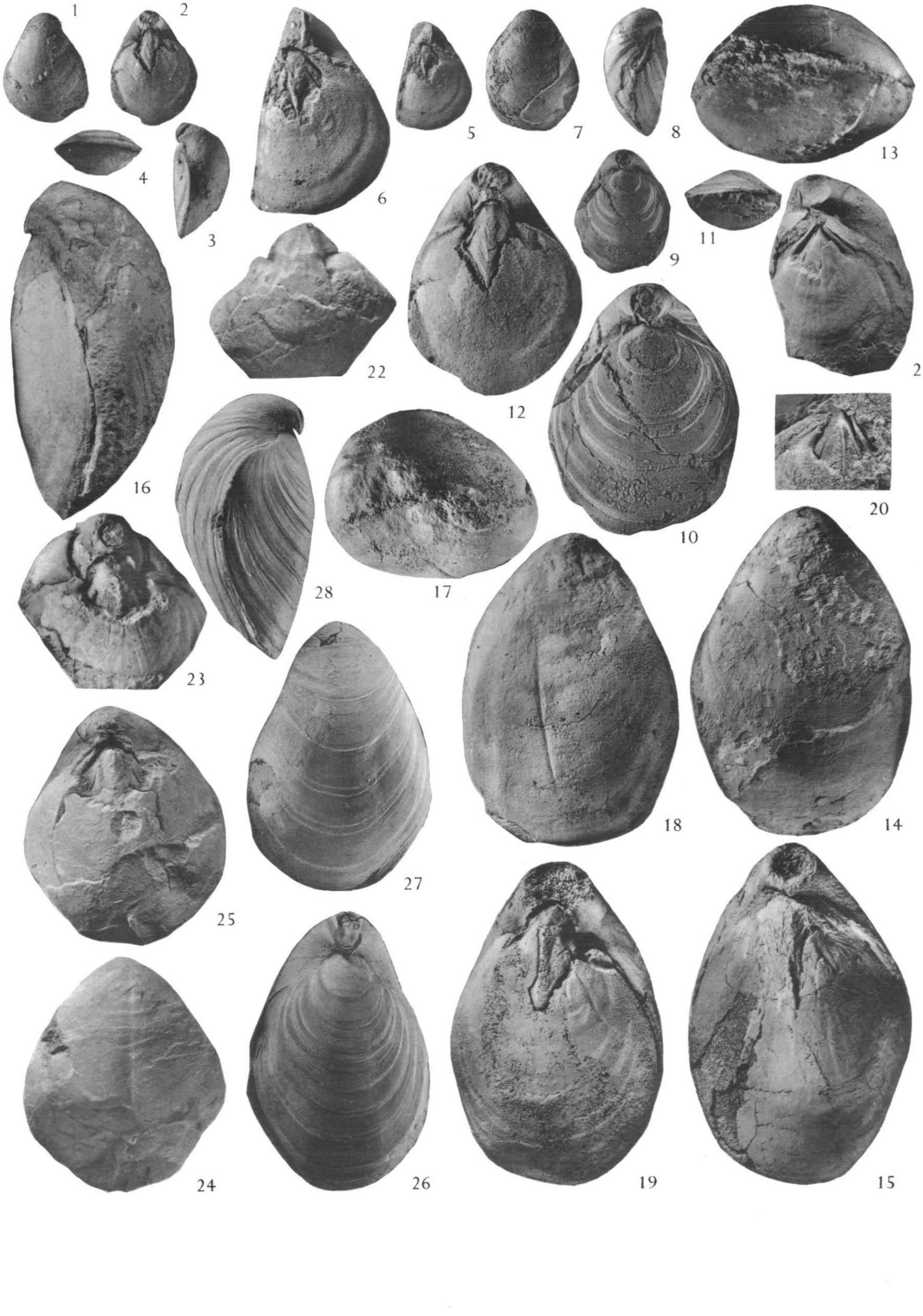
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PLATE 5

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Gilledia cymbaeformis (Morris) 72

1–4. Ventral, dorsal, lateral, and anterior views of **holotype;** B96872 B.M.N.H.

Gilledia pelicanensis sp.nov. 87

5–8. Dorsal, dorso-lateral, lateral, and ventral views of incomplete internal mould; note strong pedicle collar, narrow hinge plates, very long dorsal pedicle adjustor scars in 5 and 6, and shape of muscle field in 8; F1485 G.S.Q., **holotype,** *Strepto-rhynchus pelicanensis* Bed, Collinsville, Qld.

9. Internal mould of part of a pedicle valve; F2269 G.S.Q., same horizon, Pelican Creek, near Collinsville, Qld.

Marinurnula mantuanensis sp.nov. 102

10–12. A testiferous specimen; F25686 U.Q., **holotype,** Mantuan Formation, south of Tanderra (Nardoo) Homestead, Qld.

13. Lateral view of umbonal part of interior of brachial valve showing inner socket ridge, and outer hinge plate joined directly to floor of valve; F2257 G.S.Q., Mantuan Formation, Mount Serocold, Qld.

14. Partly exfoliated and broken pedicle valve; F2255 G.S.Q., same locality.

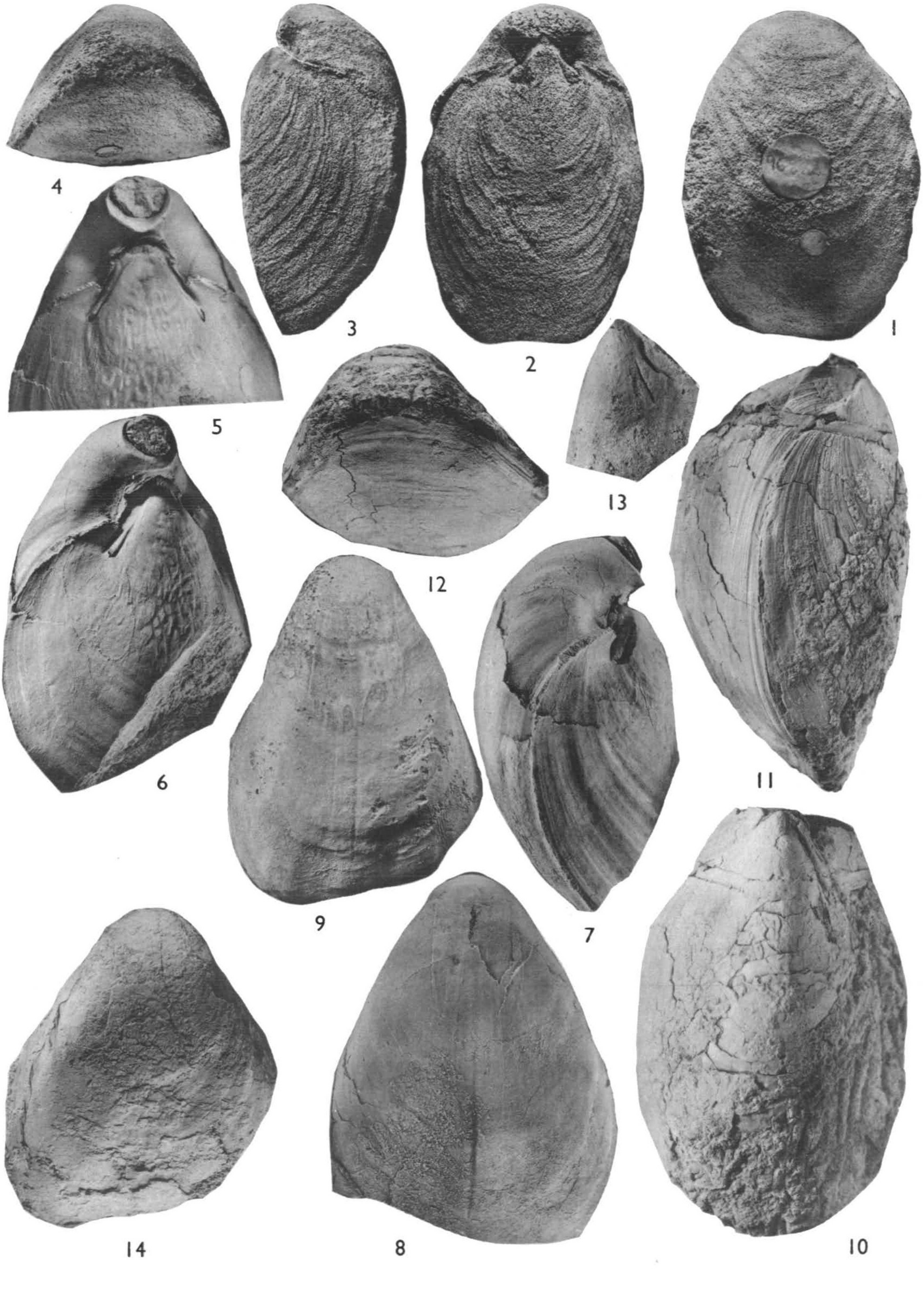

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PLATE 6

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Fletcherithyris farleyensis sp.nov. 33

1, 3. Ventral and anterior views of a small internal mould; F19478 S.U., Farley Formation, Farley.

2. Dorsal view of an internal mould; note adductor scars; F19457 S.U., same locality.

4, 5, 9. Dorsal, anterior, and ventral views; note shapes of growth-lines on septalium; F29510 A.M., same locality.

6, 10. Ventral and dorsal views of an internal mould; note low septum in front of characteristically shaped septalium; F19463 S.U., same locality.

7, 8. Lateral and dorsal views of an internal mould; note adductor scars and long straight trunks of vascula media; 14092 A.N.U., **holotype,** same locality.

Fletcherithyris amygdala (Dana) 26

11, 13–14. Ventral, anterior, and lateral views; F22659 A.M., Gerringong Volcanics, Black Head, Gerringong, N.S.W.

12. Dorsal view; note sockets and septalium; F22660 A.M., same locality.

15–18. Dorsal, lateral, ventral, and anterior views of an almost complete specimen; 3597b U.S.N.M. Dana Coll., **lectotype**, same locality.

19–21. Anterior, lateral, and ventral views; note fine ornament on shoulder of 20; F22661 A.M., same locality.

22–23. Lateral and dorsal views of a specimen with much of shell still present; note shape of foramen and labrum; 11965 A.N.U., same locality.

24. Partly dissected specimen; note growth-lines on septalium; F24140 A.M., same locality.

25–27. Ventral, lateral, and anterior views of an internal mould; note muscle field in 25; F22640 A.M., same locality.

28–31. Ventral, lateral, anterior, and dorsal views of unusually elongate specimen; note adductor scars in 31; F20274 A.M., same locality.

32–34. Two specimens showing shape of septalium; F22639 and F22638 A.M., same locality.

35. Dorsal view of a partly dissected specimen showing adductor scars; markings on scars are the result of preparation of specimen and are not natural; F22637 A.M., same locality.

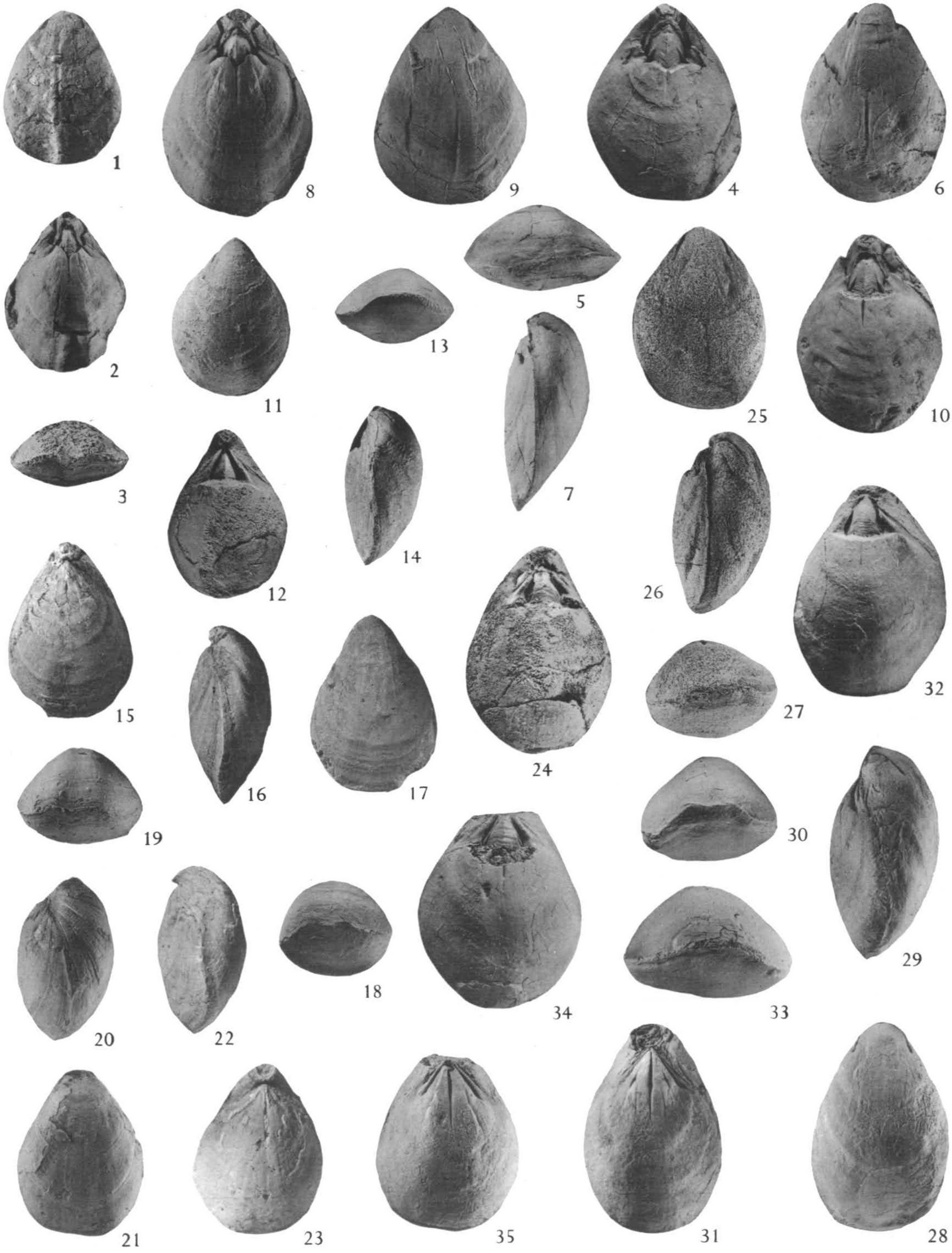

PLATE 7

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Gilledia ulladullensis sp.nov. 83

1–3. Dorsal, lateral, and anterior views of an internal mould; an unusually narrow specimen; 14093 A.N.U., just above Collinsville Coal Measures, Collinsville.

4–6. Dorsal, anterior, and lateral views of internal mould of young individual; F2231 G.S.Q., same horizon, near Collinsville.

7–9. Dorsal, lateral, and anterior views of unusually narrow specimen with long dorsal median furrow; F39486 A.M., Conjola Formation, Wyro, N.S.W.

10–12, 15. Dorsal, lateral, and anterior views of almost complete specimen; 15, latex cast of exterior of front of pedicle valve showing arrangement of fine furrows; F22828 A.M., same locality.

16. Dorsal view of dissected specimen; note myophore surfaces with a knob of shell between them; F24126 A.M., same locality.

17. Dorsal view of dissected specimen; note hinge plates, F39491 A.M., same locality.

13–14, 18. Ventral, dorsal, and lateral views of a specimen with most of its shell stripped; hinge plates dissected out; F24129 A.M., same locality.

19–22. Dorsal, ventral, anterior, and lateral views; note that some shell is stripped off, particularly around pedicle umbo; F6042 U.N.E., same locality.

23. Posterior view of latex cast of umbo of average-sized specimen showing foramen and labrum; F6045a U.N.E., same locality.

Gilledia ulladullensis alta subsp.nov. 85

24–26. Dorsal, lateral, and anterior views of an internal mould; note slight median furrow on brachial valve. Pedicle umbo almost complete: 25 gives a correct impression of its orientation; F45316 A.M., Capertee Group, Rylstone, N.S.W.

27–29. Anterior, lateral, and dorsal views of an internal mould; pedicle umbo badly broken; F43035 A.M., same locality.

30–32. Ventral, lateral, and anterior views of an internal mould; pedicle umbo slightly broken; F49647 A.M., **holotype,** same locality.

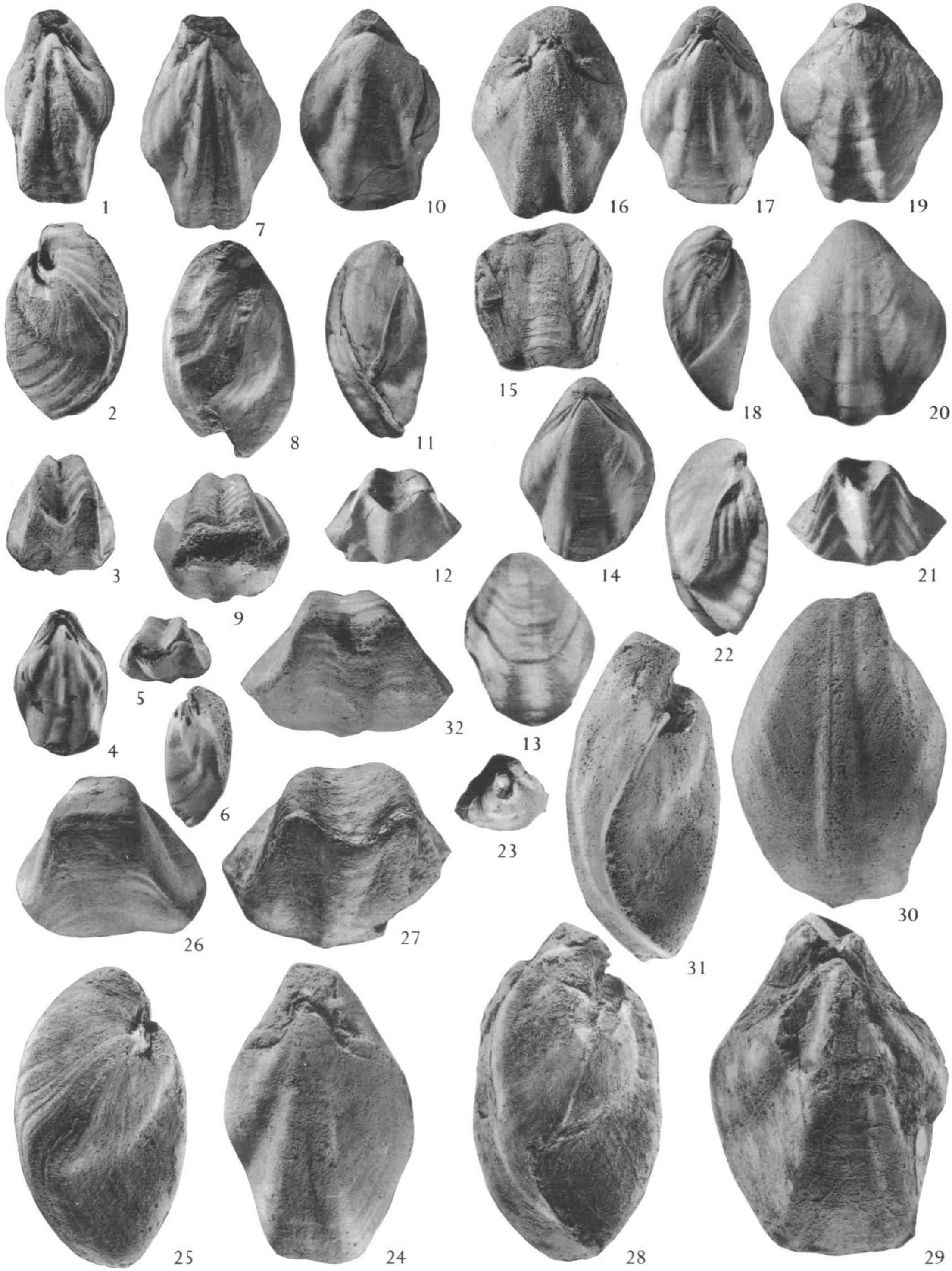
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PLATE 8

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Fletcherithyris parkesi sp.nov. 43

1–2. Dorsal and anterior views of a young specimen; F21851 A.M., Conjola Formation, Wyro.

3–5. Ventral, dorsal, and anterior views of a young specimen; F21847 A.M., same locality.

6–9. Lateral, ventral, anterior, and dorsal views of a well preserved specimen; F6048 U.N.E., **holotype,** same locality.

10–13. Lateral, ventral, dorsal, and anterior views of an unusually flat specimen; F21853 A.M., same locality.

14–15. Dorsal and lateral views of a partly dissected specimen; 14a, x 2; F21850 A.M., same locality.

16–19. Ventral, dorsal, lateral, and anterior views of a large specimen typical of the Gerringong Volcanics; note traces of fine furrows on 16 and 18; F17009 A.M., Gerringong Volcanics, Black Head, N.S.W.

20–23. Anterior, lateral, and dorsal views of an internal mould; note cardinal process and septalium in 23, which is x 2; F13746b A.M., ? Muree Formation, West Maitland.

Fletcherithyris canni sp.nov. 23

24–25, 29. Dorsal, anterior, and lateral views; note adductor scars in 24; 11983 A.N.U., ? Nowra Sandstone, Culburra Headland.

26–28. Anterior, ventral, and dorsal views; 11985 A.N.U., same locality.

30–31. Dorsal and ventral views; 11988 A.N.U., **holotype,** same locality.

Gilledia oakiensis sp.nov. 79

32. Latex cast of pedicle valve showing teeth; 11899 A.N.U., Middle Bowen Beds, Oaky Creek, near Homevale.

33. Latex cast of umbonal region showing short labrum; 11922 A.N.U., x 2, same locality.

34–37. Anterior, ventral, dorsal, and lateral views of small specimen; 11914 A.N.U., same locality.

38. Internal mould of pedicle valve; 11919 A.N.U., same locality.

39–40. Dorsal views of two internal moulds; note typical arrangement of hinge plates; radial markings on 40 not due to dissection; 11919 A.N.U. and F21269 UQ., **holotype,** same locality.

41. Lateral view of large specimen with much of shell stripped off; F21313 U.Q., same locality.

Gilledia ulladullensis alta subsp.nov. 85

42. Dorsal view; F22832 A.M., Gerringong Volcanics, Wollongong.

Hoskingia grandis sp.nov. 67

43. Internal mould showing unusually short septalium; CPC 5275, Hardman Member, locality KLC 14, W.A.

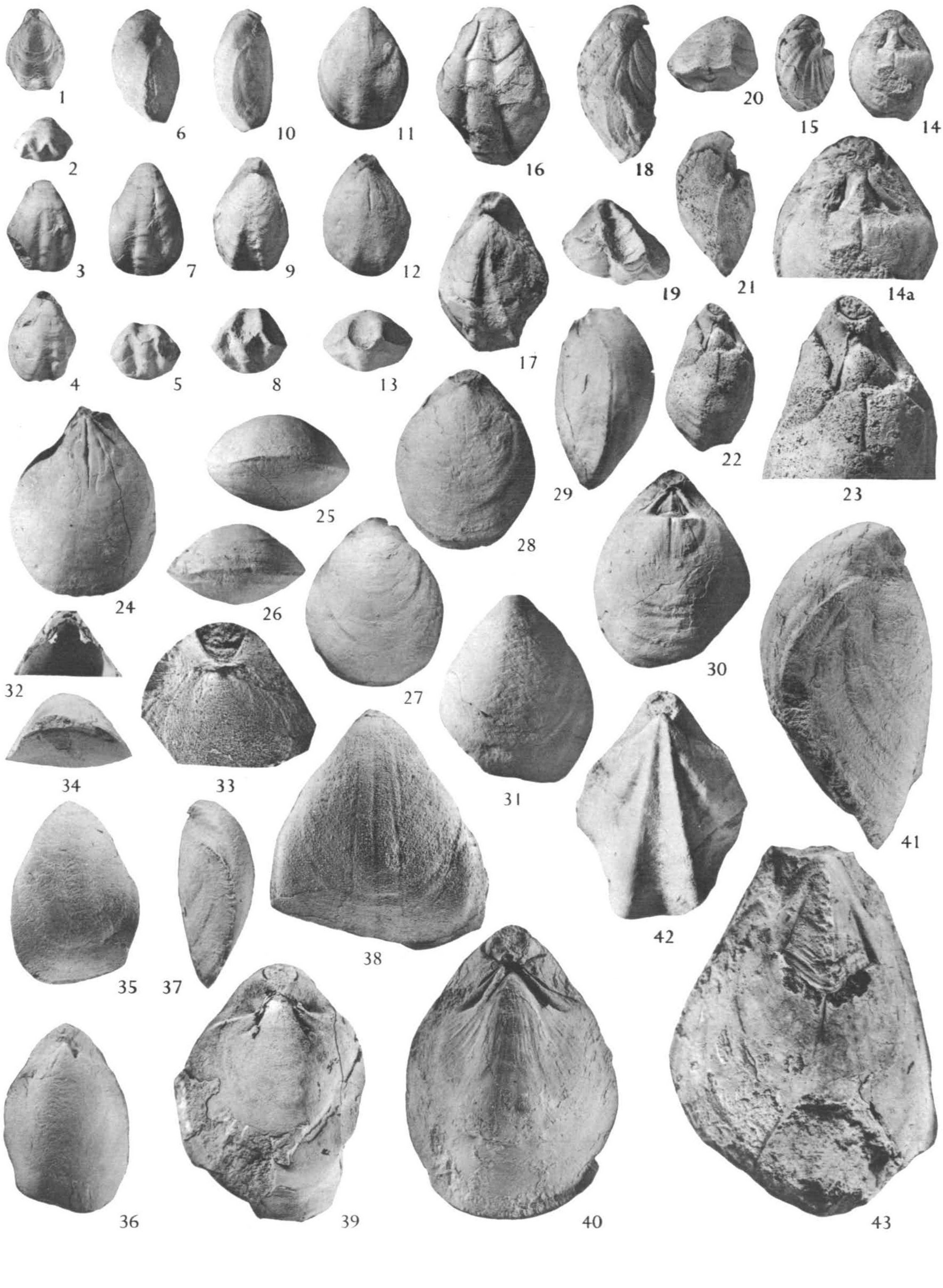
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PLATE 9

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Fletcherithyris lawarrensis sp.nov. 40

1–4. Ventral, anterior, dorsal, and lateral views; F6052 U.N.E., **holotype**, Conjola Formation, Wyro.

Yochelsonia thomasi Stehli 49

(All anterior views oriented with brachial valve downwards)

5. Latex cast of a broken umbonal part; note short labrum; CPC 5219, x 1·5, Wandagee Formation, locality ML 44.

6–7. Lateral and anterior views of specimen with broken umbones; note numerous parallel pallial trunks around strongly inflected margins of 7; CPC 5224, x 1·5; same locality.

8–11. Lateral, anterior, dorsal, and ventral views of almost complete specimen; CPC 5223, x 1·5, same locality.

12–14. Lateral, dorsal, and ventral views of slightly crushed specimen with less than normal marginal inflexion; CPC 5227, x 1·5, Noonkanbah Formation, locality PR284A.

15–18. Anterior, lateral, dorsal, and ventral views of large specimen with less than normal marginal inflexion; F28079 U.W.A., x 1·5, Coolkilya Greywacke, locality WF 8.9.

19–21. Anterior, dorsal, and ventral views of a typical specimen; CPC 5219, x 1·5, Wandagee Formation, locality ML 44.

Fletcherithyris hardmani sp.nov. 45

22–23. Interiors of two brachial valves; note 22 worn around umbo; CPC 5333 and CPC 5329, x 2, Hardman Member, locality KLC11.

24–26. Lateral, dorsal, and anterior views of slightly distorted specimen; CPC 5330, x 2, same locality.

27, 29, 30. Same views of another distorted specimen; note long labrum; CPC 5331, x 2, same locality.

28. Anterior view of unusually flat specimen; CPC 5331b, x 2, same locality.

31–32. External and internal views of well preserved pedicle valve; note labrum largely destroyed; CPC 5332, x 2, same locality.

Gilledia cf. *homevalensis* sp.nov. 79

33–34. Dorsal views of two distorted internal moulds; CPC 5306–7, Coyrie Formation, locality GW55.

35. Dorsal view of small internal mould; CPC 5304, upper Cundlego Formation, locality G317.

36–38. Lateral, dorsal, and anterior views of a complete specimen; F33359/4 U.W.A., Wandagee Formation.

39–41. Same views; CPC 5305, upper Cundlego Formation, locality G317.

Gilledia woolagensis sp.nov. 82

42, 44, 46. Lateral, dorsal, and anterior views of internal mould; note arrangement of hinge plates; F31563A U.W.A., **holotype,** High Cliff Formation, Eregulla Springs.

43, 45, 47. Dorsal views of three internal moulds; 45 with some replaced shell still adhering and showing form of labrum; 43 showing dorsal pedicle adjustor scars; note also hinge plates; F31563 b–d U.W.A., same locality.

? *Fletcherithyris farleyensis* sp.nov. ....

48. Dorsal view of crushed specimen possibly belonging to this species; CPC 5305, Coyrie Formation, locality GW48.

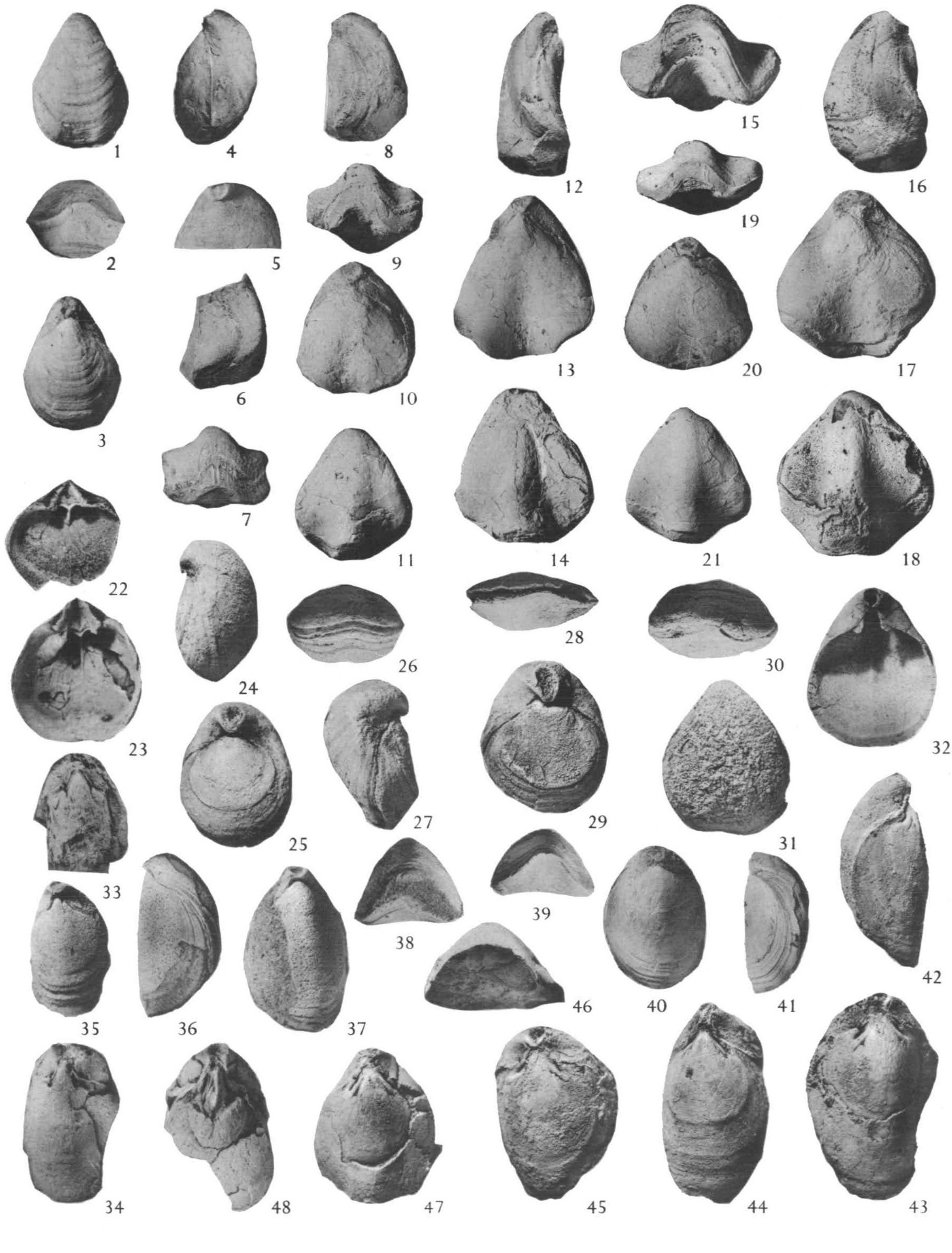
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PLATE 10

All figures natural size unless otherwise stated.

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Hoskingia wandageensis sp.nov.	61

1, 2, 4. Ventral, dorsal, and anterior views; CPC 5192, Wandagee Formation, locality ML44.

3, 5. Dorsal views of two partly dissected small specimens; note variable shape of septalium; CPC 5192 and CPC 5190, same locality.

6–8, 15. Ventral, lateral, and anterior dorsal, views of a partly dissected specimen; F27301a U.W.A., **holotype,** Wandagee Formation, locality WC (29–32)3.

9–12. Ventral, dorsal, lateral, and anterior views of typical specimen; CPC 5214, Wandagee Formation, locality CC98.

13–14. Loop of broken specimen; CPC 5189, locality ML44; 14 is x 2.

Hoskingia grandis sp.nov.	67

16. Dorsal view of incomplete internal mould; note cardinal process and form of septalium, typical of species; CPC 5274, Hardman Member, locality KLC14.

17–19. Dorsal, ventral, and lateral views of an unusually broad and triangular internal mould; CPC 5291a, Hardman Member, locality H3.

20–21. Dorsal and ventral views of an incomplete internal mould; note strong radial marking on pedicle valve; CPC 5286, Hardman Member, locality Cal 2.

Yochelsonia stehlii sp.nov.	51

22–23. Ventral and posterior views of pedicle valve with umbo slightly crushed; note foramen and short labrum; CPC 5229, Lightjack Member, locality KLD64.

24. Dorsal view of partly dissected brachial valve showing septalium; CPC 5236, same locality.

25–26. Anterior and dorsal views of testiferous brachial valve; CPC 5228, **holotype,** same locality.

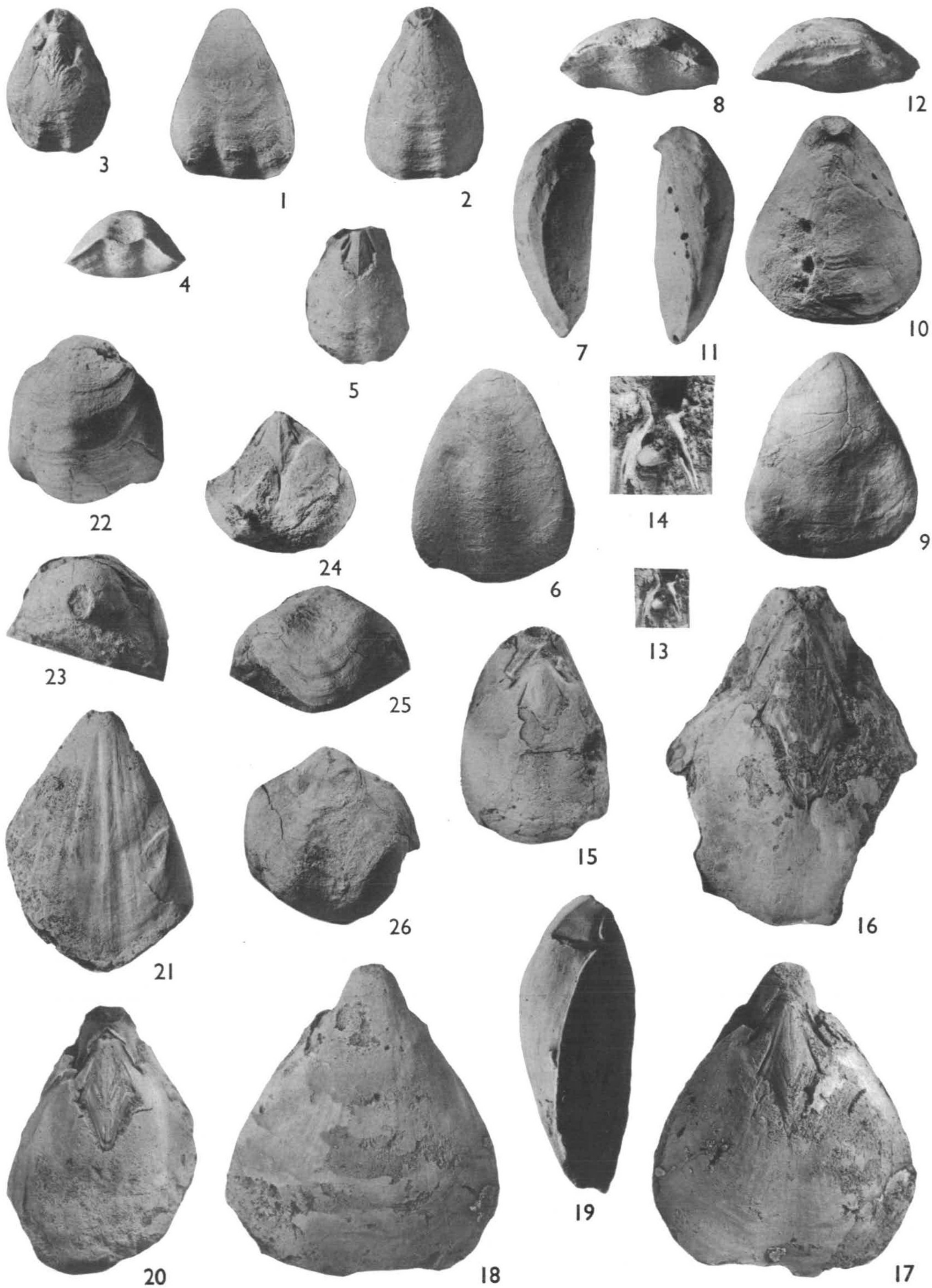
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PLATE 11

All figures natural size.

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Hoskingia grandis sp.nov. 67

1–2. Dorsal and ventral views of internal mould of wide specimen; note that sharp lines joining front edge of crural bases to inner socket ridges are only front edges of thin callus; CPC 5266, Hardman Member, locality KLC40, Mount Hardman, W.A.

3–4. Dorsal and ventral views of the internal mould of a specimen of more typical shape; CPC 5265, **holotype,** same locality.

5. Internal view of specimen with part of pedicle valve adhering to brachial valve; note pedicle collar, the way inner socket ridges are cut away in front of cardinal process, which is slightly exaggerated in this photograph, and septalium; CPC 5294, Hardman Member, near Mount Hardman windmill.

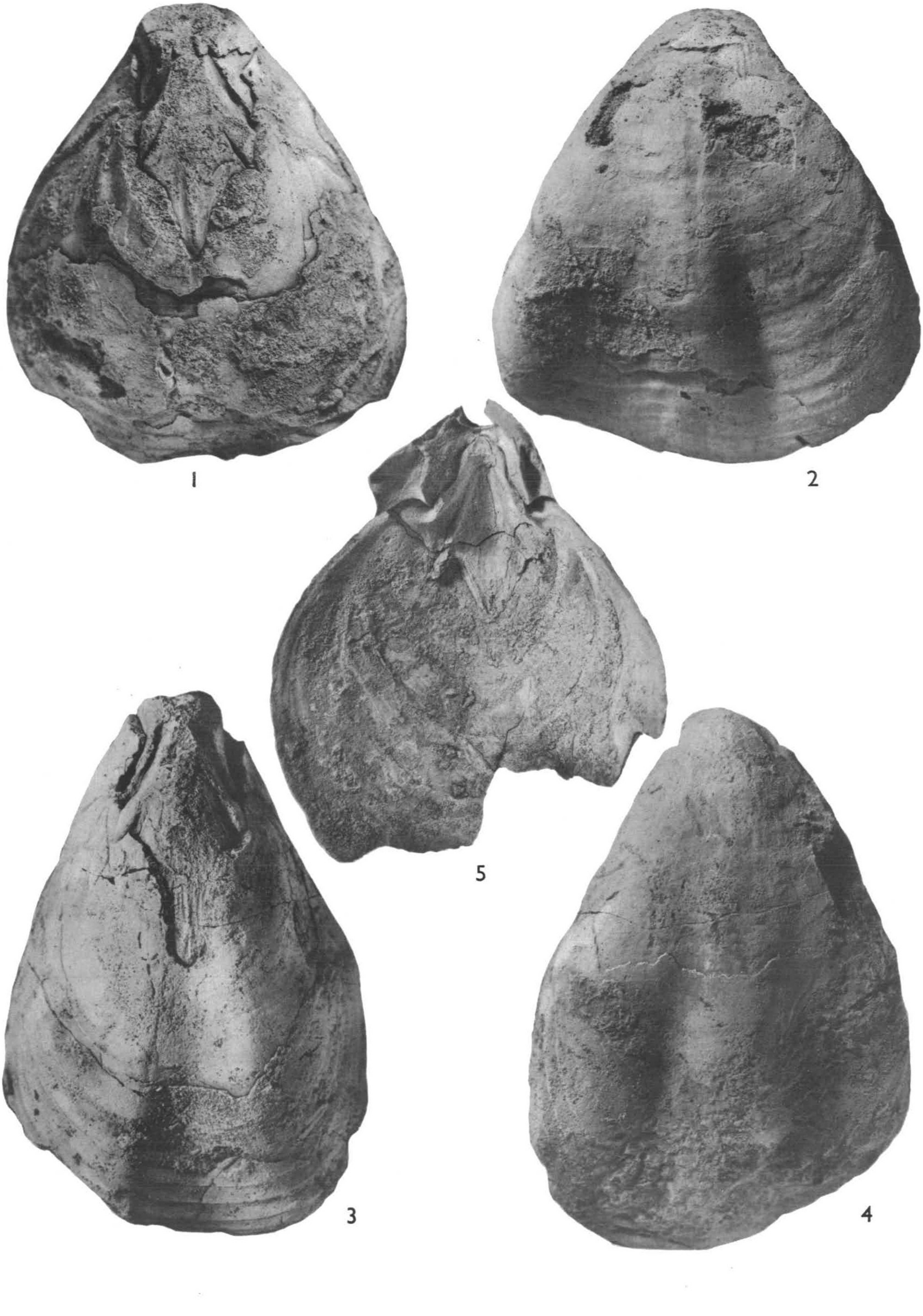
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PLATE 12

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Hoskingia kennediensis sp.nov.	65
1–2. Dorsal views of latex cast and internal mould; F17612a U.W.A., **holotype,** Bulgadoo Formation.	
3. Dorsal view of internal mould; F17612b, paratype, same locality.	
Hoskingia grandis sp.nov.	67
4. Internal mould of brachial valve of a young individual; CPC 5282, Hardman Member, locality H3.	
Hoskingia wandageensis sp.nov.	61
5–7. Ventral, dorsal, and lateral views of an unusually broad individual; CPC 5217, Wandagee Formation, Wandagee Station, W.A.	
Hoskingia nobilis (Etheridge)	59
8–11. Ventral, dorsal, lateral, and anterior views of a very well preserved internal mould; F29908a U.W.A., Mingenew Formation, Eregulla Springs Station, W.A.	
12–13. Dorsal views of two internal moulds showing shapes of adductor scars and septalium; F29908b and c, same locality.	
Hoskingia trigonopsis (Hosking)	55
14. Interior of brachial valve of testiferous specimen; note pseudo-outer hinge plates, crural bases, and septalium; CPC 5258a, Madeline Formation, locality WB135.	

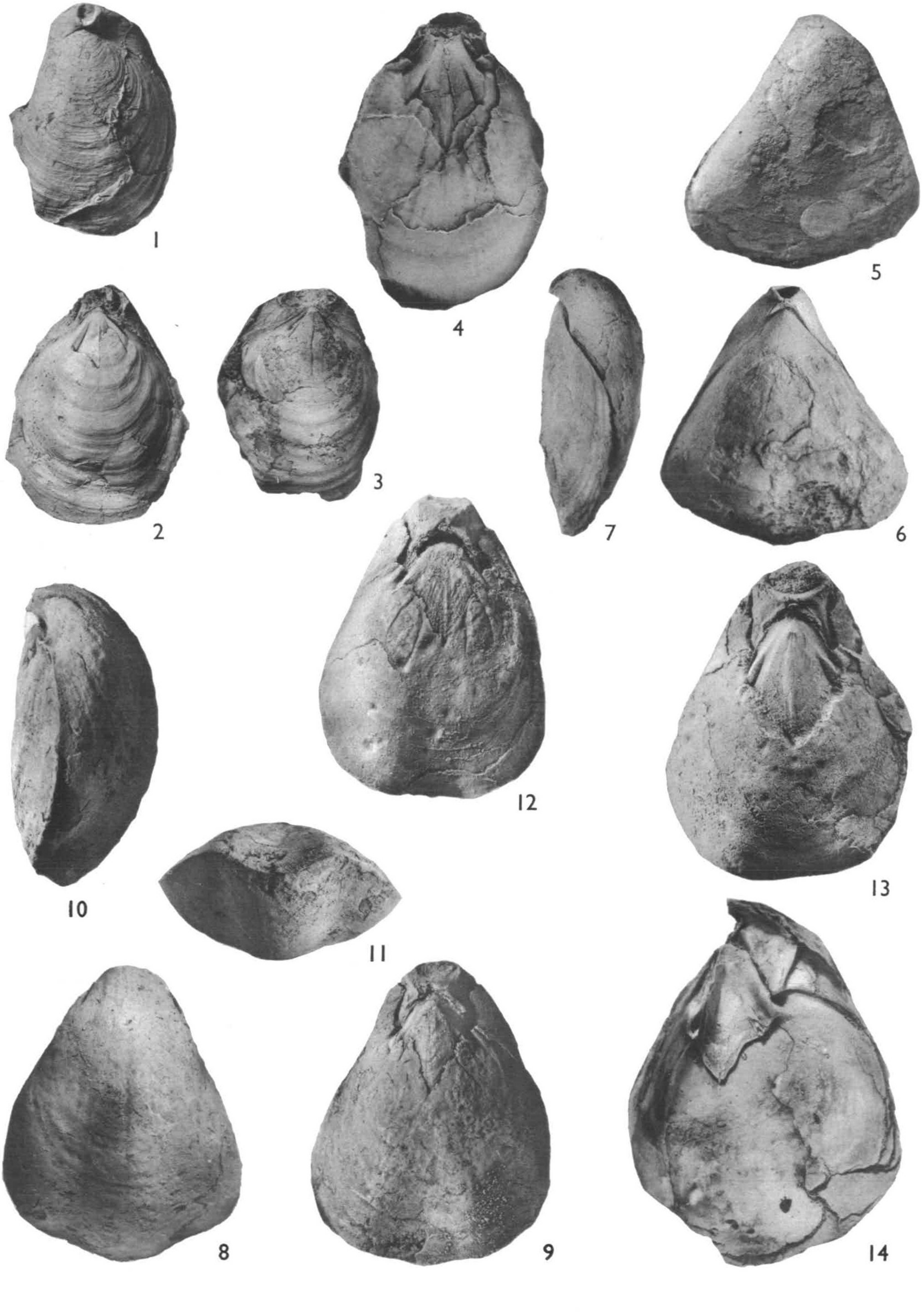
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PLATE 13

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Hoskingia trigonopsis (Hosking)	55

1–4. Ventral, lateral, dorsal, and anterior views of 1/4950 G.S.W.A., **lectotype,** Madeline Formation, Wooramel River, W.A.

5–6, 8. Dorsal views of partly dissected specimens, showing shape of septalium; note position of outer hinge plates in 5 and 6, pseudo-outer hinge plate on right of 5, shape of cardinal process in 6, and outline of adductor scars and form of foramen in 8; CPC 5247, CPC 5260 and CPC 5245 respectively, Madeline Formation, Wooramel River, W.A.

7. Internal mould of broken pedicle valve showing dental lamellae, pedicle collar, and muscle field; same specimen as in Fig. 5.

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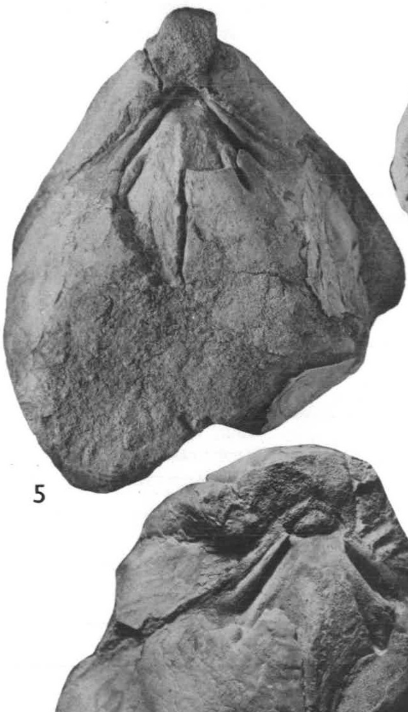

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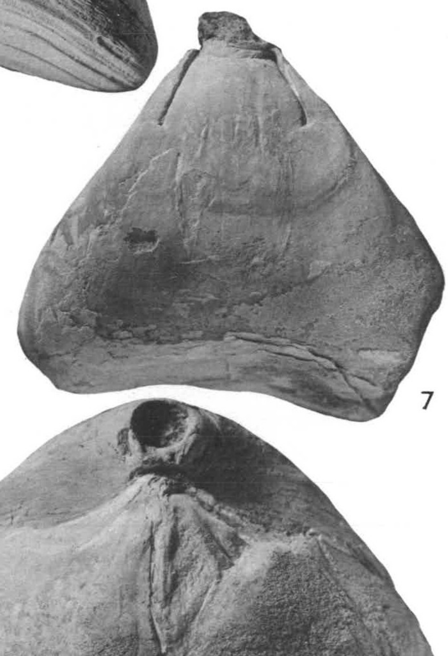

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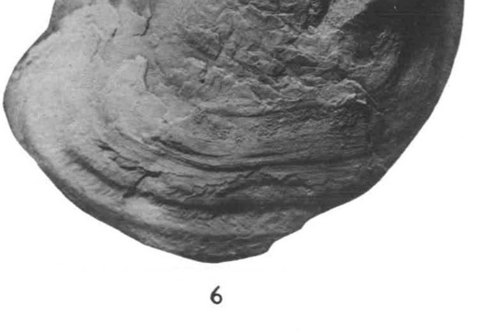

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PLATE 14

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Maorielasma callosum sp.nov. 96

1. Ventral view of internal mould; note pseudo-dental lamellae; CPC 5942, Ingelara Shale, locality SP115.
2. Posterior view of pedicle valve; note short labrum; CPC 5945, same locality.

3–4. Dorsal and postero-dorsal views of internal mould; note pseudo-dental lamellae and adductor scars; CPC 5942, same locality.

5. Dorsal view of internal mould of brachial valve with septalium exposed on left side; CPC 5944, same locality.
6. Dorsal view of internal mould; CPC 5941, **holotype,** same locality.

7–8. Internal mould of brachial valve, and latex cast from same; F5955 G.S.Q., Barfield Formation, Banana-Barfield Road.

Maorielasma globosum sp.nov. 97

9–11. Postero-dorsal, ventral, and dorsal views of a dissected specimen; CPC 5951, Mantuan Formation, locality SP391.

12. Postero-dorsal view of complete specimen; note long labrum; CPC 5963, Mantuan Formation, locality SP649.

13–15. Dorsal, ventral, and posterior views of fine internal mould; note unusually short septalium, muscle scars in both 13 and 14, growth-lines on outer hinge plate in 13, and pseudo-dental lamellae in all figures; F5946 G.S.Q., Big *Strophalosia* Zone, locality D26.

16. Interior of umbonal part of broken specimen; note unusually large callus deposits; CPC 5952, Mantuan Formation, locality SP391.

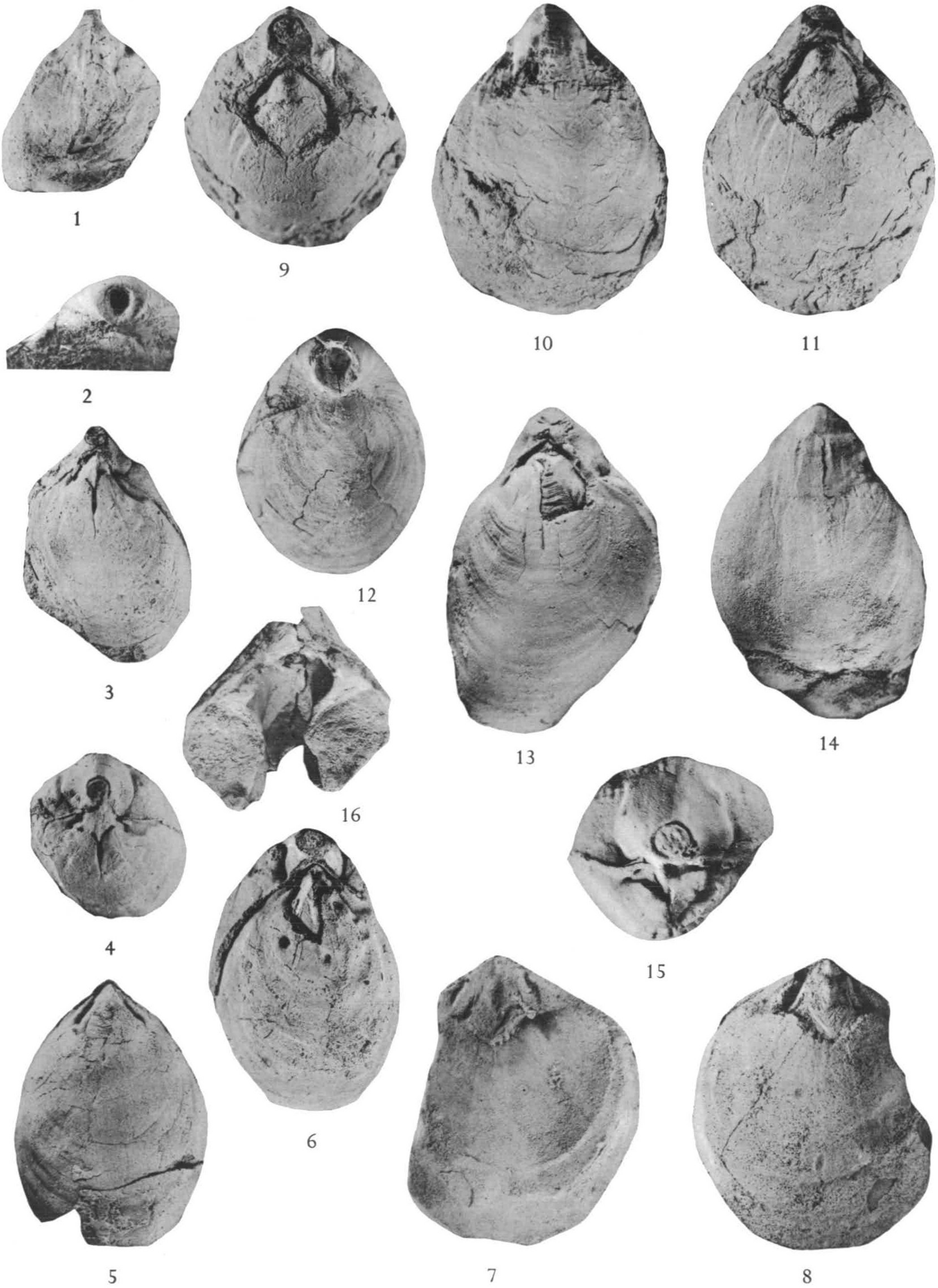
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PLATE 15

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Fletcherithyris illawarrensis sp.nov. 40

1. Dorsal view of partly dissected specimen; note very long sockets and shape of septalium; F11957 A.N.U., Conjola Formation, Wyro; x 2.

Maorielasma callosum sp.nov. 96

2–4. Almost complete specimen with most of shell stripped off and septalium exposed on left side; F42504 U.Q., Orange Creek Formation, Cracow-Theodore Road.

Gilledia pelicanensis sp.nov. 87

5–7. Anterior, dorsal, and lateral views of internal mould; CPC 5299, just below *Streptorhynchus pelicanensis* Bed, Corduroy Creek.

Gilledia ulladullensis sp.nov. 83

8–11. Dorsal, anterior, ventral, and lateral views of almost complete specimen; F20779 A.M., **holotype,** Conjola Formation, Wyro.

Gilledia jervisensis (Etheridge) 87

12. Dorsal view of an internal mould; F268 A.M., **holotype,** ? Nowra Sandstone, Jervis Bay.

Jisuina sp. 105

13–15. Ventral, lateral, and dorsal views of internal mould; note slits representing crura in 14 and 15; F35682 A.M., ? Muree Formation, West Maitland x 2.

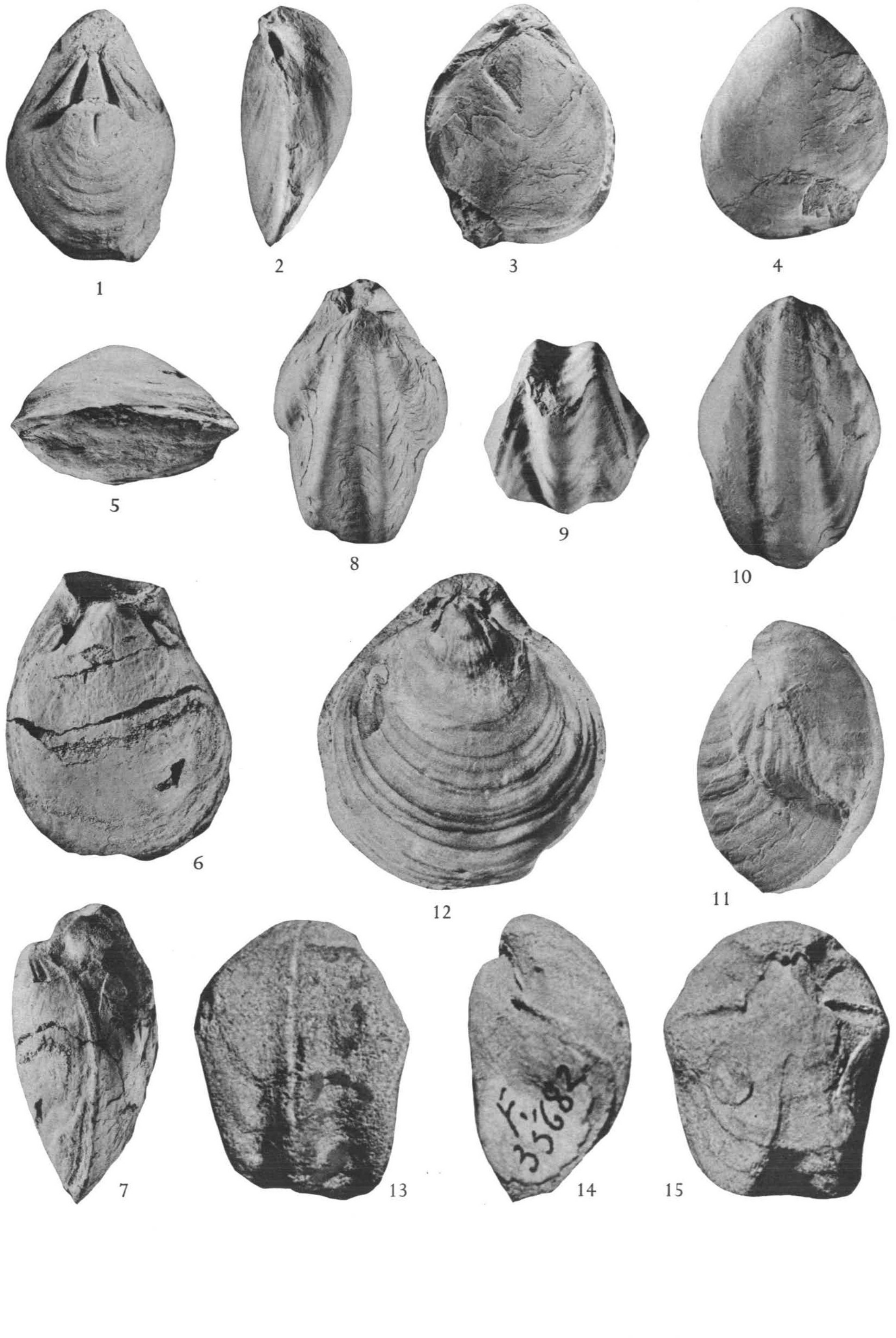
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PLATE 16

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Hemiptychina sp. 104

1. Brachial valve with broken umbo; CPC 5969, Noonkanbah Formation, locality KNF73.

Fletcherithyris cf. *hardmani* sp.nov. 47

2–4. Anterior, dorsal, and lateral views of internal mould; CPC 5355, x 1·5, Noonkanbah Formation, locality PR288.

5. Dorsal view of brachial valve; note adductor scars; CPC 5354, x 1·5, same locality.

6. Dorsal view of dissected specimen; CPC 5353, x 1·5, same locality.

Fletcherithyris hardmani sp.nov. 45

8. Interior of brachial valve; note cardinal process and the anterior socket ridges; CPC 5329, x 4, **holotype**, Hardman Member, locality KLC11.

9. Interior of part of a largely sediment-filled brachial valve with broken loop; CPC 5974, x 7, same locality.

Fletcherithyris cf. *reidi* sp.nov. 38

7. Internal mould of pedicle valve; note elongate outline, nearly parallel dental lamellae, and long pedicle collar; CPC 5949, Ingelara Shale, locality SP115.

? *Pseudodielasma* sp. 106

10–12. Lateral, ventral, and dorsal views of internal mould; CPC 5300a, *clarkei* or pelecypod bed, CL142, Clermont Sheet.

13–14. Dorsal and posterior views of internal mould; note relation of crural bases to inner socket ridges in 14; CPC 5301, Barfield Formation, near Theodore; 14 is x 2.

Gilledia cf. *pelicanensis* sp.nov. 89

15–17. Lateral, ventral, and anterior views of internal mould showing unusually strong plication; F20301 A.M., Nowra Sandstone, Jerrawangala.

18–19. Internal mould of brachial and pedicle valve of normal type for locality; F19312 and F20286 A.M., same locality.

Marinurnula mantuanensis sp. nov. 102

20. Internal mould of brachial valve; note particularly well developed outer hinge plates and divergence from inner socket ridges; CPC 5948, Ingelara Shale, locality SP115.

21. Dorsal view of almost complete internal mould; CPC 5964a, Mantuan Formation, locality SP719.

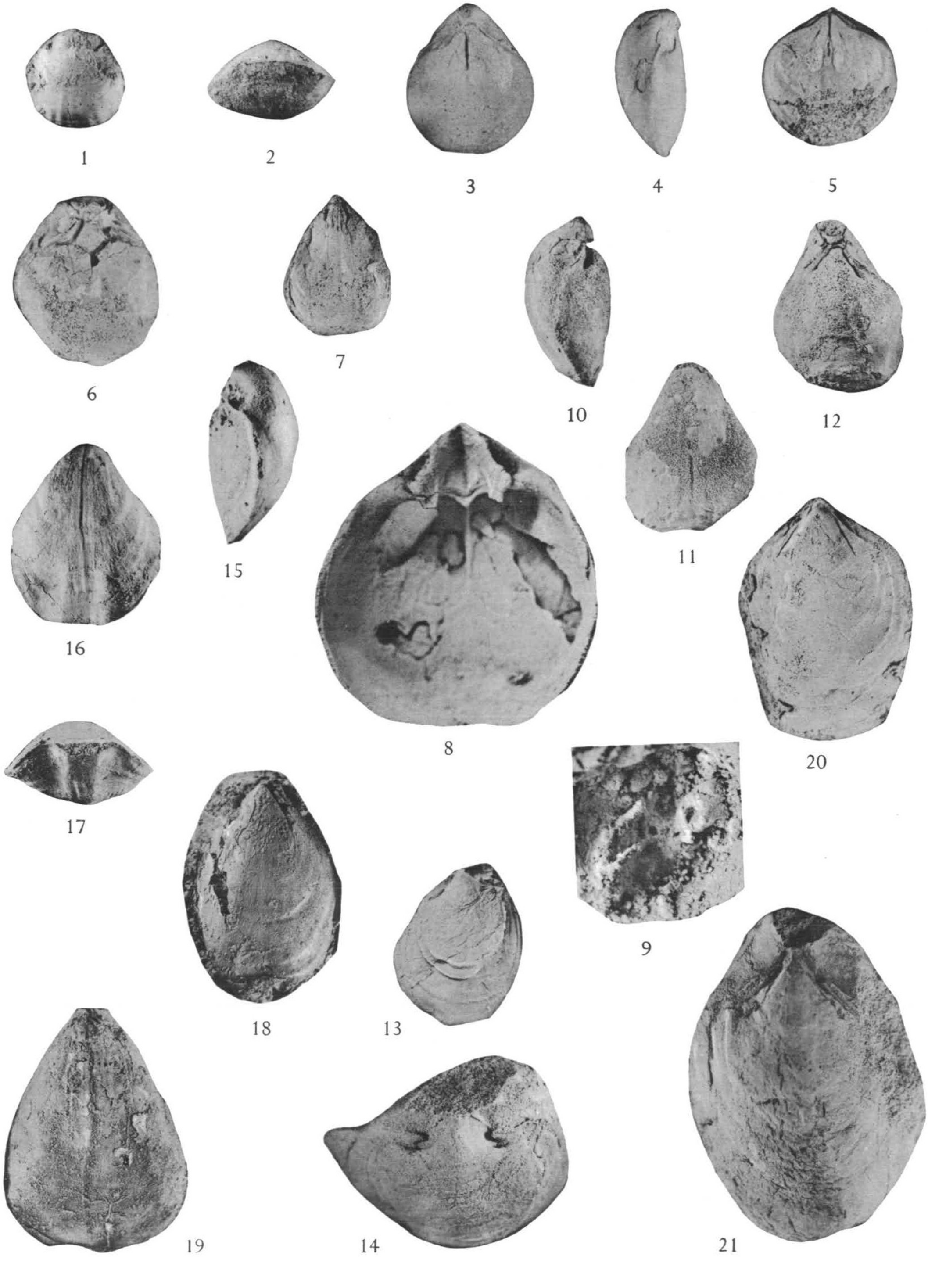
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PLATE 17

All figures x 8 approx.

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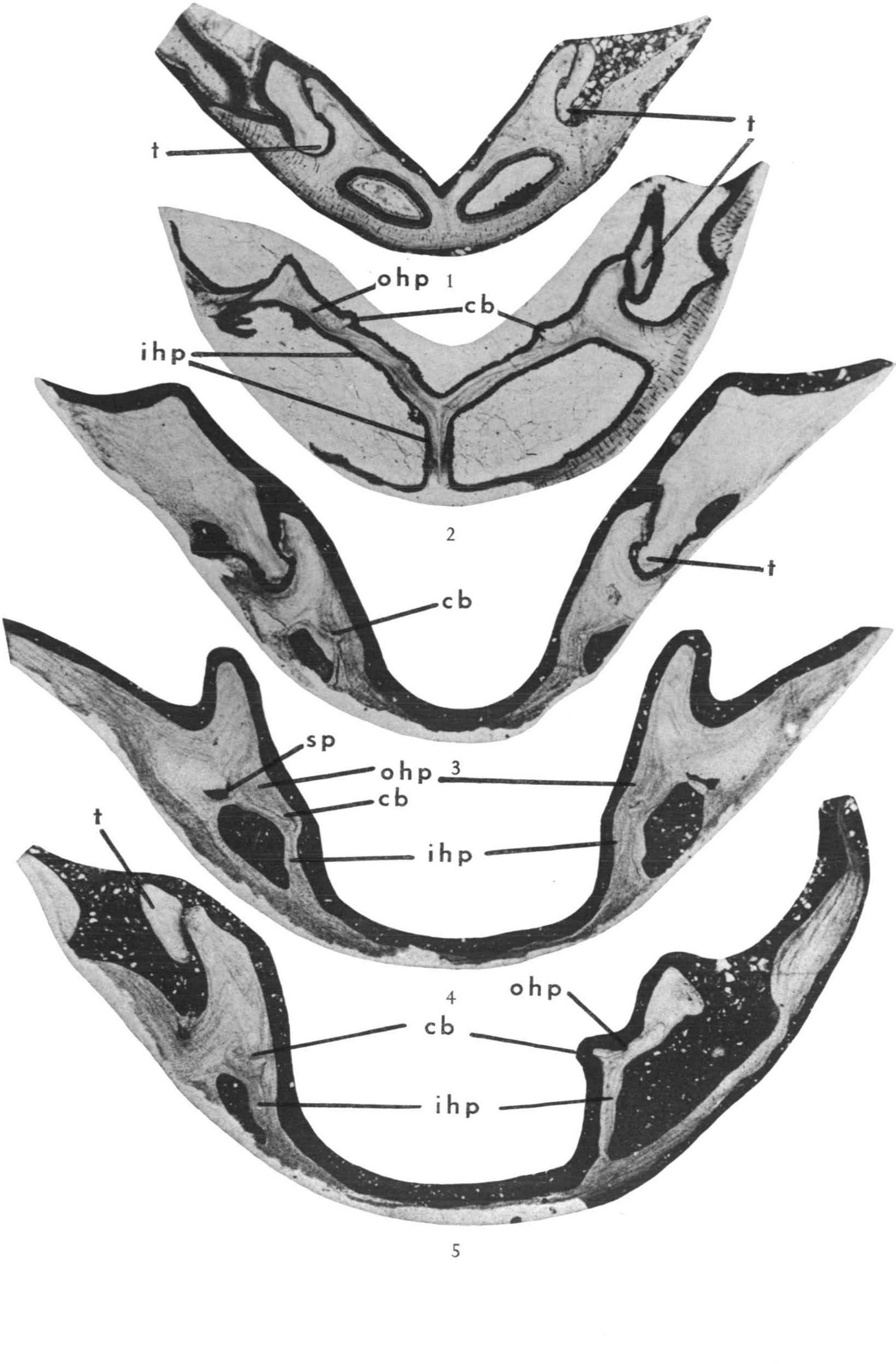
Fletcherithyris amygdala (Dana) 26

1, 2. First section cut near umbo of brachial valve and second near front of septalium; note teeth (t) in socket, outer hinge plates (o h p), crural bases (c b), and inner hinge plates (i h p); note also continuity of fibres between crural bases and base of septum; 1409 and 1410 A.N.U.

Gilledia culburrensis sp.nov. 89

3–5. Three sections cut progressively farther from umbo, in three different specimens; note fibre arrangements in inner and outer hinge plates, old crural bases embedded in later tissue especially on left of 3, and very unusual development of a second plate below socket floor in 4. Fig. 5 from a slightly oblique section, 1419a, 1419b, and 1420 A.N.U.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