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THE PERMIAN GASTROPODS OF NEW SOUTH WALES

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(Plates 7-21)

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SUMMARY

The Permian gastropod fauna of New South Wales is revised and 7 new genera and 16 new species are described and figured.

For the purposes of correlation gastropods have proved to be an unsatisfactory group. This is because they appear to be very susceptible to environmental changes and many species develop within a sequence to a marked extent in comparatively narrow limits both horizontally and vertically. Some species, however, form valuable "marker" or "index" fossils for certain horizons of limited extent.

In this paper a correlation of the Permian horizons in New South Wales is made, so far as is possible, from a study of the gastropod fauna. Special attention is directed towards the uncertain correlations of the "rock unit subdivisions" of the South Coast with those of the Hunter River Valley.

The study of the Permian gastropods has led to certain interesting correlations, but attempts made to correlate the complete sequence of Permian rocks of the South Coast with those of the Hunter River Valley have been impossible.

INTRODUCTION

Rocks of Permian age cover considerable portions of fairly widely separated areas in New South Wales. A great deal of attention has been directed to these rocks for more than a century because of the economic importance of the coal seams found in the Upper Coal Measures, the Greta Coal Measures and their equivalents.

The type locality of the Permian rocks in New South Wales is in the lower Hunter Valley where a complete and continuous sequence occurs. In this area, as well as over most of the Sydney Basin, the Newcastle Coal Measures pass upwards without angular unconformity into the overlying Narrabeen Group of Lower Triassic age. The basal glacial shales of the Permian rest also without angular unconformity upon the Kuttung Group of the Carboniferous.

The geology of the Permian areas in New South Wales has been thoroughly investigated over the years and the stratigraphy is well known, particularly in the Hunter River Valley. There is still some doubt, however, regarding the exact succession of "rock units" of the Upper Marine Series which are found outcropping on the South Coast from Wollongong to near Durras Waters a few miles north of Bateman's Bay.

The great abundance and variety of well preserved fossils found in both the Maitland (Upper Marine) and Dalwood (Lower Marine) Groups and their equivalents, has attracted the attention of palaeontologists in the past and many important contributions to knowledge have been published. Nevertheless knowledge of the marine fauna is inadequate and surprisingly incomplete.

HISTORICAL REVIEW OF PERMIAN GASTROPODS WITHIN NEW SOUTH WALES

The first Permian gastropod from New South Wales was recorded in 1838 when James D. Sowerby figured, but did not describe, a medium sized shell as "The *Trochus* . . . may be called *T. oculus*". His figures of this specimen were idealised to some extent and photographs provided by the British Museum have proved certain inaccuracies.

The location of this specimen is mentioned by Mitchell (1838) as: "A hill of some height on the right bank, situate some twenty-six miles from the sea-shore, is composed chiefly of a volcanic grit of greenish-grey colour, consisting principally of felspar, and being in some parts slightly calcareous, in other parts highly calcareous when the rock assumes a compact aspect. . . . This rock contains numerous fossils." This hill in the Hunter River Valley, now known as Harper's Hill, is the type locality for many fossil species. On the same horizon, the Allandale Formation of the Dalwood (Lower Marine) Group, are nearby localities referred to in literature as Allandale, Duguid's Hill, and "Lochinvar", a locality occasionally listed for early material obviously collected at Harper's Hill.

A series of gastropods collected from Harper's Hill, Glendon and Illawarra by P. E. de Strzelecki was described by J. Morris (1845: 285-288). The specimens are housed in the collection of the British Museum. The name Illawarra now refers to a district of considerable extent on the South Coast, but it is almost certain that Strzelecki collected his fossils at Wollongong, about 50 miles south of Sydney. Glendon is a locality in the Hunter River Valley which is referred to by several of the early authors, but there is doubt regarding its actual geographical position. The locality was usually accepted as being on the northern bank of the Hunter River about 9 miles east of Singleton. This must be incorrect as the exposed rocks in that area are unfossiliferous.

On a geological map of New South Wales and Van Diemen's Land, prepared by Strzelecki (1845, insert), the locality referred to as Glendon is marked on an unnamed creek about 5 miles north of its junction with the Hunter River. The locality could therefore be on Wattle Ponds Creek which flows into Glendon Brook. It is possible that the fossil horizon is in the Belford Formation of the Maitland (Upper Marine) Group although the described fossils also appear to indicate an association with the fauna of the underlying Fenestella Shale Formation. Further careful investigation is needed in this area before this rather important point can be cleared satisfactorily and the exact original locality of Glendon becomes known.

Morris (1845 : 285—288) described and figured the following gastropods :—

Platyschisma oculus (Sowerby). = *Trochus oculus* Sowerby. Harper's Hill.

Platyschisma rotundatum Morris. Harper's Hill.

Pleurotomaria strzeleckiana Morris. Glendon and Illawarra.

Pleurotomaria subcancellata Morris. Illawarra.

Bellerephon micromphalus Morris. Illawarra.

He also recorded from Illawarra "another species of *Pleurotomaria*, nearly related to *P. conica* Phillips, in having a bicarinated mesial band, and numerous small, oblique, rather acute striae on each volution; it differs however from that species in being smaller, more elongated and acutely conical". This shell was later described and figured by M'Coy (1847) as *Pleurotomaria morrisiana*. Most of the material described by Morris is stored in the collection of the British Museum.

It is considered most unlikely that *Platyschisma rotundatum* was ever found in abundance at Harper's Hill, as recorded by Morris, or even if it ever occurred there. The specimen figured by that author (1845 : pl. xviii, fig. 2) is a typical example of the species found at Wollongong and in my opinion an error in the labelling of the specimens must have occurred. M'Coy (1847 : 306) repeated the error when he listed *Platyschisma rotundatum* (Morris) as "abundant in the dark arenaceous limestone of Harper's Hill, New South Wales". Recent investigations have shown that this species does not occur in the Dalwood (Lower Marine) Group and its equivalents, but is common in the Maitland (Upper Marine) Group and particularly in its equivalents of the South Coast and Western Coalfield Provinces.

In a description of the Palaeozoic Formations of New South Wales and Van Diemen's Land, J. Beete Jukes (1847 : 242) listed two species of gastropods from Wollongong. These were identified by Sowerby as *Pleurotomaria strzeleckiana* and *Bellerephon contractus*, MSS., sp. nov. The latter name has no validity as it was never described or figured. It is almost certain to be the same species as described by Dana (1847 : 150) from the same locality as *Bellerephon strictus*. The specimens collected by Jukes are now in the British Museum, having been transferred from the Geological Society's Museum (London) in 1911.

In September, 1847, Frederick M'Coy (1847 : 305—308), when describing a collection of fossils made by the Rev. W. B. Clarke, included a number of Permian gastropods. He described and figured *Pleurotomaria morrisiana* from Black Head, near Gerringong, and also mentioned it was rare in the sandstone at Muree in the Hunter River Valley. Other known species recorded by M'Coy consist of *Pleurotomaria subcancellata* Morris, from Loder's Creek; *Pleurotomaria strzeleckiana* from Wollongong; *Platyschisma rotundatum* Morris and *P. oculus* (Sowerby) from Harper's Hill; *Bellerephon micromphalus* Morris from Wollongong and rare in the sandstone of Muree.

Two months after the publication of M'Coy's studies, J. D. Dana (1847 : 150—160) described a collection of fossils collected in New South Wales in 1839 by the Exploring Expedition under the command of Charles Wilkes, U.S.N. The specimens were collected from "the lower layers of the coal formation in Illawarra, and from a deposit of probably nearly the same age at Harper's Hill, valley of the Hunter". The paper was a preliminary report in which Dana described but did not figure the species he dealt with. The gastropods are as follows :—

Harper's Hill (Hunter River Valley)—

Bellerephon undulatus Dana.

Platyschisma ? *depressum* Dana.

Pleurotomaria nuda Dana.

Patella tenella Dana.

Pleurotomaria triflata Dana. (Also at Illawarra).

Illawarra (Wollongong)—

Bellerephon strictus Dana.

Natica?

Dana (1849 : 706—708) redescribed and figured the above gastropods, together with additional species, and made certain changes in nomenclature as follows :

Harper's Hill—

Pileopsis tenella Dana. = *Patella tenella* Dana.

Pileopsis alta Dana.

Pleurotomaria morrisiana Morris. = *P. triflata* Dana. (Also found at Black Head, Gerringong).

Pleurotomaria nuda Dana.

Platyschisma oculus (Sowerby).

Platyschisma depressum Dana.

Bellerephon undulatus Dana.

Illawarra. (Wollongong and Black Head)—

Pleurotomaria strzeleckiana Morris.

Platyschisma rotundatum Morris.

Natica . . . ?

Bellerephon strictus Dana.

Bellerephon micromphalus Morris.

The type specimens of the species described and figured by Dana are in the U.S. National Museum, while duplicate specimens and plastotypes are in the Peabody Museum, Yale University.

A list of Permian fossils from several localities in the Hunter River Valley and from Illawarra was recorded by M. J. Grange (1854 : 86—89) in Dumont D'Urville's *Voyage au Pôle Sud : Géologie*. The gastropods consist of species already described by earlier authors and no new forms were mentioned.

A very large collection of Palaeozoic fossils made by the Rev. W. B. Clarke was described by Professor L. G. de Koninck (1877). This work, written in French, was translated by Professor and Mrs. T. W. E. David and Mr. W. S. Dun and was republished in 1898 as *Memoir of the Geological Survey of New South Wales : Palaeontology* No. 6. The types and named specimens of the Clarke collection were on Mr. Clarke's death, purchased by the Government of New South Wales, but unfortunately they were completely destroyed in the Garden Palace fire in Sydney in 1882.

The Permian gastropods described and figured by de Koninck are :

Platyceras alta (Dana). = *Pileopsis alta* Dana. A small specimen from Lower Carboniferous rocks at Pallal and is not the typical *P. alta* of Dana.

Pleurotomaria morrisiana M'Coy. Minnamurra, near Black Head, Gerringong.

Pleurotomaria subcancellata Morris. Muree, Hunter River Valley.

**Pleurotomaria striata* Sowerby. Duguid's Hill (Harper's Hill), Hunter River Valley.

**Pleurotomaria gemmulifera* Phillips. Railway cutting between Maitland and Stony Creek, Hunter River Valley.

Pleurotomaria humilis de Koninck. Raymond Terrace, Hunter River Valley.

**Pleurotomaria naticoides* de Koninck. Harper's Hill.

Murchisonia triflata (Dana). = *Pleurotomaria morrisiana* Dana (non M'Coy). Harper's Hill.

**Murchisonia verneuilliana* de Koninck. Minnamurra, near Black Head, Gerringong.

Euomphalus oculus (Sowerby). = *Platyschisma oculus* (Sowerby). Harper's Hill; Branxton; Hunter River Valley.

Goniatites micromphalus (Morris). = *Bellerephon micromphalus* Morris. = *Bellerephon undulatus* Dana. Muree.

Goniatites strictus (Dana). = *Bellerephon strictus* Dana. Harper's Hill.

The species marked * are European forms and are questionable determinations. Some of de Koninck's species are poorly figured and in some cases it is impossible to come to any definite conclusions in regard to their relationships. No attempt has been made to apply present nomenclature to de Koninck's species and the names are those given by him. These problems are dealt with later in this paper.

Robert Etheridge, jnr. made a number of contributions to our knowledge of the Permian gastropod fauna of New South Wales. That author (1878 : 89) listed "*Goniatites micromphalus*" (Morris) as doubtfully related to *Aganides* Montford (1880 : 304), and recorded the species from the Bowen River coalfield in Queensland. This reference was repeated by Etheridge (1892 : 294).

Waagen, after a study of the bellerephontids from the Productus Limestone of the Salt Range in India, introduced a new genus *Warthia* for shells which showed no trace of a slit-band and were strongly involute and compressed. He (1880 : 160) stated that in his opinion the Australian species *Bellerephon undulatus*, *B. strictus* and *B. micromphalus* undoubtedly belonged to this genus.

Etheridge (1889 : 205; 1897 : 15) described and figured a gastropod from the Permian rocks in north-western Australia as *Pleurotomaria humilis* of de Koninck, a species described from Raymond Terrace in the Hunter River Valley. Etheridge referred the species to the genus *Mourlonia*, but in my opinion it is most unlikely that the two forms are conspecific.

Etheridge (1894 : 36) described and figured the surface sculpture and suture lines which for the first time were found preserved on a specimen of what was considered to be "*Goniatis micromphalus* (Morris)". This specimen, together with two other apparently similar shells, but showing no sutures, were obtained from the shaft of the Maitland Colliery Company, near Farley, in rocks of the Branxton Sub-group of the Maitland (Upper Marine) Group. On the evidence of the suture lines, Etheridge referred the species to *Goniatis* (*Prolecanites*?) and included, incorrectly as is now known, all the specimens previously classified as *Bellerephon micromphalus* of Morris.

In the same year and having had access to Etheridge's paper, Foord and Crick noted the resemblance of Etheridge's specimens, particularly the suture lines, to *Agathiceras uralicum* Karpinsky from the Artinsk beds of Russia, and they therefore referred the species with reservation to the genus *Agathiceras*.

Two years later, however, Frech (1896 : 501) stated that the general form and spiral ornaments of this species agree with *Gastrioceras*, while its lobes agree with those of *Prolecanites* or *Pronorites*. At that time a complete suture was not known as Etheridge had only figured a few lobes and saddles, and Frech thought that when this was known the species might possibly have to be referred to a new genus.

The species continued to be listed as *Agathiceras* in many papers dealing with the Permian of Australia, but with no comments. Several foreign references to this Australian species, which are not of great importance but which might be mentioned, are Haug (1898 : 23) and Haniel (1915).

Two new species of *Platyceras* from Harper's Hill were described and figured by Etheridge (1896 : 14) as *Platyceras* (*Orthonychia*) *cornucapella* and *P. (O.) unguis*. *Pileopsis alta* of Dana, from the same locality was redescribed as *Platyceras* (*Orthonychia*) *altum*? (Dana), while several specimens from the Maitland (Upper Marine) Group at West Maitland, were at the same time described as *Mourlonia*? *waterhousei*.

Etheridge (1898 : 176) described and figured what he considered was a depressed form of *Platyschisma oculum* (Sowerby) from the type locality at Harper's Hill. From the same locality he later (1902 : 195) instituted a new genus and species as *Keeneia platyschismoides* and a new species *Straparollus ammonitiformis*, both being gastropods of considerable size.

The bellerephontid affinities of "*Agathiceras micromphalus* (Morris)" were favoured in a paper by Girty (1908) when he stated that in all probability the species would prove to be a *Warthia*.

Laseron (1910 : 220—222) recorded *Platyschisma oculum* (Sowerby), *Mourlonia strzeleckiana* (Morris), *Ptychomphalina morrisiana* (McCoy) and *Agathiceras micromphalus* (Morris) from various localities in the Lower Shoalhaven River area of the Illawarra district. He also briefly described two single specimens, both of which have been lost, as *Capulus* sp. indet., and *Euomphalus*? sp. These were from the higher formations of the Shoalhaven Group, which are the equivalent, in part, of the Branxton (Upper Marine) Sub-group of the Hunter River Valley. It is thought that Laseron's *Capulus* sp. indet. which he figured, is identical with *Strotostoma nichollsi*, a new genus and species described in this paper. Laseron did not figure *Euomphalus*? sp., a small four-whorled shell with the spire depressed below the later whorls, and until additional specimens come to hand from the same locality the identity of this form must remain doubtful.

A rather low-spined form of gastropod from the Tasmanite Spore Beds of the Mersey River, Tasmania, was described and figured by Dun (1913 : 8) as *Keeneia twelvetreesi*. This is an important species as there is some doubt regarding the age of the Tasmanite beds. On palaeontological evidence they were previously recorded as equivalent, in part, with the Maitland (Upper Marine) Group of the Hunter River Valley of New South Wales. However, in a paper presented to the 1956 International Geological Congress, M. Banks suggested it was more probably equivalent to an horizon low in the Dalwood (Lower Marine) Group. Miss I. Crespin (verbal communication) considers that recent research on the fossil foraminifera of the area supports that conclusion.

The holotype of *Keeneia twelvetreesi* Dun has been mislaid but an examination of the figure (Dun 1913 : pl. ii), indicates a close relationship with *Planikeeneia insculpta* sp. nov., from the Allandale Formation, Dalwood (Lower Marine) Group, at Harper's Hill. The Tasmanian species is, however, smaller but agrees otherwise in all essential features, particularly in the ornamentation being strongly inflected at the centre of the body whorl.

Etheridge (1919: 188—189) discussed the characters of *Platyschisma oculus* (Sowerby), *P. rotundatum* Morris and *P. depressum*. He considered that *P. depressum* was a species of his genus *Keeneia*. A large series of internal casts of a small gastropod from the Farley Formation, Dalwood (Lower Marine) Group, were also described and figured in this paper as *Platyschisma rotundatum* var. *farleyensis*.

From the Permian rocks of Timor, Wanner (1922: 55) described and figured ? *Capulus* cf. *tenellus* (Dana). He considered that his specimens have a close similarity with *Platyceras tenella* of Dana from the Hunter River Valley, but it is almost certain that the two forms are not conspecific and any resemblance is homeomorphic.

Mitchell (1922: 278) described and figured a large depressed form of gastropod as *Platyschisma allandaleensis* from rocks of the Allandale Formation exposed in a railway cutting near Allandale railway station. This species is considered identical with the species described by Dana as *Platyschisma depressum* from the same horizon.

An additional contribution to the status of "*Agathiceras micromphalus* (Morris)" was made by Whitehouse (1926) when, apparently recognising its true affinities, he listed it among Permian species from eastern Australia as "*Bellerephon* (*Warthia*) *micromphalus*". No further observations were however communicated and in 1928 "*Agathiceras micromphalum*" was again mentioned from the Permian of Australia by Schuchert.

In 1929, Thomas reported that he and Dr. Spath had examined specimens of the alleged *Agathiceras micromphalum* from Australia and considered they could well be bellerephonitids. In the same year Reid (1929: 80) published a communication received from Whitehouse to the effect that "two similarly coiled species, a common gastropod, and a rare cephalopod, have been referred to the one species by earlier writers", in particular by Etheridge in 1894. This is the first suggestion that the specimens which had been given the specific name *micromphalus* might not necessarily all be conspecific and that the name had been applied to gastropods as well as to a cephalopod.

Reed (1930: 43) in describing some Permian fossils from Brazil which closely resembled the species of Morris, as "*Bellerephon* ? cf. *micromphalus*", stated that the true position of the species must remain an open question.

Two years later, Reed (1932: 69) identified *Warthia micromphala* (Morris) from the Agglomeratic Shales of Kashmir and commented that it was strange that no other author had been able to confirm the presence of septa, as observed by Etheridge, on any specimens referred to that species.

David and Sussmilch (1931: 500) stated that "the only specimen of an *Agathiceras* found in Australia at that time and showing a suture, and referred by Etheridge to *Agathiceras micromphalum*, was obtained from a shaft sunk in the Upper Marine Series, at a horizon a few hundred feet above the top of the Greta Coal Measures". The authors drew attention to the fossil classed as *Agathiceras micromphalum*, abundant in the Ravensfield Sandstone, but now considered to be a *Bellerephon*. On the same page Whitehouse is quoted as considering that the affinities of the ammonoid were nearer to *Paralagoceras* than to *Agathiceras*.

The next contribution to this problem was a paper by the author in collaboration with Dr. C. Teichert (Teichert and Fletcher 1943: 156—163). It was shown that the only true ammonoid found in the Permian rocks of Australia consisted of a single specimen and it was described and figured as *Adrianites* (*Neocromities*) *meridionalis*. This was the specimen on which suture lines were observed and recorded by Etheridge in 1894. The question whether or not all the aseptate specimens from the Permian of New South Wales are in fact conspecific with Morris's holotype of *Bellerephon micromphalus* was not discussed. This question is dealt with later in this paper.

It is interesting to note that two additional ammonoids have since been found in the Permian of Australia. One species was described by Teichert from Western Australia while a second species was described by the same author (1954) as *Pseudogastrioceras pokolbinense*, from the Farley Formation of the Dalwood (Lower Marine) Group in Portion 74, Parish of Pokolbin, 3 miles south-west of Cessnock.

References to the Australian Permian gastropods have appeared in the very helpful works of J. Brookes Knight (1941) and Carl C. Branson (1948).

In the list of the gastropods previously recorded from the Permian of New South Wales the nomenclature and synonyms are given as accepted prior to the present study.

OLD NAMES

Bellerephon contractus Sowerby (nom. nud.)...
Bellerephon micromphalus Dana (non Morris 1845)
Bellerephon micromphalus Morris (non Dana 1849)
Bellerephon strictus Dana
Bellerephon undulatus Dana
Capulus sp. indet. Laseron
Euomphalus ? sp. Laseron

Goniatites micromphalus Koninck (non Morris)
Goniatites (*Prolecanites*) *micromphalus* Etheridge (in part)
Keeneia platyschismoides Etheridge... ..
Keeneia twelvetreesi Dun
Mourlonia ? *waterhousei* Etheridge
Natica ? Dana
Patella tenella Dana. = *Pileopsis tenella* Dana. = ?*Capulus* cf. *tenellus* Wanner
Pileopsis alta Dana. = *Platyceras altum* Koninck. = *Platyceras* (*Orthonychia*) *alta* (Etheridge)
Platyceras (*Orthonychia*) *cornucapella* Etheridge
Platyceras (*Orthonychia*) *ungulum* Etheridge
Platyschisma allandalensis Mitchell
Platyschisma depressum Dana
Platyschisma oculus (Sowerby)
Platyschisma rotundatum Morris
Platyschisma rotundatum var. *farleyensis* Etheridge
Pleurotomaria gemmulifera Koninck 1877 (non Phillips 1836)

Pleurotomaria humilis Koninck. = *Mourlonia humilis* Etheridge

Pleurotomaria morrisiana M'Coy
Pleurotomaria naticoides Koninck 1877 (non 1843)
Pleurotomaria nuda Dana
Pleurotomaria striata Koninck 1877 (non Sowerby 1828)
Pleurotomaria strzeleckiana Morris
Pleurotomaria subcancellata Morris
Pleurotomaria triflata Dana
Straparollus ammonitiformis Etheridge
Trochus oculus Sowerby
Warthia (see *Bellerephon*)

NEW NAMES

Warthia stricta (Dana).

Warthia perspecta sp. nov.

Warthia micromphala (Morris).
Warthia stricta (Dana).
Warthia micromphala (Morris).
Strotostoma rylstoni sp. nov.
Indeterminate. Poor description and figure. Specimen lost.
Warthia micromphala (Morris).

Warthia perspecta sp. nov.
Keeneia platyschismoides Etheridge.
? *Planikeeneia insculpta* sp. nov.
No additional specimens.
Indeterminate. Poor description and figure.

? *Rhabdocantha ungulum* (Etheridge.)

Rhabdocantha alta (Dana).
Rhabdocantha cornucapella (Etheridge).
Rhabdocantha ungulum (Etheridge).
Planikeeneia depressum (Dana).
Planikeeneia depressum (Dana).
Keeneia ocula (Sowerby).
Platyschisma rotundatum Morris.

Planikeeneia occasa sp. nov.

No additional specimens. (Koninck's specimen destroyed by fire).

No additional specimens. (Koninck's specimens destroyed by fire).
Pleurocinctosa triflata (Dana).

No additional specimens.
? *Pleurocinctosa nuda* (Dana).

No additional specimens.
Mourlonopsis strzeleckiana (Morris).
Walnichollia subcancellata (Morris).
Pleurocinctosa triflata (Dana).
Paromphalus ammonitiformis (Etheridge).
Keeneia ocula (Sowerby)

SYSTEMATIC CLASSIFICATION

Unless otherwise mentioned all localities are in New South Wales and rock formations belong to the Permian. The type material is in the collection of the Australian Museum, Sydney.

Class **Gastropoda**Sub-Class **Prosobranchia**Order **Archaeogastropoda**Super-Family **Trochonematacea**Family **Platyceratidae** Hall 1859.Genus **Rhabdocantha** nov.

(*Rhabdos*, striae; *akantha*, spine)

Type Species: *Pileopsis alta* Dana 1849.

Description.—Small to medium sized, almost symmetrical cone to arcuate univalves; shell rapidly narrowing towards apex which is very slightly twisted to one side, never in contact; cross-section of valve elliptical to oval. Apertural margin not thickened, regular with no sinuations. Ornamentation consists of numerous transverse and longitudinal fine, somewhat crenulate lirae.

Discussion.—Etheridge (1896 : 14) described three species of gastropod shells and referred them to the genus *Platyceras* Conrad, finally assigning them to the "sub-generic section" *Orthonychia* Hall. He outlined the characters of *Orthonychia* as "shell arched or straight, elongately conical; the apex recurved but not spiral or enrolled; surface concentrically striate". According to Etheridge the four sectional divisions mentioned by him in his paper were only of use in extreme forms and he agreed with Meek and Worthen (1868 : 487) that it is often difficult to separate them owing to gradations by which they blend one into the other.

Knight (1934 : 147) states that the genus *Platyceras* Conrad should be limited to forms with the earlier whorls coiled and in contact, but the last whorl free. This is the accepted version of the genus and as such prevents the inclusion of most Permian Australian Platyceratidae. The same author, in his discussion of the genus *Orthonychia* Hall, includes those shells which generally show some degree of spiral twist and often an arcuate curvature, but there is no true coiling even in the nucleus. *Orthonychia* as a genus was abandoned by Hall as he did not consider that it was distinct from *Platyceras*. This course was followed by other authors, but Knight (1934 : 148) rightly considered it should be retained with *Platyceras subrectum* Hall, 1859, as the type species. Bowsher (1955 : 1) departed from the general opinion and stated that "as used in this paper, the name *Platyceras* Conrad (1840) includes such sub-genera as *Orthonychia*. . ."

Grabau (1936 : 312) introduced the genus *Geronticeras* for three species of horn-shaped gastropods from the Lower Permian rocks of the Kweichow Province, China, designating *G. latum* as the type species. These shells appear to have some affinities with the Australian species of *Rhabdocanthis*. Knight (1941 : 129) is of the opinion that *G. latum* is congeneric with *Pileopsis vetusta* Sowerby, the genotype of *Platyceras*, and should therefore be referred to that genus.

After an examination of Grabau's figures, it seems to me that *Geronticeras dubium* of Grabau (1936 : pl. xxx, figs. 9a-d), is the species which should be referred to the genus *Platyceras*. The apical portion is closely enrolled for about one and one-fourth volutions and is in contact. In the other two species *G. latum* and *G. separatum*, the apex of the shell is barely enrolled and although the beak is twisted to one side the shells are more symmetrical than in *G. dubium*. It is these species which bear some resemblance to the shells from New South Wales, but differ in being far more twisted at the apex and irregular in their growth.

Some authors are of the opinion that a distinction is not possible between the genera *Platyceras* and *Capulus*. Wanner (1922 : 47) agreed with Keys (1890 : 150) that this was the case and that the latter name should be used as it had more than thirty years precedence over the former. Knight (1934 : 146) considers that any resemblance between *Capulus* and *Platyceras* is purely superficial and regards the Platyceratidae as Aspidobranchia which have adopted a stationary mode of life.

From the Permian rocks of Timor, Wanner (1922 : 11) described 19 different species which he referred to the genus *Capulus*. All of them show fairly close relationships with species from North America, but do not resemble the Australian forms with the exception of one described as ?*Capulus* cf. *tenellus* J. D. Dana. This species was originally described from Lower Permian rocks at Harper's Hill, New South Wales. It is thought that any resemblance to the Australian species is homeomorphic.

Wanner mentioned the difficulty in determining specific characters because of the great variability in the group, a variation in form he thought was due largely to conditions under which the animal lived. This question has been discussed on many occasions by authors, particularly Keyes (1890 : 150). Variation in the form of the shell has been suggested as being influenced by conditions experienced after attachment of the individual.

Wanner states that the many types found in Timor are represented, with few exceptions, by one, or a few individuals.

In a recent most comprehensive and interesting work, Bowsher (1955 : 1—11) discussed the origin and adaptation of the Platyceratid gastropods. He recorded many examples of crinoids with attached shells of *Platyceras* over the crinoid's anal vent. It was found that the irregularities of the apertural margin of the attached shells invariably fitted the irregularities of the tegmen of the host. Bowsher concluded that *Platyceras* possessed a coprophagous habit and that the group had evolved directly from *Naticomema* in late Ordovician or early Silurian times.

The generally accepted fact that the shape of Platyceratid shells is a reflection of their stationary habit cannot be recognised in the species of *Rhabdocantha* from Harper's Hill.

It seems obvious that these shells cannot be regarded as belonging to the genus *Platyceras* as in no instance is there the slightest indication of the apex of the shell being enrolled or in contact. They appear to have certain affinities with some species referred in the past to the genus *Orthonychia* of Hall but the characters cannot be reconciled with those of the type species, *Platyceras (Orthonychia) subrectum* from the Devonian Upper Heidelberg Limestone of New York, U.S.A. The shells from New South Wales are generally dissimilar, show little or no signs of irregularity of growth and do not possess any

longitudinal grooves, nodes or spines. Close relationships with *Platyceras* and *Orthonychia* are apparent but as I am of the opinion they cannot be referred with certainty to either genus I have erected the genus *Rhabdocantha* for them. Although the species range from cone-like to a decidedly arcuate shell, they are associated generically by shell structure, form, and ornamentation which are remarkably similar.

The species of *Rhabdocantha* are interesting in that there is a progressive degree of curvature from a cone-like form to a strongly arcuate shell. The problem arises whether the shells are growth stages of the one species or whether certain forms are specifically distinct. The shells are by no means common and with the absence of a large series it is difficult to come to a definite conclusion. It is significant, however, that 4 species are represented in each case by 2 identical shells, 1 species by a single shell, and 1 species by 6 specimens which vary considerably in size but not in form. The single specimen of *Rhabdocantha intermedia*, which might be considered a growth stage of *R. ungula* is found to be entirely dissimilar from a shell of the same dimensions of that species. These facts together with a definite variation of inflation and angle of curvature indicate specific differences and they have been described as such.

In only one, doubtful, instance do the Australian Permian shells of the Platyceratidae show any evidence of a parasitic habit. A specimen of *R. ungula* (F.35586) is attached to a shell of *Keeneia ocula* (Sowerby), covering part of the spire, but although near the aperture, would not have covered it to any great extent. The apertural margin of the shell of *R. ungula* is well preserved. Beyond a slight thickening, however, it is most regular and shows no sign of having followed the outline of the shell to which it is attached. Under the circumstances it would appear that this particular association is a fortuitous one rather than an example of a parasitic coprophagous habit. Most of the shells of *Rhabdocantha* from New South Wales are comparatively large in size and in no instance does the apertural margin show any indication of irregularities due to parasitism.

Rhabdocantha alta Dana

(Pl. 7, figures 1—4.)

Pileopsis alta Dana, 1849; 706; Atlas, pl. ix, figure 14.

Platyceras (*Orthonychia*) *altum* Etheridge, 1896: 15, pl. i, figures 1—2.

Neotype (here chosen): Specimen No. F.35587, figured by Etheridge 1896: pl. i, figure 1. From Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Shell elongate-arcuate, regularly curved, essentially in the one plane; apex sharply pointed, produced well forward of the apertural margin and slightly twisted to one side. Cross-section of valve at aperture is elliptical; apertural margins not thickened, straight, showing no irregularities of attachment. Valve expanding rapidly and evenly from apex to aperture. Dorsal surface of valve rounded, flanks flattened, ventral surface rounded.

Shell surface smooth, slightly undulated by transverse ridges representing stages of growth. Ornamentation consists of numerous very fine transverse lirae with regularly arranged, interpolated, sharp stronger lirae; closely crowded longitudinal lirae form a subdued cancellate pattern. Lirae indistinctly crenulate. Shell thin. Muscle scars are not visible.

Dimensions.—

	Neotype F. 35587	Plesiotype F.35585
	mm	mm
Height	30	25
Width of aperture	22	19.5
Length of aperture	33	25
Length along curvature from apex to aperture	80	68

Remarks.—This species was originally based on a specimen in the collection of the Rev. Mr. Wilton of Newcastle, from whom it was borrowed and described and figured by Dana (1849: 706; Atlas, pl. ix, figure 14). Enquiries have not brought any results regarding the present location of this specimen, but as it is now more than a century since it was described it can safely be assumed to be lost. A neotype has therefore been chosen.

Etheridge (1896: 15) expressed some doubt whether his specimens were conspecific with the small specimen described by Dana, a shell 18 mm in height and with a length of 16 mm along the aperture. I am of the opinion they are, as the curvature of the shells is identical and although the apex of Dana's shell is not bent down to the same extent in his illustration (Dana 1849: pl. ix, figure 14a), it is mentioned in the text as being "much recurved forward". The specimens were also collected from the same horizon of the Allandale Formation at Harper's Hill.

Etheridge recorded a specimen of *R. alta* from Rutherford, 3½ miles from West Maitland, in the Hunter Valley. It cannot be traced in the collection of the Mining and Geological Museum. This locality is slightly west of Harper's Hill and it is possible the specimen came from the Rutherford Formation, originally recognised as the shales and sandstones of the upper part of the Allandale Formation.

A single specimen, 5 mm in height, was described and figured by de Koninck (1877: 180; pl. xxiii, figure 5) as *Platyceras altum* Dana, from rocks of Lower Carboniferous age at Pallal, New South Wales. This specimen which was subsequently destroyed at Sydney in the Garden Palace fire of 1882, was apparently not a typical shell of the species.

Localities and stratigraphical position.—Harper's Hill; Allandale Formation. Rutherford, 3½ miles west of West Maitland; Rutherford Formation, Dalwood (Lower Marine) Group.

***Rhabdocantha cornucapella* (Etheridge)**

(Pl. 7, figures 5—7.)

Platyceras (Ornthonychia) cornucapella Etheridge, 1896: 15, pl. 1, figure 3.

Holotype (by monotypy): Specimen No. F.35588, figured by Etheridge 1896: pl. 1, figure 3. From Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Remarks.—This species was described very fully by Etheridge who, although stressing several characteristic features, felt that it could possibly be only a variety of *R. alta* (Dana). He was no doubt influenced in this regard by the conclusions put forward by certain authors that Platyceratid shells in other parts of the world adopted individual variation because of their environment and mode of life. There is no evidence that this is the case as far as the shells of *Rhabdocantha* are concerned and as mentioned earlier in this paper there is no indication of any considerable individual variation within a species.

In general form the shell of *R. cornucapella* is rather similar to those of *R. alta*. It is readily distinguished, however, in its degree of curvature, by being less elongate, more compressed laterally and by the narrowly rounded dorsal surface. The apex is produced beyond the apertural margin and even though the point is missing could not have been nearly as incurved as in *R. alta*. The expansion or tapering of the valve from the aperture to the apex is gradual. Aperture elongate-elliptical.

The surface of the shell is produced into fairly regular concentric undulations, well defined and distinct from the ornamentation which consists of microscopic transverse, crenulate lirae. These are crossed by similar longitudinal lirae and thus form a subdued cancellate pattern.

A second specimen of this species was recently collected from the Ulladulla Mudstone at Ulladulla. There is some doubt regarding its actual locality, but if the record is correct it is the first specimen of the genus from rocks younger than the Dalwood (Lower Marine) Group. The specimen agrees very well with the holotype.

Dimensions.—

	Holotype
	mm
Height	21.5
Width of aperture	13
Length of aperture	22
Length along curvature from apex to margin of aperture	47

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

***Rhabdocantha adunca* sp. nov.**

(Pl. 7, figures 8—9.)

Holotype.—Specimen No. F.46400 from Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Paratype.—Specimen No. F.46401, from same locality and horizon.

Description.—Shell elongate, strongly arcuate; apex sharply pointed, very much incurved and almost in contact with the shell at the anterior apertural margin; not enrolled but slightly twisted to one side. Degree of expansion is rapid from apex to aperture of shell; two-thirds of shell laterally compressed, markedly inflated near and at the aperture. Aperture elliptical in outline, margins or peristome straight, regular, with no sinuations. Dorsal surface of shell very narrowly rounded, evenly curved longitudinally; elongate; ventral margin restricted, short, forming a small almost complete circle.

Surface marked by regular concentric undulations. Ornamentation consists of well defined, longitudinal crenulate lirae, crossed by less defined and less numerous concentric lirae.

Dimensions.—

	Holotype mm
Height	32
Length of aperture	32
Width of aperture	22
Length along curvature from apex to margin of aperture	86

Remarks.—This outstanding and easily recognised species is represented by two specimens. The holotype is a well preserved shell with portion of the original shell and ornamentation still attached. The paratype is incomplete and is practically a steinkern. The characteristic features of the species are its very arcuate form, lateral compression, and extreme inflation at the aperture.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

***Rhabdocantha intermedia* sp. nov.**

(Pl. 7, figures 10—11.)

Holotype.—Specimen No. F.26950, from Allandale, near Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Shell elongate-conical, somewhat arcuate, expanding rapidly from the apex and attaining maximum inflation at the aperture; apex obtuse, not projecting beyond the apertural margin, not incurved, slightly twisted to one side. Dorsal margin of shell broadly and evenly convex; ventral margin sloping inwards from margin in a wide curve to the apex. Aperture elongate-oval with regular and straight margins.

Surface of shell marked by occasional transverse undulations representing growth stages. Ornamentation consists of numerous, fine longitudinal lirae, crossed by indistinct transverse almost microscopic lirae. Shell substance thin.

Dimensions.—

	Holotype mm
Height	48
Width of aperture	21
Length of aperture	27
Length along curvature from apex to apertural margin	45

Remarks.—This species, represented by a single well preserved specimen, may be considered as an intermediate form which links the more elongate and arcuate species of *Rhabdocantha* with the conical shells of *R. ungula*. It would appear to be a more adult and therefore more elongate form of the former species, but this is not the case as a shell of *R. ungula* of approximately the same dimensions retains the distinctive features of that species. The shell of *R. intermedia* is distinguished from those of the foregoing species by its more conical form, the apex situated within the marginal limits, and the aperture, faintly campanulate, is more oval in outline than elliptical. As mentioned previously the ornamentation in all the species of *Rhabdocantha* is very similar.

Locality and stratigraphical position.—Allandale near Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

***Rhabdocantha ungula* (Etheridge)**

(Pl. 7, figure 12; pl. 8, figures 1—3; pl. 9, figures 3—4.)

Platyceras (Orthonychia) ungula Etheridge, 1898: 16, pl. i, figure 4.

Holotype (by monotypy): Specimen No. F.35586, figured by Etheridge 1898: pl. i, figure 4. **From Harper's Hill, Dalwood (Lower Marine) Group.**

Remarks.—As pointed out by Etheridge (1898 : 16) in his very complete description of this species it includes shells which are conical in form and not produced posteriorly in the form of an arc. The apex is blunt, not incurved and is restricted within the marginal limits of the shell. The dorsal margin of the shell is slightly curved while the ventral margin is straight to slightly concave; evenly inflated with sides slightly convex, not flattened; aperture oval, slightly longer than wide, with a straight and regular, non-sinuate, peristome.

Dimensions.—

	Holotype	F.46402
	mm	mm
Height	19	26
Length of aperture	20	27
Width of aperture	17	25†
Length along curvature from apex to margin of aperture	23	29

† Estimated width as specimen is flattened on one side due to pressure during preservation.

This particular species has very few definite characters to distinguish it from conical shells of similar form described from widespread localities and various stratigraphical formations.

Dana (1847 : 151) briefly described a small conical shell from Harper's Hill as *Patella tenella*. Two years later (1849 : 706) he referred it to the genus *Pileopsis* with the following description : " Short, conical, oblong, acuminate at apex, and very narrowly recurved. Apex anterior to centre, but situated over the base; aperture ovate-elliptical, entire, half narrower anteriorly. Surface smooth. Length of aperture $\frac{3}{4}$ th of an in; breadth $\frac{2}{3}$ th of an in; height of cone same as breadth."

Etheridge (1898 : 15) held the opinion that this specimen is an abnormally depressed form and considered it was distinct from *R. ungula*. The dimensions and form, with the exception of the curved anterior margin, are not dissimilar from shells of that species. An examination of a plastotype of the specimen figured by Dana indicates that the apex has been damaged to some extent during preservation. The apical portion has been forced forward and to one side and if this proves to be the case the shell would agree very well with *R. ungula*. It is possible that Dana's figure (1849 : pl. ix, figures 13a, b), has been idealised to some extent. An examination of the type material in the collection of the United States National Museum, Washington, would no doubt determine whether the two forms are conspecific.

A very small specimen, height 6 mm and length 8 mm, from Carboniferous rocks at Colocolo, was described by de Koninck (1877 : 319) as *Platyceras tenella* Dana. Its relationships are impossible to determine from the description and figure, but it almost certainly differs from that species. De Koninck himself stated that the specimen, together with that of *P. alta*, could be young individuals of an unknown species. The specimens were subsequently destroyed in the Garden Palace fire of 1882, in Sydney.

From the Permian rocks of Timor, Wanner (1922 : 55; pl. clii, figure 22) described and figured a conical form of shell as ?*Capulus cf. tenellus* Dana. It bears a superficial resemblance to Dana's species from New South Wales, but with conical shells of this type I consider that, with shells so geographically distinct, any similarity is homeomorphic.

In the series of specimens of *R. ungula* from Harper's Hill there is considerable variation in the size of the shells, but not in form and the distinguishing characters are constant.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

***Rhabdocantha irregularis* sp. nov.**

(Pl. 8, figures 4—5; pl. 9, figures 1—2.)

Holotype : Specimen No. F.27525, from Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Shell moderately arcuate, subconical not produced posteriorly; depressed; apex sharply pointed very slightly bent downwards, twisted to one side, not extending to any great extent beyond the apertural limits. Aperture somewhat ovoid, wide below the apex and narrowing anteriorly. Expansion of shell increasing rapidly from apex to the aperture, slightly asymmetrical causing a slight twist to the dorsal surface which is sharply rounded; flanks flattened, greatest inflation and width posteriorly.

Surface marked by regular transverse undulations of growth. Ornamentation consists of fine almost microscopic transverse lirae, cancellated by similar type of longitudinal lirae.

Dimensions.—

	Holotype
	mm
Height	21
Length of aperture	38
Width of aperture	27
Length along curvature of dorsum	57

Remarks.—This outstanding and interesting species is represented by only two specimens from the Allandale Formation at Harper's Hill. The twisted nature of the shell, due to asymmetrical growth is exhibited in both specimens and almost certainly is not caused by pressure and distortion. It is readily distinguished from *R. ungula* by the curved dorsum and the downwardly produced apex; it is a characteristic species, but has similar ornamentation to other species of the genus.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Genus *Platyceras* Conrad 1840.

Type Species, by subsequent designation of Knight 1934: 147, *Pileopsis vetusta* Sowerby 1829.

Remarks.—As mentioned earlier in this paper the characteristic features of the genus consist of shells with earlier whorls coiled, in contact, and the last whorl free and expanded.

Two very poorly preserved specimens in the collection of the Australian Museum from the Dalwood (Lower Marine) Group, have been referred to the genus *Platyceras*. One specimen, F.46403, from the Allandale Formation at Allandale, is somewhat similar to shells of *Rhabdocantha adunca* in that it is strongly arcuate and depressed sub-conical in form. It differs however, markedly, in that the extreme apical portion is enrolled to form a small volution which is in contact, joining the body whorl slightly above the posterior extremity of the aperture. The specimen is not sufficiently preserved and is too incomplete for description. It is mentioned only as a record of the genus *Platyceras* in the Allandale Formation.

The second specimen, F. 30004, is from the Ravensfield Sandstone at the base of the Farley Formation. It is a complete shell and is not conspecific with the Allandale specimen, differing in the length and shape of the aperture. The small whorl is barely elevated and does not rise above the plane of the large expanded body whorl. In the Silurian rocks of the Yass district, several undescribed species agree with the characters of the genus *Platyceras* Conrad 1840. These shells possess a fairly close relationship with *P. farleyensis* sp. nov., from the Permian rocks of the Hunter River Valley.

Platyceras farleyensis sp. nov.

(Pl. 8, figure 6.)

Holotype: Specimen No. F.30004, from the Ravensfield Quarry, near Farley. Ravensfield Sandstone, Farley Formation, Dalwood (Lower Marine) Group.

Description.—Shell of comparatively small size, obliquely horn-shaped of about two whorls, the last greatly expanded dorso-ventrally, broadly curved; apical portion twisted, extremity coiled to form a small volution contiguous with body whorl slightly above posterior apertural margin; last or body whorl rapidly expanding to the aperture, compressed, only slightly inflated; peristome regular with a possible slight anterior sinus. Dorsal surface sharply rounded, almost angulate posteriorly, widening and more rounded towards aperture; apex depressed below the plane of the body whorl; shape of aperture unknown, but narrow; surface of shell with faint concentric undulations of growth; ornamentation not preserved.

Dimensions.—

	mm
Height	15
Length along curvature from apex to aperture	39
Total width	23
Breadth	11

Remarks.—The species is represented by a single specimen which is not sufficiently preserved to reveal any traces of ornamentation or distinct features of the aperture. The peristome shows an indication of a sinus, a doubtful character however, which may be the result of weathering. The aperture is not campanulate.

This species is intermediate between the horn-shaped shells of *Rhabdocantha* and the apically coiled shells of *Strotostoma* gen. nov. The three genera, *Rhabdocantha* gen. nov., *Platyceras* Conrad, and *Strotostoma* gen. nov., could possibly be evolutionary phases within the Platyceratidae. The shells of *Strotostoma*, found in the higher formations of the Maitland (Upper Marine) Group attained considerable size.

The single shell of *Platyceras farleyensis* appears to me to be the only one from the Permian of New South Wales which agrees with the accepted characters of the genus as defined by J. Brookes Knight. Its strongest affinities are not with *P. vetusta* (Sowerby), the type species of the genus, but more with species in which the shells are arcuate, such as those described by Hall (1859: 311, figures 1—2 on p. 310), as *P. ventricosum*. Both are broadly curved forms in which the small volution merges into

and is contiguous with the body whorl near the posterior apertural margin. The coiling however, in *P. farleyensis* is less pronounced and the aperture is not campanulate. The species is described from a single specimen, so that this type of gastropod would be recorded as occurring in the Permian rocks of New South Wales.

Locality and stratigraphical position.—Ravensfield Quarry, near Farley. Ravensfield Sandstone, base of Farley Formation, Dalwood (Lower Marine) Group.

Genus **Strotostoma** nov.

(*Strotos*, spread; *stoma*, mouth.)

Type Species: *Strotostoma rylstonensis* sp. nov.

Generic Description.—Moderately large naticiform gastropods, transversely produced with a small, low spire and large inflated body whorl; base extended; three to three and a half whorls; whorl profile broadly arched, somewhat flattened above and below; sutures deep. Aperture large, sub-oval to oval; false umbilicus; surface with well defined spiral and transverse costae. Shell thin.

Remarks.—A series of 25 specimens of species placed in this genus has been collected from three localities in rocks of the higher formations of the Maitland (Upper Marine) Group and its equivalents. The material is mainly from about 2 miles north-west of Rylstone (Western coalfield); five specimens are from Gerringong (Illawarra district) and a single specimen is from Congewai, near Cessnock (Hunter River Valley). The material is not particularly well preserved and in no instance has an aperture with its complete peristome been preserved.

The shells are outstanding forms as far as the Permian gastropod fauna of New South Wales is concerned and two species are represented.

There is no doubt in my opinion regarding the relationship of these shells with those of the Platyceratidae. They bear a close resemblance to a single shell described and figured by Waagen (1880: 105) as *Platystoma indicum* from the Permian of the Salt Range, India. In fact it is possible that the two forms may prove to be congeneric. Waagen apparently was doubtful regarding the correct classification of his shell, but finally referred it to the genus *Platyostoma* (corrected spelling).

The holotype of *Platyostoma ventricosa* Conrad, the type species of the genus *Platyostoma* Conrad (1842: 275) was re-described in detail and figured by Brookes Knight (1941: 253). It bears little relation to *Strotostoma* as it is a distinct naticiform type of gastropod with strongly rounded whorls and a closely coiled body whorl.

Grabau (1931: 359) in describing Waagen's species of *Platystoma indicum* from the Permian of Mongolia, referred it to the genus *Strophostylus* Hall, 1859, (type species *S. andrewsi* Hall). Some of the features of *Strotostoma* bear a close resemblance to those of *Strophostylus*, but an important character of that genus is a "strongly developed, twisted, platelike fold in the columella". This is not present in the Australian shells and apparently is also absent in both the Indian and Mongolian species.

It seems impossible to reconcile the Australian shells to either of the above genera with any degree of certainty. Both *Platyostoma* and *Strophostylus* are also more characteristic of middle Palaeozoic rocks rather than late Permian.

***Strotostoma rylstonensis* sp. nov.**

(Pl. 8, figures 7—11; pl. 9, figure 5.)

Capulus sp. indet. Laseron 1910: 221.

Holotype: Specimen No. F. 40940, from about 2 miles north-west of Rylstone. Base of Capertee (Upper Marine) Group.

Paratypes: Specimens No. F.39682 and F.45392, same locality and horizon.

Description.—Moderately explanate gastropods with a small low spire and a greatly enlarged body whorl forming the greater part of the shell. Body whorl increases rapidly in size spreading outwards and downwards and extending the base of the shell. Three to three and a half whorls; whorl profile broadly rounded, flattened on the upper half and flatly arched on the lower half. Sutures between whorls deep. A false umbilicus is developed. Aperture large, oval and obliquely distended; peristome thin. Columella lip straight, slightly thickened and reflected back; lower lip sharply bent at its junction with the columella lip, then flatly curved to merge uninterruptedly with the broadly downward curved outer lip.

Ornamentation consists of numerous fairly coarse spiral costae and finer transverse costae forming a lattice structure.

Dimensions.—

						Holotype	Paratypes	
						F.40940	F.39682	F.45392
Height	...	...	...	...	...	36 mm	40 mm	33 mm
Breadth	...	...	...	...	...	42 mm	52 mm	43 mm
Breadth of aperture	...	...	...	...	...	...	29 mm	...
Apical angle	...	...	...	...	...	142°	138°	142°

Remarks.—As mentioned earlier this species is a characteristic one and with perhaps the exception of *Strotostoma inflata* sp. nov. cannot be confused with any other Permian gastropods from New South Wales. The small spire, greatly enlarged and obliquely distended body whorl, and characteristic ornamentation make it an outstanding species.

Most of the specimens were collected from the Capertee Formation near Rylstone and they show a considerable variation in size. One small specimen (F.39628), slightly crushed, has a height of 26 mm and a breadth of 24 mm. A series of five small specimens, from the Westly Park Tuff at Gerringong, approximately 22 mm in height and 25 mm in breadth, almost certainly belong to this species. They agree perfectly in most characters and they possess the characteristic ornamentation. A single, incomplete specimen (F.39859), from an unspecified locality near Congewai, near Cessnock, could belong to either the Muree or Mulbring Formations, and is also a typical example of the species. This species therefore has a fairly wide horizontal distribution while stratigraphically its vertical range is very small as in all probability most of the formations in which it occurs will prove to be correlatives.

The well defined ornamentation as shown on an exceptionally well preserved portion of specimen No. F.39625 (pl. 8, figure 8), is not exhibited to the same extent on all specimens. In most cases weathering has considerably subdued the ornamentation pattern, but nevertheless the spiral and transverse costae are usually visible.

The single specimen described by Waagen (1880 : 105), as *Platystoma indicum* from the upper region of the middle division of the Productus-limestone of India, bears a very strong resemblance to *Strotostoma rylstonensis* sp. nov. Waagen however, mentions a thickened inner lip which is not present on the Australian shells and it is doubtful whether the ornamentation is similar. In *S. rylstonensis*, even on badly weathered specimens, the strong spiral costae are a strong feature.

Localities and stratigraphical position.—Two miles north-west of Rylstone; base of Capertee (Upper Marine) Group. Gerringong; Westley Park Tuff, Gerringong (Upper Marine) Volcanics, Burrier; Wandrawandion Formation, Shoalhaven (Upper Marine) Group. Congewai, near Cessnock; Muree or Mulbring Formations, Maitland (Upper Marine) Group.

***Strotostoma inflata* sp. nov.**

(Pl. 9, figures 6—8.)

Holotype : Specimen No. F.45350, from about 2 miles north-west of Rylstone. Base of Capertee Group.

Paratype : Specimen No. F.44246, same locality and horizon.

Description.—Moderately large, sub-globular gastropods with a low, distinct, small spire and large inflated body whorl; base extended on the apertural (right side) of shell. Three to four whorls, those on the spire small and closely coiled, expanding rapidly to form a very large body whorl which forms the greatest bulk. Whorl profile rounded, sutures well pronounced. Aperture oval, peristome thin with no apparent thickening of the columella lip. Well defined transverse growth ridges developed on body whorl. Ornamentation consists of spiral ribbing with possible transverse costae.

Dimensions.—

						Holotype	Paratype
						F.45350	F.44246
Height	...	...	...	...	...	44 mm ‡	53 mm
Breadth	...	...	...	...	...	56 mm	49 mm
Breadth of aperture	...	...	...	...	...	...	33 mm
Height of aperture	...	...	...	...	...	...	33 mm
Apical angle	...	...	...	...	...	116°	103°

‡ Specimen slightly distorted.

Remarks.—This species is represented by seven rather poorly preserved specimens in which the apertural characters are to a great extent missing. The ornamentation is not preserved except for traces of coarse spiral costae on the spire of the holotype. The species, however, is so closely related to *S. rylstonensis* sp. nov., with which it is associated, that in all probability the type of ornamentation is similar. It is readily separated from that species by its more inflated whorls, a more erect and distinct spire, and the development of definite growth ridges on the body whorl, a feature which appears to be constant.

Locality and stratigraphical position.—Two miles north-west of Rylstone; conglomerate at base of the Capertee (Upper Marine) Group.

Super-Family **Pleurotomariacea.**

Family **Pleurotomariidae.**

Genus *Mourlonopsis* nov.

Type Species : *Pleurotomaria strzeleckiana* Morris.

Generic Description.—Medium sized turbate pleurotomarids with a moderately high spire, five to six distinct, rounded whorls, slightly shouldered close to the upper suture; a narrow selenizone bordered by carinae, situated above the whorl periphery; sutures sharply angular and deep; base rounded, phaneromphalous; outer lip with a wide insinuation, culminating in a short slit; aperture elongate-oval, its vertical plane sloping inwards at about 35°; columella lip thick, somewhat flattened, arcuate and to some extent reflexed; ornamentation consists of striae following the line of growth and possible fine spiral lirae. Shell thin.

Discussion.—This genus is introduced for the species *Pleurotomaria strzeleckiana* described by Morris (1845 : 287) as it has been pointed out by Knight (1941 : 21) that the genus *Pleurotomaria* (genotype *Pleurotomaria similis* Sowerby 1816), constitutes a Jurassic group of shells with little or no resemblance to Palaeozoic species.

The genus *Mourlonopsis* bears some resemblance to *Platyleichum*, a genus introduced by Campbell (1953 : 23) for turbate gastropods from the Permian of Queensland. Marked features in that genus, which are not found in *Mourlonopsis*, include the flat upper whorl surfaces; the whorls overlap to the base of the slit-band which forms the whorl periphery.

Among other related genera, *Mourlonia* of de Koninck 1883 (genotype *Helix carinatus* Sowerby 1812), appears to be somewhat similar. *Mourlonopsis* is differentiated however, by a more erect spire with a smaller body whorl and an even decrease in the size of the whorls, the pleural angle being 71°. The whorls are not at all impressed over the adjoining ones, but are closely separated by deep, slightly angular sutures. The narrow selenizone is situated above the periphery of the whorls and well above the lower suture.

Mourlonopsis has no close relationship with species such as *Pleurotomaria morrisiana* M'Coy, which in this paper are referred to the genus *Pleurocinctosa* nov. Campbell (1953 : 24) correctly concluded that his genus *Platyleichum* is not congeneric with that group.

***Mourlonopsis strzeleckiana* (Morris)**

(Pl. 9, figures 9—11.)

Pleurotomaria strzeleckiana Morris, 1845 : 287, pl. xviii, figure 5.

Pleurotomaria strzeleckiana M'Coy, 1847 : 306.

Pleurotomaria strzeleckiana Dana, 1849 : 707.

Pleurotomaria strzeleckiana Plews, 1858 : pl. iii, figure 4.

?*Mourlonia strzeleckiana* Etheridge, 1892 : 287, pl. xv, figure 2.

Mourlonia strzeleckiana Laseron, 1910 : 221.

Holotype : (by monotypy) : Specimen figured by Morris 1845 : pl. xviii, fig. 5, in the collection of the British Museum.

Description.—Medium sized pleurotomarids with a moderately high spire, five and occasionally six whorls, base rounded, phaneromphalous; whorl profile rounded, slightly shouldered close to upper suture; whorls not overlapping the previous ones but clearly separated by deep, slightly angular sutures; an even decrease in the size of the whorls; outer lip with a wide insinuation culminating in a short slit which gives rise to a well defined, narrow selenizone bordered with indistinct carinae, and situated above the whorl periphery; outer lip much longer below the selenizone than above it; umbilicus moderately deep and narrow; aperture elongate-oval, its vertical plane sloping inwards at about 35°; columella lip straight, arcuate vertically, flatly rounded, slightly reflected and wider at its junction with the penultimate whorl and the outer lip; shell thin.

Ornamentation of growth lines paralleling outer lip; indications of spiral ridges.

Dimensions.—

					F.46579	F.21762	F.21255
Height	...	...	...	...	35 mm	46 mm	45 mm
Width	...	...	...	...	31 mm	41 mm	39 mm
Pleural angle	...	...	...	...	71°	71°	73°
Height of aperture	...	...	...	...	...	...	22 mm
Width of aperture	...	...	...	...	...	...	19 mm

Remarks.—This species is very abundant in the Gerringong Volcanics and Shoalhaven Group (Upper Marine Series) of the South Coast, particularly at Wollongong and Gerringong. It is also known from other localities including Rylstone (Western Coalfield) and Glendon (Hunter River Valley). It is not known from the Dalwood (Lower Marine) Group or its equivalents.

The species was originally described and figured by Morris (1845 : 287) as *Pleurotomaria strzeleckiana* and was recorded as being abundant at Glendon and Illawarra (Wollongong and Gerringong). The illustration of his specimen (1845 : pl. xviii, figure 5), the holotype, is the only one in which I have observed the complete margin of the outer lip, the wide insinuation and short slit. The illustration may be idealised to some extent, as Campbell (1953 : 24) states that the specimen is a steinkern with small traces of shell in the sutures and the umbilical region. In a large series of more than seventy specimens there is not one specimen on which the original shell material has been completely preserved. On several specimens small portions of the very thin shell indicate the presence of spiral ribbing above and below the selenizone. In steinkerns the selenizone is preserved as a narrow ridge, bordered by shallow sulcations.

M'Coy (1847 : 306) simply listed *Pleurotomaria strzeleckiana* Morris as being common in the fine calcareous grits at Wollongong, while Dana (1849 : 707), stated the species was abundant in the Illawarra Sandstone, but no Glendon or Harper's Hill specimens were met with. A specimen illustrated by Plews (1858 : plan iv) as *Pleurotomaria strzeleckiana* Morris, with no comments, is a typical example of the species.

Etheridge (1892 : 287) was of the opinion that the species should be referred to the genus *Mourlonia*. He described and figured a specimen as *Mourlonia strzeleckiana* (Morris), from the Gympie beds, near Rockhampton, Queensland, although he mentioned it was a more inflated form than the typical species. Some of the shells from New South Wales attain the same length as the Queensland form and possess equally inflated whorls. I have been unable to examine any specimens from Queensland and for the present its status must remain doubtful, although it appears they are not conspecific.

The shells of *Mourlonopsis strzeleckiana* (Morris) are characterised by the moderately high spire, the development of a selenizone, and very rounded whorls. The only other species it even remotely resembles in the Permian of New South Wales is *Pleurocinctosa triflata* (Dana) which is much smaller in size and has an entirely different whorl profile. *Platyteichum costatum* Campbell, differs from *M. strzeleckiana* (Morris) in being smaller in size, with a flattened profile on the upper half of the whorl; the sutures are much less pronounced and the whorls overlap to the base of the slit-band.

Localities and stratigraphical positions.—Wollongong, Gerringong, Kiama, (Gerringong Volcanics); Kioloa, Burrier, Ulladulla, Wyro, near Ulladulla, Jervis Bay, (Shoalhaven Group); Rylstone, (Capertee Group); Maitland, (? Mulbring Formation); Glendon, (? Belford Formation, Maitland Group).

Genus *Cyclosцена* nov.

(*Kuklos*, circle; *scene*, tent.)

Type Species : *Cyclosцена anomphala* sp. nov.

Description.—Moderately large, sub-trochiform, anomphalous, gastropods; five whorls with a slight keel on the periphery of the body whorl and a less defined carina slightly superior to it; whorl profile between sutures gently arched; periphery sub-angulate to rounded; base moderately convex, sutures fine, almost linear; ornamentation numerous fine lirae and growth lines. Aperture sub-circular; shell moderately thick; columella lip thick, flattened.

Remarks.—This genus is a unique form in the Permian gastropod fauna of Australia, characterised by being distinctly anomphalous, its broadly conical form, the thickly developed and broad, flattened columella lip, and the fine and abundant lirae of the ornamentation.

The genus bears a striking resemblance to the genus *Mourlonia* Koninck 1812 (Genotype *Helix carinatus* J. Sowerby 1812) and particularly to a large specimen (PG.40) in the British Museum collection, and figured by Knight (1941 : pl. xxix, figure 1b). It differs, however, from members of that genus in not possessing a defined selenizone, in the adpressed development of the upper whorls, and also the absence of any revolving striae.

It differs from *Gosseletinia* Fischer 1885, (Genotype *Pleurotomaria callosa* Koninek 1843), in its more conical form, steeply arched body whorl and a keel developed on the periphery, whereas in *Gosseletinia* a well defined selenizone is developed high on the whorls.

The genus is represented by the single species, *C. anomphala* sp. nov.

***Cycloscena anomphala* sp. nov.**

(Pl. 10, figures 1—3).

Holotype: Specimen No. 29777. Allandale Formation, Dalwood (Lower Marine) Group; Allandale, Hunter River Valley.

Paratype: Specimen No. F.46586, same horizon and locality.

Description.—Large broadly conical, sub-turbinate, anomphalous gastropods with five whorls; apex erect, pointed; an ill-defined carina on the periphery of the body whorl with an even less defined second carina slightly superior to it; body whorl moderately extended transversely; upper margins of whorls slightly extended vertically and closely pressed on to previous whorls; a narrow sulcus is developed near the upper margins of the whorls; profile of apical whorls steeply sloping, gently arched; body whorl broadly arched; periphery narrowly rounded almost carinate at penultimate whorl; base flatly convex; sutures fine, almost linear; outer lip seemingly directed obliquely backwards, without sinus; columella lip thick, wide and flattened, merging with the base; aperture sub-circular. Ornamentation sharp, numerous lirae, 18—20 in 5 mm, with occasional heavy growth lines, directed obliquely backwards, increasing in obliquity near the periphery where a slight angle is formed as the lirae cross and extend almost straight across the base. Shell thick at upper suture thinning towards periphery, lower inner lip and columella lip thick.

Dimensions.—

							Holotype F.29777	Paratype F.46586
Height	...	...	...	...	...	...	63 mm	69 mm
Width	...	...	...	...	...	...	80 mm	83 mm
Pleural angle	...	...	...	...	...	...	100°	100°

Remarks.—This very outstanding species is represented by four specimens from the type locality at Harper's Hill. Its characteristic features have already been outlined in remarks on the genus. In no instance has the peristome been preserved and the presence of a sinus of any description on the outer lip is doubtful. The ridge or keel developed on the periphery and the ill-defined carina above it cannot be regarded as defining a selenizone and are in all probability ridges formed by a thickening of the shell on the outer lip. Removal of the shell by weathering, particularly the thickened portion at the sutures, reveals the steinkerns to be very broadly rounded on the body whorl with a wide and deep space at the suture.

Locality and stratigraphical position.—Harper's Hill, near Allandale, Allandale Formation. Dalwood (Lower Marine) Group.

Genus *Keeneia* Etheridge 1902.

Type Species: By original designation, *Keeneia platyschismoides* Etheridge, 1902: 198.

Description.—Very large trochiform, narrowly phaneromphalous gastropods with a narrow insinuation in the outer lip; profile of whorls (four to five in number), shouldered below upper suture, flattened to slightly convex, sloping outwards; periphery of body whorl angulate to sharply rounded; base flatly arched; sutures shallow. Aperture large, obliquely quadrangular. Columella lip thickened, parietal inductura thin to moderately thick. Ornamentation sharp, fine transverse lirae, resembling a false selenizone on the whorl periphery.

Remarks.—This is an outstanding genus and is characterised by its large size, strongly shouldered and almost flat sloping whorl profile, and the development of a pseudoselenizone on the angulate, almost carinate, periphery of the body whorl.

Dana (1849: 707, pl. x, figure 1) described and poorly figured a specimen from Harper's Hill as *Platyschisma oculus* (Sowerby). Etheridge (1902: 199) was of the opinion that this specimen "has every appearance of a peculiarly drawn example of *Keeneia platyschismoides*". An examination of a plastotype of this specimen leaves no doubt that it is the species suggested by Etheridge.

Etheridge (1902 : 199) in his observations on his species, *K. platyschismoides*, suggested that *Platyschisma depressum* Dana was a second species of his genus *Keeneia*. This assumption at the time was to some extent correct, but in my opinion a group of forms with depressed shells after the type of *P. depressum* Dana are so dissimilar to the type species of *Keeneia* that they warrant distinct generic rank. The genus *Planikeeneia* has been erected for these shells.

The single shell from the type locality of *P. depressum* Dana, and described by Mitchell (1923 : 278) as *Platyschisma allandaleensis* is conspecific with the former species and has been placed as a synonym of it.

Etheridge (1902 : 199) was also of the opinion that what he had considered in 1898 (p. 176, pl. xix, figures 14—17) as a specimen of *Platyschisma oculus* (Sowerby), was really a young individual of *Keeneia platyschismoides*. This beautifully preserved specimen, an adult shell, together with additional material is almost certainly a distinct species and has been described as *Planikeeneia minor* sp. nov.

Johnston (1888 : pl. xviii, figure 4) figured, but did not describe, a specimen from the Permian of Tasmania as *Platyschisma ocula* (Sowerby). From the illustration it has a close resemblance to *Keeneia trochiforme* sp. nov. and has been tentatively placed as a synonym of that species. The specimen has been mislaid in the collection of the Tasmanian Museum, Hobart.

Branson (1948 : 702) following the advice of Brookes Knight (personal communication) referred *Platyschisma ocula* (Sowerby), to the genus *Keeneia* Etheridge 1902, and also placed *Keeneia platyschismoides* Etheridge as a synonym of that species. It is considered that *Platyschisma oculus* (Sowerby) should possibly be referred to the genus *Keeneia*, but it is a distinct species and quite unlike *Keeneia platyschismoides*.

Etheridge (1902 : 198) considered that *Platyschisma oculus* (Sowerby) was generically distinct from his genus *Keeneia* and quoted points of difference which are referred to later in this paper in the discussion of the species. These differences could perhaps be taken as only of specific value and following the example of Branson and Brookes Knight it has been referred to the genus *Keeneia*. The large series of specimens of both *Keeneia platyschismoides* Etheridge and *Keeneia ocula* (Sowerby), as shown later in this paper, prove conclusively in my opinion that they cannot be considered as being conspecific.

***Keeneia platyschismoides* Etheridge.**

(Pl. 14, figures 1—2; pl. 15, figures 1—2.)

Platyschisma oculus Dana (non Sowerby), 1849 : 707, pl. x, figure 1.

Keeneia platyschismoides Etheridge, 1902 : 198, pl. xxii, figures 1—2; pl. xxiii, figure 3. (non figures 4—5).

Holotype : By subsequent designation of Brookes Knight (1941 : 163), specimen No. F.7257, figured by Etheridge 1902 : pl. xxii, figure 2. From Harper's Hill, Allandale Formation, Dalwood (Lower Marine) Group.

Paratype : Specimen No. F.7258, same locality and horizon, figured by Etheridge 1902 : pl. xxxii, figure 1.

Description.—Shell large, trochiform, much wider than high, narrowly phaneromphalous; spire of four to five whorls, moderately depressed; body whorl large, sutures shallow. Whorl profile, well shouldered below the upper suture, flattened to gently convex on the sloping (35° — 40°) sides to the periphery; flattened to gently convex from the periphery to the umbilicus. Periphery sharply angulate becoming sub-angular nearing and at the aperture; aperture large, obliquely quadrangular. Columella lip almost straight, thickened, reflected slightly over the umbilicus; parietal inductura thin; lower lip sharply curved at its junction with the columella lip, almost straight to the angulate periphery; outer lip with a narrow insinuation developed at the periphery of the whorl, not a notch or slit, culminating in a pseudo-selenizone; base of shell flattened becoming arched towards the aperture. Shell thick of two definite layers, an outer thick layer and an inner thin layer.

Ornamentation consists of fairly coarse transverse lirae, usually about five in 5 mm, directed obliquely backwards on the upper half of the whorls; a sharp backward U-shaped bend at the periphery forms a band or false selenizone. On the lower half of the whorls the lirae extend forwards in a faint sigmoidal curve and are gathered together as they enter the umbilicus.

***Dimensions.*—**

		Holotype F.7257	Paratype F.7258	Topotype F.19006
Height	...	90 mm	85 mm	86 mm
Width	...	120 mm	122 mm	124 mm
Pleural angle	...	95°	98°	95°
Length of aperture	...	65 mm	...	67 mm
Width of aperture	...	46 mm	...	48 mm

Remarks.—This species was fully described by Etheridge (1902 : 199) and later by Brookes Knight (1941 : 164), when he selected as the holotype a specimen (F.7257) in the Australian Museum collection and figured by Etheridge (1902 : pl. xxxii, figure 2). This specimen was forwarded to Brookes Knight on loan as the only type material of the species which could be found at that time. In the meantime the other specimen (F.7258) figured by Etheridge (pl. xxxii, figure 1) was found. It would appear that Etheridge inferred that the holotype was specimen F.7258, as in his explanation of the plate he stated that Figure 2 is "another specimen" and again on Pl. xxxiii, that Figure 5 is "yet another example". He thus inferred that the specimen figured on Pl. xxxii, Figure 1, was the holotype. Furthermore it is a well preserved specimen with a complete shell, whereas several of the most apical whorls are missing in the specimen selected as holotype by Brookes Knight. The illustrations figured by Etheridge (1902 : pl. xxxiii, figures 4—5), showing an enlargement of the peripheral bands are not typical shells of *Keeneia platyschismoides*.

The species, *K. platyschismoides*, is represented in the collection by more than thirty large and fairly well preserved specimens from the Allandale Formation at Harper's Hill. It is an outstanding species and is readily recognised from *K. trochiforme* and *K. ocula* by its larger size, much greater width than height, and the presence of a well defined shoulder on the upper part of the whorls.

Etheridge (1902 : p. 199) pointed out that the specimen described and figured as *Platyschisma oculus* (Sowerby) by Dana (1849 : 707), could be conspecific with *Keeneia platyschismoides*. An examination of a plastotype of Dana's specimen proves that his illustration (Atlas, pl. x, figure 1) is a very poor and misleading one and gives no indication of its true features. The specimen actually shows little or no distortion and is a typical example of *K. platyschismoides*. Furthermore it came from the type locality at Harper's Hill. Dana (p. 707) described the specimen as "somewhat rounded conical, the large spire a little depressed, and the angle of the spire about 90°". The greatest diameter of any specimen in his possession was 3½ inches and the figured specimen he thought represented a depressed specimen, believed to be of this species, *Platyschisma oculus* (Sowerby); "it was probably distorted by pressure".

Localities and stratigraphical position.—Harper's Hill (type locality); Allandale; Duguid's Hill. Allandale Formation, Dalwood (Lower Marine) Group.

***Keeneia trochiforme* sp. nov.**

(Pl. 10, figures 4—6; pl. 11, figures 1—2.)

Holotype : Specimen No. F.46571, from Harper's Hill, near Maitland; Allandale Formation, Dalwood (Lower Marine) Group.

Paratype : Specimen No. F. 46572, same locality and horizon.

Description.—Large trochiform, narrowly phaneromphalous gastropods with a flatly convex base, aperture vertically produced; whorls five; whorl profile, very slightly shouldered at the upper suture, flat steeply sloping sides to the angulate periphery; sutures shallow. Umbilicus narrow, covered to some extent by the columellar lip which is thickened at its junction with the penultimate whorl. Parietal inductura thin. Ornamentation consists of fairly coarse lirae, numerous and directed backwards on the upper half of the whorls; at the periphery the lirae sweep acutely back, then forward again to form a false selenizone or band; on the flattened base the lirae curve forwards finally entering the umbilicus. Aperture subquadrangular, moderately oblique.

Dimensions.—

							Holotype F.46571	Paratype F.46572
Height	...	...	...	...	...	...	66 mm	76 mm
Width	...	...	...	...	...	...	67 mm	97 mm
Pleural angle	...	...	...	...	...	...	80°	95°
Width of aperture	...	...	...	...	...	...	29 mm	39 mm
Length of aperture	...	...	...	...	...	...	38 mm	47 mm

Remarks.—The holotype of this species is a beautifully preserved specimen with the exception of the aperture which is incomplete. It is smaller in size than the other ten specimens of a series considered to be conspecific with it. The material is from Harper's Hill in the Hunter River Valley.

This species is very similar in general appearance to *K. platyschismoides*, but differs from it in several important features. The shell is more conical in form, the shoulder at the upper suture is poorly developed and the whorl profile is steeply sloping and flattened. In *K. platyschismoides* the aperture is produced obliquely outwards whereas in *K. trochiforme* it is distinctly more vertical in position. In the latter species the columella lip is very thickened and appears to be reflected partly covering the umbilicus.

A specimen, from the Huon Road, Hobart, Tasmania, from an horizon thought to be the equivalent of the Berridale Limestone (Upper Marine Series), was figured by Johnston (1888: pl. xviii, figure 4), as *Platyschisma ocula* (Sowerby). This specimen is an example of the genus *Keeneia*, and it exhibits the characteristic features of *K. trochiforme*. The body whorl is steeply sloping, the shoulder is absent and the shell is more conical in appearance than in *K. platyschismoides* Etheridge. The specimen is the only one known from rocks other than the Allandale Formation, of the Hunter River Valley. A doubtful specimen is that figured, but not described, by Plews (1858: plate iv), as "*Platyschisma oculus*" from Harper's Hill. The illustration is very poor and one which would be impossible to identify specifically. Certain features indicate that possibly its place might be either with *K. platyschismoides* or *K. trochiforme*. The whereabouts of the specimen is unknown.

Localities and stratigraphical position.—Harper's Hill (type locality), Allandale, Duguid's Hill, Allandale Formation, Dalwood (Lower Marine) Group. Huon Road, near Hobart, Tasmania. Berridale Limestone (Upper Marine Series).

Keeneia ocula (Sowerby)

(Pl. 19, figures 1—7; pl. 20, figures 1—6).

Trochus oculus Sowerby, 1838: 15, pl. ii, figures 3—4.

Platyschisma oculus Morris, 1845: 286, pl. xviii, figure 1.

Euomphalus oculus de Koninck, 1877: 330, pl. xxiii, figures 18a—c.

Keeneia ocula Branson, 1948: 702.

Holotype (by monotypy): Specimen PG. 1061, figured by Sowerby 1838: pl. ii, figures 3—4. From "right bank of Hunter River"=Harper's Hill; Allandale Formation, Dalwood Group. Collection of the British Museum.

Description.—Medium sized, sub-globular; narrowly phaneromphalous gastropods of four to five whorls; penultimate and body whorls moderately inflated, remainder reduced and depressed; sutures shallow; whorl profile gently arched, steeply sloping from upper suture to subangulate to angulate periphery; lower half of body whorl flatly convex gaining in convexity towards the aperture; outer lip directed somewhat obliquely backward; a shallow sinus possibly developed at the periphery (not observed); junction of outer and inner lip angulate; columella lip fairly broad, flatly rounded, extending in a broad curve, backwardly directed, to the periphery and losing its thickness near that point; ornamentation numerous fine, transverse lirae, partly wavy, directed somewhat obliquely backward; crossing the periphery a further backward and then forward curve of the lirae forms a moderately shallow sinus, possibly indicative of the sinus of the outer lip; lirae on the base moderately straight; shell comparatively thick; aperture sub-oval.

Dimensions.—

					Holotype	Topotypes		
					PG.1061	F.27539	F.27535	F.46588
Height	...	...	...	...	44 mm	44 mm	36 mm	45 mm
Width	...	...	...	...	60 mm	59 mm	50 mm	62 mm
Pleural angle	...	...	...	...	100°	101°	98°	105°
Width of aperture	...	...	...	...	...	33 mm	27 mm	34 mm
Height of aperture	...	...	...	...	...	30 mm	23 mm	29 mm

Remarks.—Sowerby (1838: 15) named his specimen *Trochus oculus*, but gave no description. His illustrations (pl. ii, figures 3—4) are to some extent idealised drawings of what is actually a rather poorly preserved specimen. Photographs of this specimen, the holotype PG.1061, were kindly forwarded to me by the British Museum and are reproduced. Photographs of the specimen described and figured by Morris (1845: 286) were also forwarded by the British Museum and there is no doubt it is conspecific with the holotype.

There is a considerable variation in the size of shells of *Keeneia ocula* (Sowerby) from the type locality. A large series of specimens from the Maitland Group of the Hunter Valley and particularly in the equivalent rocks, in part, of the South Coast, are smaller in size than typical examples of the species. Unfortunately the material is invariably poorly preserved, mainly in the form of steinkerns, and apertural characters are rarely present. However, it would appear that the species has an extensive vertical range in the Permian rocks of New South Wales, extending from the Lochinvar Formation of the Dalwood Group to the topmost beds of the Maitland Group and its equivalents.

The species was mentioned by M'Coy (1847 : 306) as common in the "aranaceous limestone" of Harper's Hill, with no other comments. De Koninck (1877 : 330; pl. xxiii, figure 18) described and figured the species as *Euomphalus oculus* (Sowerby), recording it from Harper's Hill and from a yellowish sandstone at Branxton. His material, subsequently destroyed in the Garden Palace fire at Sydney in 1882, was typical of the species. Johnston (1888 : pl. xvi, figure 3) figured what appears to be a steinkern from the Huon Road, near Hobart, Tasmania, and referred it to *Platyschisma oculus* (Sowerby). The specimen has not been examined and there is a possible doubt regarding its relationship with this species. It was mentioned earlier in this paper that the specimen figured by Johnston (1888 : pl. xvii, figure 4) as *Platyschisma oculus* (Sowerby), also from the Huon Road locality, appears to be conspecific with *Keeneia trochiformis* sp. nov. The specimens from Permian rocks in Queensland, described and figured by Etheridge (1892 : 286) as *Platyschisma oculus* (Sowerby) do not appear to be typical examples of the species. The shape of the body whorl and the aperture are very dissimilar.

Laseron (1910 : 220) recorded *Platyschisma oculus* (Sowerby) from several localities in the Lower Shoalhaven River area on the South Coast. The specimens were not figured and have subsequently been mislaid.

Etheridge (1902 : 198) considered that *Platyschisma oculus* (Sowerby) was generically distinct from his genus *Keeneia*. In shells of that genus there is developed on the periphery of the body whorl a distinct flattened band or pseudo-selenizone, defined by the striae which at this point sweep deeply concave backwards. In *P. oculus* there is only a slight inflection, or curving backwards of the striae on passing over the obtuse periphery of the body whorl. Apart from the great difference in size there is a distinct general resemblance between the two species and I agree with Branson and Brookes Knight (1948 : 702) that they are congeneric. This resemblance is particularly noticeable in the specimens figured on pl. xiv, figure 1 and pl. xix, figure 4.

I cannot agree, however, with the above authors in their suggestion that *Keeneia platyschismoides* and *Keeneia ocula* are conspecific. The flattened peripheral band of the former, together with the acutely inflected striae and sharply angulate periphery, are markedly different from the more rounded periphery of *K. ocula* and only slightly and broadly backwardly inflected striae of that species as they cross the periphery. Furthermore, apart from the great difference in size, the whorl faces of *Keeneia platyschismoides* are steeply sloping and flattened in contrast with the more moderately and evenly inflated whorls of *K. ocula*. Both species are distinct forms and are readily recognised.

Morris (1845 : 286) when he described *Platyschisma rotundatum*, remarked that it could possibly be a variety of *P. oculus* (Sowerby). Etheridge (1919 : 188) rightly considered them to be distinct species.

Localities and stratigraphical positions.—Lochinvar; Lochinvar Formation. Harper's Hill, Allandale; Allandale Formation, Dalwood (Lower Marine) Group. Branxton; Branxton Sub-group; Maitland (Upper Marine) Group. Wyro, near Ulladulla, Ulladulla; Shoalhaven (Upper Marine) Group. Wollongong, Gerringong; Gerringong (Upper Marine) Volcanics. Bundanoon; (Upper Marine). Rylstone; Capertee (Upper Marine) Group.

Genus *Planikeeneia* nov.

Type Species: *Planikeeneia minor* sp. nov., Harper's Hill. Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Moderately medium sized to large, low-spined gastropods of four to five whorls with low convexity; a narrow sinus in the outer lip; a pseudo-selenizone occasionally; whorl profile gently arched between sutures; angulate to sub-angular on periphery of body whorl; base flatly convex; sutures moderately deep. Ornamentation numerous to crowded fine, sharp, transverse lirae, deflected backwards on the periphery of the body whorl.

Remarks.—This genus is introduced for the following species which are depressed, low-spined gastropods, with whorls of low convexity: *Planikeeneia minor* sp. nov., *Planikeeneia occasa* sp. nov., *Platyschisma depressum* Dana and *Planikeeneia insculpta* sp. nov.

These species with the exception of *P. occasa* sp. nov., are associated in the Allandale Formation of the Dalwood (Lower Marine) Group at Harper's Hill. *Planikeeneia occasa* is found in the Branxton (Upper Marine) Sub-group and also occurs in its equivalent beds in the South Coast.

It is considered that the above species are precluded from the genus *Platyschisma* M'Coy 1844, by the development of the distinctly angulate periphery of the whorls and the depressed spire. It was suggested by Etheridge (1902 : 199) that *Platyschisma depressum* Dana should be referred to his genus *Keeneia*. The shells of that genus are very dissimilar to those of *Platyschisma depressum* Dana, and the species is referred to the new genus *Planikeeneia*.

Planikeeneia minor sp. nov.

(Pl. 14, figures 3—6.)

Platyschisma oculus Etheridge (non Sowerby), 1898 : 176, pl. xix, figures 14—17.*Keeneia depressum* Etheridge (non Dana) 1919 : 188—189. Specimen from Lochinvar.

Holotype : Specimen F.46578, figured by Etheridge 1898 : pl. xix, figures 14—17. From Harper's Hill. Dalwood (Lower Marine) Group.

Paratype : Specimen F.6640, mentioned by Etheridge 1919 : 188—189, from same locality and horizon as the holotype.

Description.—Moderately small, low-spined and depressed gastropods, five to six whorls of low convexity, narrowly phaneromphalous; sutures distinct, shallow; whorl profile sub-angulate, sharply angulate in steinkerns, upper surface broadly convex, slightly shouldered below the upper suture; a pseudo-selenizone developed on the periphery; lower surface of whorl flatly convex; columella lip thickened, reflexed, increasing in strength towards its junction with the slightly curved lower lip; character of outer lip not observed; aperture oval, obliquely transverse; ornamentation numerous fine, transverse lirae, 18—30 in 5 mm, directed obliquely backward to the periphery where they bend sharply back and forward again to form a narrow apparent band or pseudo-selenizone; below the periphery the lirae extend to the umbilicus in a somewhat sigmoidal manner.

Dimensions.—

		Holotype F.46578	Paratype F.6640
Height		22 mm	32 mm
Width		37 mm	57 mm
Pleural angle		130°	132°
Height of aperture		16 mm	...
Width of aperture		22 mm	...

Remarks : The holotype of this species was originally described and figured by Etheridge (1898 : 176) as a very depressed form of *Platyschisma oculus* (Sowerby), at the same time stating, however, that it could with justification be regarded as a new species.

Etheridge (1919 : 188—9) recorded, but did not figure, a specimen from Lochinvar as *Keeneia depressum* (Dana). He remarked on the "peripheral band" truncating the entire edge or keel, which in his opinion corresponded to the "back sub-truncate" of Dana's species. The specimen is quite unlike *P. depressum* Dana, but agrees very well with a series of about twenty specimens of this species from Harper's Hill. It bears a superficial resemblance to the smaller shells of *Walnichollisia pygmaea* sp. nov., from the South Coast, differing, however, in having a distinct angulate whorl periphery and an entirely different type of ornamentation.

Localities and stratigraphical positions.—Lochinvar, Lochinvar Formation; Harper's Hill Allandale Formation; Ravensfield, Farley Formation; Dalwood (Lower Marine) Group.

Planikeeneia depressum (Dana)

(Pl. 17, figures. 1—2; Pl. 18, figures 1—2.)

Platyschisma ? depressum Dana, 1847 : 151.*Platyschisma depressum* Dana, 1849 : 707, pl. x, figures. 2a, b.*Platyschisma allandaleensis* Mitchell, 1923 : 278, pl. xxxv, figures 1—2.

Holotype (by monotypy) : Specimen figured by Dana 1849 : pl. x, figures 2a, b. From Harper's Hill, Allandale Formation, Dalwood Group. Collection of the United States National Museum, Washington.

Description.—Large to medium sized, somewhat explanate, phaneromphalous gastropods of four to five whorls; much wider than high; whorls of the spire much reduced, depressed; sutures narrow, not deep; whorl profile flattened for most of the distance from the suture to the periphery which is narrow, sub-truncate to rounded; base flatly convex; aperture elongate-oval, almost horizontal in position; outer lip moderately oblique backwards from the upper suture, a narrow insinuation on the periphery, not a notch or slit, continuing with the same obliquity on the base; apertural characters not preserved; ornamentation fairly coarse transverse lirae; transverse grooves following the direction of growth, well developed on the whorls; shell thick, particularly at junction of whorls.

Dimensions.—

						Plastotype	Mitchell's Specimen	Topotype
						L.694	F.27084	F.27085
Height	...	...	...	...	...	47 mm	68 mm	51 mm
Width	...	...	...	...	...	109 mm	118 mm	105 mm
Pleural angle	...	...	...	...	...	140°	140°	147°
Height of aperture	...	...	...	...	...	...	47 mm	30 mm
Width of aperture	...	...	...	...	...	...	70 mm	75 mm

Remarks.—Dana (1847 : 151) and later in 1849, (p. 707) stated that this species “differs widely from the *oculus* in its very depressed form, and flattened whorls, the outer of which has the back sub-truncate”. His specimen has a width of $4\frac{1}{2}$ in and the surface is unevenly and coarsely marked with striae of growth. A plastotype (L. 694) of Dana's holotype, proves very conclusively that it is a distinct species and because of the very depressed nature of the shell is considered as referable to the genus *Planikeeneia*.

Etheridge (1919 : 188) was of the opinion that Dana's specimen was crushed from above, but after an examination of a plaster replica of the holotype he agreed that Dana's description was strictly accurate. Etheridge also recorded, but did not figure, a much smaller specimen, F.6640, from Lochinvar in the Hunter River Valley, which he thought agreed with Dana's description of *P. depressum* in that a peripheral band is developed truncating the entire edge or keel. This specimen is an adult shell of *Planikeeneia minor* sp. nov.

Mitchell (1922 : 278) described and figured a single large shell from Allandale, near Harper's Hill, as *Platyschisma allandalensis*. The specimen is a steinkern with practically none of the original shell material preserved. The periphery is to some extent more rounded than Dana's specimen, but there is no doubt that the two are conspecific. Mitchell records “a notch or gape” in the outer lip of his specimen, similar to what is found in the present-day genus *Ianthina* and the species *Platyschisma oculus* (Sowerby). This character is not a well marked feature and if present is in the form of a very shallow insinuation and certainly not a distinct notch.

The shell in this species is thick and in decorticated specimens a considerable space is left around the upper suture of the body whorl where the shell attained a maximum thickness.

Localities and stratigraphical position.—Harper's Hill, Allandale; Allandale Formation, Dalwoo (Lower Marine) Group.

***Planikeeneia occasa* sp. nov.**

(Pl. 18, figures 3—6.)

? *Platyschisma rotundatum* var. *farleyensis* Etheridge, 1919 : 189, pl. xxviii, figure 9.

Holotype : Specimen No. F.28295, from Branxton, Hunter River Valley, Elderslie Formation, Branxton (Upper Marine) Sub-group.

Paratype : F.29869, same locality and horizon.

Description.—Moderately small, low-spined, sub-discoidal, narrowly phaneromphalous gastropods of four whorls; a wide shallow sinus in the outer lip; body whorl produced transversely, somewhat explanate; whorl profile gently arched between sutures, a flattened area below the upper sutures; periphery of body whorl sub-angulate; base flatly convex; sutures shallow, whorls overlapping preceding ones to a marked extent; columellar lip rounded, thickened above, tapering and broadly curved with a slight obliquity backwards to the sinus; outer lip thin directed moderately obliquely backward produced considerably in front of the inner and lower lip; aperture oval, obliquely transverse. Ornamentation numerous fine lirae with distinct occasional growth ridges; a slight inflection or curving backwards of the lirae as they cross the periphery.

Dimensions.—

						Holotype	Paratype
						F.28295	F.29869
Height	...	...	...	...	...	30 mm	31 mm
Width	...	...	...	...	...	47 mm	46 mm
Pleural angle	...	...	...	...	...	122°	130°

Remarks.—This species is represented by a series of 11 well preserved specimens from Branxton, Greta and Richmond Vale in the Hunter River Valley. A single steinkern in the series agrees very well with a suite of steinkerns from Farley, described by Etheridge (1919 : 189) as *Platyschisma rotundatum* var. *farleyensis*. He recorded the internal casts as of less than the normal dimensions of *P. rotundatum* Morris and stated that "the sulci resulting from the protrusion of the inner shelly ribs, described by Morris, are always in evidence". This is apparently not the case entirely as many of his specimens show no trace of sulci. Steinkerns invariably show more rounded whorls than specimens still retaining the original shell. There is such a strong similarity between the two forms that they are tentatively considered to be conspecific.

The internal casts described by Etheridge are from the Farley Formation, Dalwood (Lower Marine) Group, while complete specimens of *P. occasa* are from the Elderslie Formation of the Branxton (Upper Marine) Sub-group. The two formations are separated by the Greta Coal Measures with a thickness of 200 ft.

It is also possible that this species is represented at Gerringong in rocks of the Westley Park Tuff (Gerringong Volcanics). The material, however, is poorly preserved and a definite identification is impossible.

This species is somewhat similar in appearance to *Platyschisma branxtonensis* sp. nov. with which it is associated in the same horizon. It differs in being a more explanate type of shell, in the presence of a sub-angulate periphery and different ornamentation.

Localities and stratigraphical positions.—Farley; Farley Formation, Dalwood Group. Branxton, Greta, Richmond Vale; Elderslie Formation, Branxton Sub-group. ? Gerringong; Westley Park Tuff, Gerringong Volcanics.

***Planikeeneia insculpta* sp. nov.**

(Pl. 17, figures 3—5.)

Holotype: Specimen No. F.29904, from Allandale; Allandale Formation, Dalwood Group.

Description.—Moderately large, sub-discoidal narrowly phaneromphalous gastropods of five whorls with a possible narrow sinus in the outer lip (not observed); body whorl produced somewhat transversely with a sub-angulate periphery; whorl profile rounded from the upper suture to the periphery, with a narrow depressed, flattened area below the upper suture; periphery sub-angulate, base flatly convex; sutures shallow; aperture sub-quadrangular, lower lip straight; columellar lip thickened, flattened and reflexed, increasing in width towards its junction with the lower lip. Ornamentation crowded sharp, fine striae, curved obliquely backwards to the periphery, where as they cross, a moderately deep sinus is developed to form a pseudo-selenizone; striae straight on the base; an indistinct series of spiral striae can be traced in the form of faint ridges between the transverse striae.

Dimensions.—

							Holotype
Height	...	...	...	...	...	...	40 mm
Width	...	...	...	...	...	...	64 mm
Pleural angle	...	...	...	...	...	...	140°

Remarks.—This species is represented by a single beautifully preserved specimen from Allandale. It is an outstanding depressed form with a distinct band or pseudo-selenizone on the periphery of the body whorl, and characteristic ornamentation. It has a superficial resemblance to *P. occasa* sp. nov., from higher in the Permian sequence, but is readily distinguished by its more inflated body whorl and entirely different shape of the aperture and columellar lip.

Dun (1913 : 8) described and figured a small low-spined gastropod from the Tasmanite Spore beds of the Mersey River, Tasmania, as *Keeneia twelvetreesi*. It has points of resemblance to *Planikeeneia insculpta* sp. nov. particularly in the strong inflection of the growth lines forming a slightly raised band on the periphery of the body whorl. The holotype of *K. twelvetreesi* Dun has been mislaid and until it can be found and examined a relationship between the two species is only suggested.

Locality and stratigraphical position.—Allandale; Allandale Formation, Dalwood Group.

Genus **Mourlonia** ? Koninck 1883

Mourlonia ? *waterhousei* Etheridge

Mourlonia ? *Waterhousei* Etheridge, 1898 : 17, pl. i, figures 7—8.

Remarks.—This is a most outstanding species of the Permian gastropod fauna of New South Wales. Etheridge's description is : "Shell depressed turreted, deeply umbilicate; whorls four (as far as preserved); upper whorls nearly straight-walled, flat and tabulate above, sharply keeled at the peripheries; body whorl generally rounded above and below, bearing three spiral keels, one peripheral in position, a second supra-peripheral, and a third similar, but rather more widely separated from the second than the first and second are from one another; surface, except the space between the first and second keels, which is concave and plain, traversed by spiral raised lines, with traces of indistinct obtuse, or flattened varices, especially on the body whorl".

The mouth and apex are not preserved on the material described by Etheridge. He considered that the only other Australian Permian species it resembled is *Walnichollsia subcancellata* (Morris), differing from it, however, in many essential features. Unfortunately the specimens described by Etheridge have been mislaid in the collection of the Mining and Geological Museum, Sydney, and I know of no other specimens. It is apparently a most distinctive species and cannot be compared with any known gastropod from the Permian of Australia.

Locality and stratigraphical position.—A quarter of a mile north-west of the Water-works, West Maitland, Hunter River Valley; Muree Formation of the Branxton Sub-group or the Mulbring Sub-group, Maitland (Upper Marine) Group.

Genus **Pleurocinctosa** nov.

(*Pleura*, side; *Cinctosa*, girded)

Type Species : *Pleurotomaria trifilata* Dana, 1847 : 150.

Description.—Small moderately high-spined, minutely phaneromphalous or anomphalous gastropods, mainly of four to six whorls; a narrow sinus in the outer lip culminating in a narrow, deep selenizone bordered on either side by an acute carina, the lower forming the periphery; whorl profile gently arched above and below the selenizone; base roundly subconical; whorls overlapping on previous whorls close to selenizone; columella lip flattened, somewhat arcuate, considerably thickened and reflexed; aperture oval; ornamentation oblique transverse lirae.

Remarks : Species of this genus have been referred in the past to *Pleurotomaria*, *Ptychomphalina* and *Murchisonia*. It is now recognised that the name *Pleurotomaria* is not valid for Palaeozoic forms and the new genus *Pleurocinctosa* has been introduced for the three species from New South Wales, *P. trifilata* (Dana), *P. allandalensis* sp. nov. and *P. elegans* sp. nov. It differs from the genus *Ptychomphalina* Fischer 1885 (genotype *Helix* ? *striatus* Sowerby 1817) in its more erect spire, an acute pleural angle and the gradual and even increase in the size of the whorls, which do not overlap to the selenizone.

The genus *Murchisonia* Archiac and Verneuil 1841 (genotype *Muricites turbinatus* Schlotheim 1820), from the middle Devonian rocks of Germany, is represented by high-spined shells with the whorl profile concave above and below the selenizone, a feature absent in the Australian shells. The genus *Pleurocinctosa* resembles somewhat superficially the shells of *Goniostropha* Oehlert 1888, which are however high-spined and the selenizone separates the whorl faces into equal upper and lower surfaces.

There is a close relationship between shells of *Pleurocinctosa* and those of the genus *Peruwispira* Chronic 1949, (genotype *P. delicata*), from the lower Permian of Peru. An important difference is the strongly developed columella lip of *Pleurocinctosa* and other apertural features.

It is considered that *Pleurocinctosa trifilata* (Dana), a small somewhat conical species from the Maitland (Upper Marine) Group and its equivalents, and *P. allandalensis* sp. nov., from the Dalwood (Lower Marine) Group, are both essentially bicarinate groups. A third carina is occasionally represented by a spiral ridge bordering an ill-defined sulcus below the selenizone. A third species, *P. elegans* sp. nov., is comparatively rare and has been recorded only from the Belford Formation of the Maitland Group in the Hunter River Valley. It is a definite tricarinate form and is quite distinct from *P. trifilata* (Dana) and *P. allandalensis* sp. nov.

Pleurocinctosa trifilata (Dana)

(Pl. 11, figures 3—6)

Pleurotomaria (nearly related to *P. conica* Phillips) Morris, 1845 : 288.*Pleurotomaria trifilata* Dana, 1847.*Pleurotomaria morrisiana* M'Coy, 1847 : 306, pl. xvii, figure 5.*Pleurotomaria morrisiana* Dana, 1849 : 706, pl. ix, figures 15, 15a, (non figure 16).*Pleurotomaria morrisiana* Koninck, 1877 : 321, pl. xxiii, figure 12.

Lectotype (here chosen) : Specimen figured by Dana 1849 : 706, pl. ix, figures 15, 15a, from Black Head, near Gerringong. Westley Park Tuff, Shoalhaven (Upper Marine) Group. Collection of the United States National Museum, Washington.

Description.—Somewhat conical, moderately high-spined, minutely phaneromphalous or anomphalous gastropods of four whorls, occasionally five; a narrow sinus in the outer lip culminating in a deep, narrow selenizone lying between two acute carinae, the lower forming the periphery of the whorl; whorl profile gently arched and steeply sloping above the selenizone, convex below; base rounded, sub-conical; aperture circular, parietal inductura thin; columella lip thickened, arcuate, considerably reflexed and sutures moderately deep; ornamentation very fine crowded lirae, obliquely directed backward from the upper suture to the selenizone, straight with slight forward curvature on base.

Dimensions.—

							F.21396
Height	...	...	...	...	...	...	11 mm
Width	...	...	...	...	...	...	7.5 mm
Pleural angle	...	...	...	...	...	...	50°

Remarks.—Dana (1847 : 150) described this species as occurring at Harper's Hill, Dalwood (Lower Marine) Group, and also from Illawarra, Gerringong (Upper Marine) Volcanics. His material must have included specimens of two species. The description of his species is almost certainly that of a shell from Illawarra and is as follows : "Shell rather short turreted, whorls four, separated by a distinct suture, back tricarinate, the middle carina largest, subacute, aperture orbicular". The dimensions of the shells he referred to as "large specimens" are "eight lines long, and five broad at base". These are the elongate shells found in abundance at Harper's Hill and consist of at least six or more whorls. They are distinct from the smaller conical shells from the Illawarra district.

Morris (1845 : 288) was actually the first author to record the presence of this species at Illawarra. In discussing the affinities of his *Pleurotomaria subcancellata*, he mentioned a well-defined impression of another species with a bicarinate mesial band, and numerous small, oblique, rather acute striae on each volution. Morris considered it to be a "species of *Pleurotomaria*, nearly related to *P. conica* Phillips, as it is small, elongated and acutely conical".

M'Coy (1847 : 306) described and figured the small conical form from Black Head, near Gerringong, as *Pleurotomaria morrisiana*. His figure (1847 : pl. xvii, figure 5) is a typical example although the whorl faces are incorrectly illustrated as being concave. Dana (1849 : 706) redescribed the small conical form, but again records the dimensions of the larger shells from Harper's Hill. He also states that "the specimens from Harper's Hill are mostly larger than those from Illawarra". Dana accepted the fact that his shells were conspecific with those described by Morris and incorrectly adopted M'Coy's specific name *morrisiana* in preference to his earlier *trifilata*. He considered "the honour is well due to Mr. Morris". Such a change of name is against the accepted Rules of Nomenclature and Dana's original specific name *trifilata* must stand with M'Coy's specific name *morrisiana* as a synonym. The specimen figured by Dana (1849 : pl. ix figure 15a) shows three carinae encircling the whorls and is from Illawarra.

Koninck (1877 : 327) described but did not figure the more elongate and larger form as *Murchisonia trifilata* Dana. He placed as synonyms, *Pleurotomaria trifilata* Dana 1847, and *P. morrisiana* Dana 1849, *exclusa* figure 15, (non M'Coy). Koninck's specimens which came from Harper's Hill are described as elongated conical shells composed of seven or eight whorls with a triple keel. The dimensions are length "about 20 mm and a diameter of from 9 to 10 mm". Its pleural angle is about 51°.

Koninck referred this form to the genus *Murchisonia* because of its greater relative length, and this fact, together with the smallness of the spiral angle and the presence of a triple keel, made him conclude it was distinct from *P. morrisiana* M'Coy, which has a double keel. This conclusion is correct, but it is considered that Dana's descriptions of *P. trifilata*, both in 1847 and 1849, refer to the small conical shell with four to five whorls, and his name must be used for them. The specimen figured by Dana (1849 : pl. ix, figure 15, and enlarged figure 15a) is from Illawarra. The specimen figured by him on Plate ix, Figure 16, is from Harper's Hill. The elongate form with six to seven whorls from Harper's Hill is described later in this paper as *Pleurocinctosa allandalensis* sp. nov.

Koninck (1877 : 321) redescribed and figured *Pleurotomaria morrisiana* McCoy, from Minnamurra, near Gerringong. It is the small conical form with four to five whorls, a double keel, and a pleural angle of 60°. It is the form recognised in this paper as *P. triflata* (Dana).

It would appear from a close study of more than four hundred specimens of *P. triflata* and *P. allandalensis* that the former is restricted mainly to rocks of the Gerringong (Upper Marine) Volcanics of the South Coast in which it is abundant. The latter species is restricted to the Dalwood (Lower Marine) Group of the Hunter Valley where it is abundant in the Lochinvar and Allandale Formations. It is also widely distributed in rocks of equivalent age in New South Wales.

It has been noticed that both bicarinate and tricarinate shells of *P. triflata* (Dana), occasionally occur together in the same matrix and are obviously the same species. The narrow, deep selenizone lies above the periphery of the whorls and is bordered by an acute upper carina and a slightly stronger lower carina forming the periphery of the whorl. Immediately below the periphery is an ill-defined encircling narrow sulcus which is hardly discernible in well preserved specimens. Its lower margin is bordered by a faint ridge and in weathered specimens the ridge becomes more distinct and forms a third carina. It is suggested that this may be the explanation of the tricarinate nature of certain shells of *P. triflata* and *P. allandalensis*, but not *P. elegans* in which a definite tricarination is developed.

Koninck (1877 : 329) described and figured a small elongate conical form of shell from Minnamurra, near Gerringong, as *Murchisonia verneuilliana* Koninck. It has a small narrow selenizone, limited by two slightly grooved carinae, placed almost centrally on the whorls. Its length is about 10 mm, diameter 7 mm, and the pleural angle is 41°. No further specimens of this species have come to my notice. It could possibly be a fourth species of *Pleurocinctosa*.

Localities and stratigraphical positions.—Gerringong; Black Head, near Gerringong; Minnamurra, near Gerringong; Crooked River, near Gerringong. Westley Park Tuff, Gerringong (Upper Marine) Volcanics. Rylstone. Base of Capertee (Upper Marine) Group. Muree. Branxton Sub-group, Maitland (Upper Marine) Group.

***Pleurocinctosa allandalensis* sp. nov.**

(Pl. 11, figures 7—9; Pl. 12, figures 2—3)

Pleurotomaria morrisiana Dana, 1849 : 706, pl. ix, figure 16 (non figure 15, 15a).

Murchisonia triflata Koninck, 1877 : 327.

Holotype: Specimen figured by Dana 1849, pl. ix, figure 16. Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group. Collection of the United States National Museum, Washington.

Description.—Small moderately high-spired gastropods of six to eight whorls; minutely phaneromphalous or anomphalous; outer lip with a possible narrow sinus culminating in a short slit that gives rise to a peripheral selenizone (actual sinus and slit not clearly observed); selenizone moderately deep, concave, lying between two acute carinae, the lower and stronger projecting slightly beyond the upper and forming the periphery of the whorl; whorl profile gently arched from the upper suture to the selenizone; below the selenizone a narrow groove is developed bordered by a spiral ridge, varying in strength and occasionally appearing as a third carina; base rounded; sutures fine somewhat linear; aperture circular, parietal lip thin with a thin inductura; columella lip swollen, flatly rounded, slightly reflected; ornamentation numerous fine, sharp and even transverse lirae, with a gentle forward, curve, but obliquely directed backward to the selenizone; lunulae fine, vertical; lirae forwardly curving to the umbilicus below; shell thin.

Dimensions.—

							F.27545	F.27545
Height	...	...	...	...	...	...	16 mm	16 mm
Width	...	...	...	...	...	...	9 mm	10 mm
Pleural angle	...	...	...	...	...	...	32°	40°

Remarks.—The status of this species with the preceding *Pleurocinctosa triflata* (Dana) has already been discussed. As pointed out Dana (1847 : 150) obviously had two distinct forms in the material used for his description of *Pleurotomaria triflata*, a small conical shell of four whorls from Illawarra, and a larger elongate form with six to eight whorls from Harper's Hill.

Dana's description is almost certainly based on the conical form from Illawarra and furthermore, later in 1849 (pl. ix, figures 15, 15a) he figured a specimen and an enlarged whorl of the same form. Unfortunately he also figured on plate ix, figure 16, a specimen of the second species from Harper's Hill. The measurements of the species are apparently based on a specimen from the same locality and now recognised as *P. allandalensis*.

Dana (1849 : 706) recognised that his species was conspecific with the species described by M'Coy as *Pleurotomaria morrisiana*, but incorrectly adopted this specific name in preference to his own of earlier date. Dana's name *P. triflata* must stand for the small conical shells from the South Coast and M'Coy's species, *P. morrisiana*, becomes a synonym of it. This leaves the elongated shells of six to eight whorls from Harper's Hill without a name and the species *Pleurocinctosa allandalensis* sp. nov. has been introduced for them.

The species was described in detail by Koninck (1877 : 327) when he named elongate shells from Harper's Hill as *Murchisonia triflata* (Dana). He stated that a block of greenish, calcareous sandstone was full of specimens of this species. He pointed out that Dana confused his species with *Pleurotomaria morrisiana* M'Coy. Koninck apparently agreed that Dana's specimen figured on Plate ix, Figures 15 and 15a, even though tricarinate, are conspecific with *P. morrisiana* M'Coy, as in his synonymy of *Murchisonia triflata* he included only Dana's specimen figured on Plate ix, Figure 16. These assumptions are correct except that in my opinion Koninck was in error in retaining Dana's name *Pleurotomaria triflata* for the shells from Harper's Hill. The enlarged whorl of the specimen illustrated by Dana (1849 : pl. ix, figure 15a) according to its profile is definitely a specimen from Illawarra and is conspecific with *P. morrisiana* M'Coy. The tricarinate character of these shells was discussed earlier in this paper.

The species, *Pleurocinctosa allandalensis* sp. nov., first appears in the Lochinvar Formation at Lochinvar, where in shales about 1,280 ft. from the base of the Dalwood Group it is not uncommon. The shells are mainly steinkerns. It is fairly widely distributed in rocks of the Dalwood Group of the Hunter River Valley and its equivalents in New South Wales. There is some variation in size and also in ornamentation. Shells from the Macleay Group in the Manning-Macleay Province possess slightly heavier lirae than found on typical examples from the type locality at Harper's Hill.

Localities and stratigraphical positions.—Lochinvar; Lochinvar Formation. Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group. Yessabah; Tait's Creek Formation. Kimbriki; Warbro Formation, Macleay Group.

***Pleurocinctosa elegans* sp. nov.**

(Pl. 12, figure 1)

Holotype: Specimen No. F.46587, from Richmond Vale, Hunter River Valley. Elderslie Formation, Branxton Sub-group, Maitland (Upper Marine) Group.

Description.—Small, moderately high-spined, minutely phaneromphalous or anomphalous gastropods of five or six distinct, sub-angulated whorls; sinus or slit not observed; moderately deep, narrow selenizone between two well marked and acute carinae; the lower carina projecting beyond the other and forming the periphery of the whorl; a third carina bordering a definite spiral groove immediately underlying the periphery; whorl profile sub-angular at the periphery, straight, steeply sloping above, gently arched below; base broadly arched; sutures fine; junction of whorls with preceding ones moderately recessed well below selenizone; aperture oval; peristome not observed; ornamentation consists of numerous, closely crowded, fine lirae.

Dimensions.—

Height	...	...	...	...	...	...	6 mm
Width	...	...	...	...	...	...	4 mm
Pleural angle	...	...	...	...	...	...	30°

Remarks.—This species is represented in the collection by a number of shells embedded in a small piece of fine sandstone from Richmond Vale in the Hunter River Valley and is apparently abundant at that locality. It is not possible with the available material to determine the characters of the inner or outer lips and the sinus and slit are unknown.

The species is readily recognised from other species of the genus by its very small size, well differentiated whorls and slender spire. The whorls are tricarinate although occasionally the third carina below the periphery is absent.

Locality and stratigraphical position.—Richmond Vale; Elderslie Formation, Branxton Sub-group, Maitland (Upper Marine) Group.

? *Pleurocinctosa nuda* (Dana)

Pleurotomaria nuda Dana, 1847 : 151.

Pleurotomaria nuda Dana, 1849 : 706, pl. ix, figure 17.

Remarks.—From the description of this species by Dana (1847 : 151 and 1849 : 706), it could well belong to the above genus. The shells are "short, conical, angle of spire about 115°; whorls four or five rounded, separated by a suture, smooth, slightly carinated, with another obsolete carina either side". The dimensions are length half-an-inch; breadth about three-quarters of an inch. The specimens figured by Dana (1849 : pl. ix, figures 17a, b, c.), show few distinct characters with the exception that the aperture is apparently very obliquely and transversely produced. This feature is not revealed markedly in a plastotype I have examined of possibly the specimen represented by his

Figure 17c, a basal view. To my knowledge no additional specimens of this species have been collected from the type locality at Harper's Hill or elsewhere. The species is characterised by shells with a large body whorl, seemingly tricarinate, and a low short spire of three to four whorls. It has been placed tentatively in the genus *Pleurocinctosa*.

Waagen (1891 : 120) recorded a single shell as this species from the upper limit of the boulder beds at Dillur in the Salt Range of India. It has a certain resemblance to the Australian shells, but certain differences in the description and figures indicate they are not conspecific. The body whorl in Dana's specimens is much larger in proportion to the spire than shown in Waagen's figures (1891 : pl. iv, figures 4a, b, c,) and the shape of the aperture is very dissimilar.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Genus *Walnichollsia* nov.

(A proper name)

Type Species : *Pleurotomaria subcancellata* Morris 1845.

Description.—Large sub-turbinate, thin-shelled, widely phaneromphalous gastropods of five whorls; body whorl extended somewhat transversely; whorl profile rounded at the periphery, gently arched above and below; no apparent sinus on the outer lip (not actually observed); an ill-defined, shallow selenizone is developed lying between two faint carinae barely distinguishable from the spiral costae, and developed on the periphery; aperture elongate-oval, obliquely transverse; ornamentation strong spiral costae crossed by finer transverse lirae, forming a definite lattice structure.

Remarks.—As already mentioned in this paper the genus *Pleurotomaria* Sowerby 1816 cannot be used for Palaeozoic species. It is a Jurassic genus and quite unlike any Palaeozoic gastropods, a fact made clear by Knight (1941 : 21).

Morris (1845 : 288) noted a close resemblance of his species to *Pleurotomaria delphinuloides* Goldfuss. = *Helicites delphinuloides* Schlotheim 1820, from the middle Devonian of Germany. This species is the genotype of *Euryzone* Koken 1896, a genus to which *Walnichollsia* gen. nov. bears a strong resemblance. It differs, however, in the more erect nature of the shell, more inflated whorls, a wider umbilicus and strong characteristic spiral costae.

The genus *Walnichollsia* is represented by two species, *N. subcancellata* (Morris) and *N. pygmaea* sp. nov., both occurring in rocks of the Maitland (Upper Marine) Group and its equivalents.

The genus was named after Mr. W. Nicholls of Rylstone, who devoted many years to the collecting of fossil material in that district.

Walnichollsia subcancellata (Morris)

(Pl. 13, figures 1—6)

Pleurotomaria cancellata Strzelecki, 1845 : 91. (nom. nud.).

Pleurotomaria subcancellata Morris, 1845 : 288, pl. xviii, figure 6.

Pleurotomaria subcancellata M'COY, 1847 : 305.

Pleurotomaria cancellata Grange, 1854 : 89.

Pleurotomaria subcancellata Koninck, 1877 : 322.

Holotype (by monotypy): Specimen figured by Morris 1845: pl. xviii, figure 6, from Illawarra; Gerringong (Upper Marine) Volcanics, in the collection of the British Museum.

Description.—Large sub-turbinate, thin-shelled, widely phaneromphalous gastropods of five whorls, moderately high-spired; a possible sinus (not observed) in the outer lip culminating in an indistinct selenizone forming the periphery of the whorl; selenizone shallow, narrow, bordered by two faint carinae or more strongly developed costae; whorls inflated, the body whorl produced somewhat transversely; whorl profile narrowly rounded at the periphery, gently arched above and below; sutures moderately wide and deep; aperture elongate-oval, transversely oblique; ornamentation coarse spiral costae, lightly crossed by fine transverse lirae, slightly nodular at intersections, but more in the form of fine vertical ridges in the comparatively wide inter-costal spaces.

Dimensions.—

						F.45348	F.43066
Height	...	...	...	...	...	45 mm	52 mm
Width	...	...	...	...	...	63 mm	72 mm
Pleural angle	...	...	...	...	...	98°	110°

Remarks.—This species is a very thin-shelled form and to some extent shells have been considerably flattened by pressure. The ornamentation on many specimens is not well preserved because of weathering, but the strong spiral costae are usually present. The selenizone is not a well marked character.

The species is represented by a large series of specimens agreeing perfectly with the holotype figured by Morris (1845: pl. xviii, figure 6) which has a diameter across the base of $2\frac{1}{2}$ inches. His specimen is incomplete, the upper whorls of the spire being missing, but the essential characters of the genus and species are well shown. The same specimen was re-figured later by Koninck (1877: 322, pl. xxiii, figure 15) who recorded the species from Muree in the Hunter Valley. McCoy (1847: 305) listed the species as occurring at Loder's Creek, Hunter River Valley. Waagen (1932: 65) thought that perhaps this species was allied to *Pleurotomaria brenensis* Waagen, from the Agglomeratic Slate of Kashmir, but finally concluded they were dissimilar.

Localities and stratigraphical position.—Loder's Creek, Branxton, Muree, (Hunter River Valley); Branxton Sub-group, Maitland (Upper Marine) Group. Wollongong, Jamberoo, Broughton, near Berry, (Illawarra District); Gerringong (Upper Marine) Volcanics. Ulladulla; Shoalhaven Group, Rylstone (Western Coalfield); Capertee (Upper Marine) Group. Bundanoon, (Southern highlands); "Upper Marine Series".

***Walnichollsia pygmaea* sp. nov.**

(Pl. 12, figures 4—8)

Holotype: Specimen No. F.46585, Black Head, near Gerringong, New South Wales; Westley Park Tuff Formation, Gerringong Volcanics (Upper Marine).

Paratypes: Specimen F.21594, from the same locality and horizon. Specimens F.21576, F.21634 Wyro, near Ulladulla; Ulladulla Mudstone, Shoalhaven (Upper Marine) Group.

Description.—Moderately small gastropods, much wider than high with five whorls; a low spire only slightly elevated above the body whorl; widely phaneromphalous; outer lip without a distinct sinus; an indistinct selenizone developed on the whorl periphery; whorl profile transversely oval, gently convex upper and lower surfaces, narrowly rounded on outer-face; peristome moderately thickened; outer lip gently arched from the suture to periphery, straight and directed obliquely backward below; aperture transversely elongate-oval. Ornamentation fairly numerous close-set spiral costae with numerous fine transverse lirae developed more as ridges in the inter-costal spaces and forming a minute lattice structure. Shell thin.

Dimensions.—

							Holotype F.46585	Paratype F.21634
Height	...	...	...	...	...	...	16 mm	19 mm
Width	...	...	...	...	...	...	36.5 mm	36 mm
Pleural angle	...	...	...	...	...	...	150°	152°

Remarks.—This species is represented by a series of fourteen specimens including several well preserved examples. It is a thin-shelled form and the body whorl in some cases has been flattened by pressure forming an apparent carinate periphery. A paratype (F.21594) is one of the few Permian gastropods from New South Wales in which an almost complete peristome is preserved. In steinkerns it is bordered by a distinct shallow groove. The presence of a selenizone although indicated on several specimens is a doubtful character and if present is very faint. There is seemingly no trace of a sinus on the outer lip.

This species together with *Walnichollsia subcancellata* (Morris), is easily recognised by the very characteristic ornamentation, the wide rather flattened whorls and transversely produced aperture. It differs from *W. subcancellata* in its much smaller size and low, almost flattened spire. It was considered that the specimens of this species may be immature shells of *W. subcancellata*, but it is most unlikely that growth would elevate the spire to the extent developed in that species.

Localities and stratigraphical position.—Wyro, near Ulladulla; Ulladulla; Ulladulla Mudstone, Shoalhaven (Upper Marine) Group. Gerringong; Westley Park Tuff, Gerringong (Upper Marine) Volcanics. Rylstone; Capertee (Upper Marine) Group. Muswellbrook; Branxton Sub-group, Maitland (Upper Marine) Group.

Genus *Platyschisma* M'Coy 1844

Type Species: By subsequent designation of De Koninck, 1881: 107, *Ampullaria helicoides* J. de C. Sowerby, 1826.

Remarks.—The genus *Platyschisma* M'Coy is represented by moderately large globular shells, narrowly phaneromphalous, with a low spire, a large body whorl and a notchlike sinus in the upper half of the lip. In the past the Permian gastropods from New South Wales recognised as belonging to this genus consisted of *Platyschisma oculus* (Sowerby), *P. depressum* Dana = *P. allandaleensis* Mitchell, *P. rotundatum* Morris, and *P. rotundatum* var. *farleyensis* Etheridge.

It was suggested by Etheridge (1902: 199) that *P. depressum* Dana has closer affinities with his genus *Keeneia* than with *Platyschisma*. It is quite distinct from the typical species of *Keeneia* and has been placed in the genus *Planikeeneia*, erected for depressed shells of this type.

As already mentioned in this paper *Platyschisma oculus* (Sowerby) is now referred to the genus *Keeneia*, while *P. rotundatum* var. *farleyensis* Etheridge is tentatively placed with *Planikeeneia occasa* sp. nov.

It is considered that *Platyschisma rotundatum* Morris is a doubtful representative of the genus *Platyschisma* M'Coy 1844, as defined by the genotype. Unfortunately, although the species is fairly abundant, very few specimens are well preserved and many characters, particularly those of the aperture, are not exhibited. Morris (1845: 286) mentioned that an ill-defined sinus is developed in the outer lip. In general form and particularly in the rounded profile of the whorls the shells are not unlike those of *Platyschisma* and until further complete specimens may prove otherwise, the species is retained in that genus.

A second and much smaller species from the Elderslie Formation of the Braxton Sub-group, Maitland (Upper Marine) Group of the Hunter River Valley, is also referred to the genus as *Platyschisma braxtonensis* sp. nov.

Platyschisma rotundatum Morris

(Pl. 16, figures 6—9)

Platyschisma rotundatum Morris, 1845: 286, pl. xviii, figure 2.

Platyschisma rotundatum M'Coy, 1847: 306.

Platyschisma rotundatum Dana, 1849: 707.

Platyschisma rotundatum Plews, 1858: pl. 4. (non) *Platyschisma rotunda* Etheridge, 1892: 286, pl. xv, figure 6.

Platyschisma rotundatum Etheridge, 1919: 188.

Holotype (by monotypy): Specimen figured by Morris 1845, pl. xviii, figure 2, from ? Harper's Hill, Allandale Formation, Dalwood (Lower Marine) Group. Collection of British Museum.

Description.—Large turbiniform, widely phaneromphalous gastropods of five whorls, a moderately low spire; whorls inflated and a large body whorl with a shallow ill-defined sinus in the outer lip; whorl profile gently arched between sutures, rounded on the body whorl with a slight depression below the upper suture; sutures fine, shallow; base broadly rounded; outer lip with a very shallow sinus at the periphery of the whorl, not culminating in a slit or notch; the margin of the lip gently convex forward with a backward obliquity to the sinus, continuing straight below the sinus to the umbilicus; ornamentation fine transverse growth lines with very characteristic thickenings of the shell; in steinkerns these are represented by very distinct transverse sulcations; no indication of revolving striae.

Dimensions.—

						F.45323	F.2192	F.29925
Height	...	...	...	...	...	48.5 mm	49 mm§	39 mm
Width	...	...	...	...	...	60 mm	63 mm	55 mm
Pleural angle	...	...	...	...	...	90°	101°	103°

§ Estimated

Remarks.—Morris (1845: 286) introduced this species for shells rather similar to *Platyschisma oculus* (Sowerby), but differing in having distinctly rounded whorls, an ill-defined sinus in the outer lip and "the inner part of the outer lip appears to have been periodically thickened, leaving deep sulcations in the cast of the shell". He recorded it as abundant at Harper's Hill in the Allandale Formation of the Dalwood (Lower Marine) Group. In the light of our present knowledge this occurrence is surprising as the form now recognised as *Platyschisma rotundatum* Morris, is apparently restricted to rocks of the Gerringong (Upper Marine) Volcanics, the Shoalhaven (Upper Marine) Group, and their equivalents.

M'Coy (1847 : 306) listed the species as abundant at Harper's Hill, occurring in a dark arenaceous limestone. The species was also listed by Dana (1849 : 707), with a comment that it is "not uncommon in the sandstone at middle and southern Illawarra", referring no doubt to Wollongong and Gerringong.

The species is represented in the collection by a large series of specimens, mainly steinkerns, from various localities on the South Coast, at Rylstone, and at Branxton and Muswellbrook in the Hunter River Valley.

This species has not been recognised by me from Harper's Hill and in my opinion the holotype figured by Morris (1845 : pl. xviii, figure 2) is a typical shell from Wollongong. An examination of this specimen in the British Museum collection may indicate its true locality.

The species is a characteristic one and Etheridge (1919 : 188) briefly stated its characters as : "The body whorl is distinctly rounded, or convex, above and below, there is no peripheral angle, or keel, and the inner part of the outer lip appears to have been periodically thickened leaving sulcations in the cast". It has a superficial resemblance to *Walnichollisia subcancellata* (Morris) as both species have rounded somewhat inflated whorls and a moderately erect spire. It is readily distinguished from that species by the characteristic transverse sulcations, more rounded whorls and absence of strong spiral costae, crossed by finer transverse lirae, forming a lattice structure.

Localities and stratigraphical position.—? Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group. Grasree, near Muswellbrook; Belford Formation, Branxton Sub-group. Branxton; Elderslie Formation, Branxton (Upper Marine) Sub-group. Wollongong, Gerringong, Kiama; Gerringong (Upper Marine) Volcanics. Wyro, near Ulladulla, Jervis Bay; Shoalhaven (Upper Marine) Group. Rylstone; Capertee (Upper Marine) Group.

***Platyschisma branxtonensis* sp. nov.**

(Pl. 16, figures 1—3)

Holotype : Specimen No. F.28297, from Aberdare, 1 mile west of Cessnock; Elderslie Formation, Branxton (Upper Marine) Sub-group.

Paratypes : Specimens No. F.28294, from Aberdare and F.28305 from Branxton, near Maitland; same locality horizon as holotype.

Description.—Medium sized turbiniform gastropods, moderately low-spined of five inflated whorls, apex somewhat pointed; narrowly phaneromphalous; a possible wide shallow sinus in the outer lip (not observed), without slit or selenizone; whorl profile rounded with a slight shoulder developed below the upper suture; whorls closely impressed against preceding ones; sutures narrow, shallow; base convex; parietal lip seemingly wide, flattened and parietal inductura moderately thick; other apertural characters not preserved; ornamentation exceedingly fine numerous, transverse lirae, gently arched, almost straight, directed obliquely backward to the lower suture; lirae on body whorl periphery forming a wide shallow sinus, possibly indicative of the sinus on the outer lip; below the periphery the lirae extend straight into the umbilicus where they are closely packed; moderately sharp growth lines occasionally interpolated; aperture transversely oval.

Dimensions.—

							Holotype F.28297	Paratype F.28294
Height	...	...	...	...	...	...	29.5 mm	30 mm
Width	...	...	...	...	...	...	39.5 mm	37 mm
Pleural angle	...	...	...	...	...	...	96°	96°

Remarks.—This species bears a very close resemblance to *Platyschisma rotundatum* Morris although very much smaller and not possessing the very distinct transverse sulcations of that species. The closely crowded fine lirae, backwardly directed at the periphery of the body whorl, is a characteristic feature. There are also faint indications of very occasional spiral costae, particularly on the holotype.

Localities and stratigraphical position.—Aberdare, 1 mile west of Cessnock; Branxton; Elderslie Formation, Branxton (Upper Marine) Sub-group.

Super-Family **Euomphalacea**

Family **Straparollidae**

Genus **Paromphalus** Grabau, 1936

***Paromphalus ammonitiformis* (Etheridge)**

(Pl. 21, figures 1—5)

Straparollus ammonitiformis Etheridge, 1902 : 200, pl. xxxiii, figures 1—2.

Holotype (by monotypy) : Specimen No. F.7669, figured by Etheridge; Duguid's Hill, near Harper's Hill, Hunter River Valley, New South Wales. Allandale Formation, Dalwood (Lower Marine) Group. Australian Museum Collection.

Description.—Shell discoidal of five whorls; apex flat, depressed below level of body whorl, widely phaneromphalus. Sutures moderately deep. Whorl profile straight at the suture, broadly curved to periphery where there is a faint trace of a sinus; lower half similarly curved. No trace of a slit-band or selenizone; a faint pseudo-keel developed at the angle of the lirae on the periphery. Aperture elongate-oval, transverse. Ornamentation numerous fine transverse lirae (10–12 in 5 mm), and growth lines extending obliquely backwards to the periphery where they reverse direction at an acute angle to form a forwardly directed broad curve to the wide umbilicus. Shell moderately thick.

Dimensions.—

						Holotype	Plesiotypes	
						F.7669	F.28302	F.30018
Height	...	...	...	...	...	20 mm	12 mm	33 mm
Width	...	...	...	...	...	70 mm	34 mm	102 mm

Remarks.—Etheridge (1902 : 200) in describing *Straparolus ammonitiformis* referred it to the depressed section of the genus as characterised by *S. aequalis* Sowerby. The genotype of the genus is *S. dionysii* Montfort 1810 a trochiform gastropod with a wide, deep umbilicus and an obscure, broadly rounded revolving ridge on the upper whorl surface. Knight (1934 : 144) summarized the characters of Palaeozoic Euomphalidae and concluded that the species fell into two sub-groups *Straparolus* (ss) and *Euomphalus*. The sub-group *Straparolus* (ss) included those shells, grouped around *S. dionysii* Montfort, with a relatively high spire and rounded or only slightly shouldered whorls.

It is difficult to reconcile the characters of *Straparolus ammonitiformis* Etheridge, with those of *Straparolus* as defined by Knight. The Australian shell is discoidal with a very depressed flat spire, a wide shallow umbilicus and rounded whorls with no trace of shouldering.

Grabau (1936 : 302) introduced a new genus *Paromphalus* for planispiral gastropods in which the whorls are in contact, but not impressed; circular or oval in section, smooth and non-carinate. The apertural margin is uniform and rarely faintly sinuous. The single species of the genus is *P. mapingensis*, a small form with a maximum width of 21.8 mm, from the Lower Permian of China.

The characters of the Australian species, *Straparolus ammonitiformis* Etheridge, agree so perfectly with those of *Paromphalus* that it is considered its relationship is more with that genus than with *Straparolus*.

Since Etheridge (1902 : 200) described his species from a single specimen, two additional shells have come to hand from the same formation and very close to the type locality. These show a great variation in size, one specimen (F.28302) has a diameter of 34 mm, while the other (F.30018) has a diameter of 102 mm.

Etheridge in his original description stated that "one more whorl certainly existed than those shown in the illustration . . .". This is not the case as what Etheridge thought was the line of junction of another whorl is simply a discoloration of the steinkern and was most likely caused by the differential weathering of the shell material.

Locality and stratigraphical position.—Duguid's Hill, near Harper's Hill; Harper's Hill. Allandale Formation, Dalwood (Lower Marine) Group.

Super-Family Bellerephontacea

Family Bellerephontidae

Genus **Warthia** Waagen, 1880

Types Species : *Warthia brevisinuata* Waagen 1880, Nila Wan ravine, Salt Range, India. Lower Productus Limestone, Permian.

Remarks.—There can be little doubt regarding the congeneric affinities of the three Australian species of this form with the genus *Warthia* as defined by Waagen. That author considered the Australian shells undoubtedly belonged to his genus although they were specifically different from the Salt Range species.

The genus consists of "smooth globular shells without slit-band and a broad tolerably deep sinuosity on the outer lip as in *Platyschisma*; inner lip only very slightly callous. No spiral sculpture".

Warthia micromphala (Morris)

(Pl. 16, figures 4–5)

Bellerephon micromphalus Morris, 1845 : 288, pl. xviii, figure 7.

Bellerephon undulatus Dana, 1847 : 150.

Bellerephon undulatus Dana, 1849 : 706, pl. x, figures 4a, b.

Goniatites micromphalus Koninck, 1877 : (non Romer 1850), pl. xxiv, figures 5, a.

Warthia micromphala Reed, 1932 : 69, pl. xii, figures 12–14.

Holotype (by monotypy): Specimen figured by Morris 1845, pl. xviii, figure 7, from Illawarra, Gerringong (Upper Marine) Volcanics. Collection of the British Museum.

Description.—Deeply involute, anomphalous spiral gastropods of medium size; moderately wide and deep sinus in the anterior lip not developing into a slit or band; whorl profile narrowly rounded dorsally, gently arched laterally; peristome thickened, slightly expanded; lateral margins of aperture moderately convex forward as rounded lobes on each side of sinus; columella lips gently convex backward, partly covering a minute umbilicus; aperture semi-lunate, somewhat elongate, not widely expanded; ornamentation indistinct fine growth lines, occasionally interrupted by moderately wide transverse ridges following the line of growth. Shell thin.

Dimensions.—

		F.7937	F.8174
Greatest diameter		20.5 mm	23 mm
Width at umbilicus		8 mm	9 mm
Width at aperture...		11.5 mm	14 mm
Height of aperture from whorl		8 mm	8 mm

Remarks.—This species was originally described and figured by Morris (1845: 288) from the Illawarra district as *Bellerephon micromphalus*. He mentioned the presence of "slightly elevated ridges on the surface curving backwards from the minute umbilicus". As foreshadowed in an earlier paper (Teichert and Fletcher 1943: 156) the specimen figured by Morris (1845: pl. xviii, figure 7) is quite unlike what was later to be considered a typical shell of that species.

In the Permian rocks of New South Wales there are found three distinct species of involute shells which belong to the genus *Warthia* Waagen 1880, namely, *W. undulata* (Dana), *W. stricta* (Dana) and *W. micromphala* (Morris). The specimen of the last mentioned species described and figured by Dana (1849: pl. x, figures 6a, b) is not conspecific with that figured by Morris (1845: pl. xviii, figure 7), and yet it is the form generally accepted as *Warthia micromphalus* (Morris).

It is considered that *Bellerephon micromphalus* of Morris 1845, is conspecific with the species described and figured by Dana (1849: 706, pl. x, figures 4a, b) as *Bellerephon undulatus*. The transverse ridges, a varying character in the species, are less defined on the body of the shell figured by Morris (1845: pl. xviii, figure 7) although one is represented at the peristome giving it the characteristically thickened appearance of the species. The general appearance, and particularly the shape of the aperture, are identical.

The holotype of *Warthia undulatus* (Dana) is recorded from Harper's Hill in rocks of the Dalwood (Lower Marine) Group. This specimen, figured by Dana, is a typical example of a shell from Wollongong and it is suggested that an error in labelling has occurred. His other two species of the genus are from Illawarra and furthermore I have never seen this species at Harper's Hill or in collections from that locality.

A great deal of uncertainty has long existed regarding the status of "*Bellerephon micromphalus* Morris" and at different times the species has been referred by different authors to such genera as *Goniatites*, *Warthia*, *Agathiceras*, *Prolecanites*, *Paralegoceras* and others. The history of "*Bellerephon micromphalus*" has been mentioned earlier in this paper and is also dealt with more completely in an earlier paper (Teichert and Fletcher 1943: 156). There is no necessity for it to be repeated here.

In *Warthia micromphala* (Morris) (non *Bellerephon micromphalus* Dana), there is a considerable amount of variation in the strength and number of the transverse ridges on the dorsal and lateral surfaces of the shells. A ridge usually is developed at the peristome giving it a rather thickened and campanulate appearance.

Koninck (1877: 339) in describing this species as *Goniatites micromphalus* (Morris), remarked that *Warthia undulatum* (Dana) is only a *W. micromphalus* (Morris) with more pronounced "furrows". This is correct as he was comparing Dana's species with that of Morris's, forms which are conspecific, and not with *W. micromphala* (Dana) an entirely different species.

The species recorded by Reed (1932: 69) as *Warthia micromphala* (Morris), from the Agglomeratic Slate of Kashmir, could very well belong to this species. The specimen figured by him (1932: pl. xii, figure 14) shows the transverse ridges, while the smoother examples (figures 12—13) show only one apparent difference in the greater depth of the sinus. Foord (1890: 104) recorded *Warthia micromphala* (Morris) from the Permian of Western Australia and Reed (1930: 43) recorded it doubtfully from Brazil. In both these cases it would be necessary to examine actual material before the true status of the forms could be decided.

Etheridge (1880: 304) and (1892: 294—5) recorded this species from Permian rocks at the head of Pelican Creek, in the Bowen River district of Queensland, as *Goniatites micromphalus* (Morris). He pointed out that his specimens differed from "*Bellerephon micromphalus* Morris, in that the depth of the body whorl near the mouth is not so great, but they agreed with Dana's figure of "*Bellerephon*

micromphalus". As already pointed out these two forms are distinct species and it would appear that the Queensland shells are examples of *Warthia perspecta* sp. nov., a species introduced in this paper for shells as defined and named by Dana (1849 : 708, pl. x, figures 6a, b) as *Bellerephon micromphalus* (non *B. micromphalus* Morris 1845).

Shells of *Warthia micromphala* (Morris) are fairly abundant in rocks of the Gerringong (Upper Marine) Volcanics at Wollongong on the South Coast. It is also abundant in the Hunter River Valley at Ravensfield, where it occurs in the Ravensfield Sandstone at the base of the Farley Formation of the Dalwood (Lower Marine) Group. Occasional poorly preserved specimens have been collected from rocks of the Branxton Sub-group in the Hunter River Valley and its equivalent (in part), the Shoalhaven (Upper Marine) Group of the South Coast.

Localities and stratigraphical positions.—Wollongong; Gerringong; Gerringong Volcanics. Ravensfield; Ravensfield Sandstone, base of Farley Formation, Dalwood (Lower Marine) Group; Harper's Hill (doubtful locality); Dalwood Group. Muree; Branxton Sub-group, Dalwood Group.

Warthia perspecta sp. nov.

(Pl. 15, figures 3—10)

Bellerephon micromphalus Dana (non *B. micromphalus* Morris 1845), 1849 : 708, pl. x, figures 6a, 6b.

Goniatites micromphalus Etheridge, 1880 : 304.

Goniatites micromphalus Etheridge, 1892 : 294—5.

Goniatites (Prolecanites ?) micromphalus Etheridge (in part), 1894 : 36, pl. vii, figures 10—11 (non figures 9, 12, 13, 14).

Holotype : Specimen figured by Dana (1849, pl. x, figures 6, 6a) as *Bellerephon micromphalus*, from the Illawarra District. Gerringong (Upper Marine) Volcanics. Collection of the United States National Museum, Washington.

Description.—Moderately large, deeply involute, inflated, anomphalous, spiral gastropods with a wide moderately shallow sinus in the anterior lip and not developing into a notch or band; whorl profile rounded; peristome thin, very slightly reflexed; lateral margins of aperture concave backwards at umbilicus, gently arched forward in the form of lobes on each side of the sinus; aperture lunate, expanded with moderately wide side extensions; ornamentation indistinct fine transverse, broad, V-shaped, growth lines; shell thin.

Dimensions.—

		F.39686	F.7931	L.695	F.35733¶
Greatest diameter	...	29 mm	34.5 mm	27 mm	26 mm
Thickness at umbilicus	...	12 mm	16 mm	11 mm	12 mm
Width at aperture...	...	18.5 mm	20.5 mm	17 mm	16.5 mm

|| Plastotype of specimen figured by Dana (1849; pl. x, figs. 6a, 6b).

¶ Specimen figured by Etheridge (1894; pl. vii, fig. 10.)

Remarks.—This is a very distinct and easily recognised species and is represented in the collection by a large series of specimens. It is distinguished from *Warthia micromphala* (Morris) by its distinctly rounded and more inflated appearance. The aperture is lunate and wide and the sinus in the anterior lip is wide and shallow.

Dana (1849 : pl. x, figures 6a, b) figured a specimen which he considered to be conspecific with *Bellerephon micromphalus* Morris 1845. His only remarks were (p. 708) : "This species, like the preceding (*B. strictus* Dana) has the aspect of a goniatite. It differs from *B. strictus* in being proportionately much thicker". The specimen came from Illawarra.

As mentioned earlier in my discussion on *Warthia micromphala* (Morris), the specimen figured by Dana is distinct from the shell figured by Morris (1845 : pl. xviii, figure 7). Morris's specimen is not nearly as inflated, the aperture is elongate and narrow and a side view shows a distinct transverse groove and a ridge forming a thickened anterior lip. Morris also remarked on the presence of "a deep sinus in front". These characters are all consistent with those of Dana's *Bellerephon undulatus*, now *Warthia micromphala* (Morris), and the two forms are without doubt conspecific.

The specimen figured by Dana (1849 : 708, pl. x, figures 6, 6a) as *Bellerephon micromphalus* Morris is without a name and is described as *Warthia perspecta* sp. nov.

This species is abundant at Wollongong, on the South Coast, and also at Ravensfield in the Hunter River Valley, where it is associated at both localities with *Warthia micromphala* (Morris). The shells attain considerable size and become very inflated.

Localities and stratigraphical positions.—Wollongong; Gerringong; Jamberoo; Gerringong (Upper Marine) Volcanics. Bundanoon. Rylstone; base of Capertee (Upper Marine) Group. Ravensfield; Ravensfield Formation, Dalwood (Lower Marine) Group. Farley; Elderslie Formation, Branxton (Upper Marine) Sub-group. Muree; Belford Formation, Branxton Sub-group.

Warthia stricta (Dana)

(Pl. 15, figures 11—14)

Bellerephon strictus Dana, 1847 : 150.

?*Bellerephon contractus* Jukes, 1847 : 242. (nom. nud.)

Bellerephon strictus Dana, 1849 : 707, pl. x, figures 5a, b.

?*Goniatites strictus* Koninck, 1877 : 341.

Holotype (by monotypy) : Specimen figured by Dana (1849 : pl. x, figures 5a, 5b) as *Bellerephon strictus*, from Wollongong. Gerringong (Upper Marine) Volcanics. Collection of the United States National Museum, Washington.

Remarks.—Moderately small, deeply involute, compressed, anomphalous, spiral gastropods; moderately deep and narrow V-shaped sinus in the anterior lip, not culminating in a band; whorl profile narrowly rounded, almost dorsally ridged, gently arched to flattened laterally; aperture elongate, its lateral margins closely pressed against preceding whorl near umbilicus; sloping obliquely forward and inward to sinus into which it abruptly curves; an occasional ill-defined transverse groove following the lines of growth; shell thin; ornamentation unknown.

Dimensions.—

					F.1081	L.701**
Greatest diameter	...	...	...	...	21.5 mm	21 mm
Thickness at umbilicus	...	...	...	...	9 mm	10 mm
Width at aperture...	...	...	...	...	11 mm	11 mm
Height of aperture from whorl	...	...	...	...	9 mm	7 mm

** Plastotype of specimen figured by Dana (1849; pl. x, figs. 5a, b.)

Remarks.—Dana (1847 : 150) described this species from Wollongong as “a discoid, much compressed form in which the aperture is narrow-compressed-lunate, not dilated”. In 1849 (p. 707) he figured a specimen of the species without any additional comments.

Koninck (1877 : 341) described a very compressed form as this species and referred it to the genus *Goniatites*. He records his specimen from a black limestone at Harper's Hill, whereas the only other known material is from much higher beds in the Permian sequence at Wollongong and Gerringong, Koninck's specimen represents a very compressed form with a diameter of 11 mm, and a thickness of 5 mm. It is doubtful whether his form is conspecific with *W. stricta* (Dana). His material was subsequently destroyed in the Garden Palace fire at Sydney, in 1882.

In listing a collection of fossils from Wollongong, (identified by J. Sowerby), Jukes (1847 : 242) included *Bellerephon contractus* MSS. The species was never described, but as its name implies a shell with contracted sides it has been placed in the synonymy of *W. stricta* (Dana).

This species is rare in comparison with *W. micromphala* (Morris) and *W. perspecta* sp. nov. It is readily distinguished from them by its laterally compressed sides, elongate and narrowed aperture, and moderately deep, narrow sinus.

Localities and stratigraphical position.—Wollongong; Gerringong. Gerringong (Upper Marine) Volcanics. ? Harper's Hill. Dalwood (Lower Marine) Group.

THE LIMITS OF PERMIAN ROCKS IN NEW SOUTH WALES

It is now generally accepted that the complete sequence of rocks in the Hunter River Valley passes upward from the basal Lochinvar glacial beds to the Newcastle Coal Measures which are overlain by the Triassic Narrabeen Series.

The use of the term Permo-Carboniferous was introduced into Australian geology by Etheridge in 1880 and it then came into general use for the above succession of rocks. Previous to this the “Upper Coal Measures” were referred to as being of Permian age, while the “Upper Marine Series”, the “Lower Coal Measures” and the “Lower Marine Series” were considered to be of Upper Carboniferous age.

It was suggested later that if the Kuttung Series, underlying the Permian sequence in the Hunter Valley, was of Middle Carboniferous age then we should look to the lowest beds of the “Lower Marine Series” for sediments of Upper Carboniferous age. It was considered by some authors that certain faunal elements in the lower part of the “Lower Marine Series” had Upper Carboniferous affinities and because of this the name Kamilaroi was introduced by David in 1931 to include all Permo-Carboniferous sediments above the base of the Allandale Formation. The Lochinvar Formation was thus considered to be of Upper Carboniferous age.

It was proved conclusively that there is no palaeontological evidence to support a separation of the "Lower Marine Series" into Upper Carboniferous and Lower Permian or Kamilaroi (Raggatt and Fletcher 1937). The fossil fauna of the Lochinvar Formation has strong affinities with the undoubted Permian and practically none with the Upper Carboniferous. The entire marine fauna of Dalwood (Lower Marine) Group, the Maitland (Upper Marine) Group and their equivalents are therefore of Permian age.

STRATIGRAPHY AND GASTROPOD FAUNA OF THE PERMIAN IN NEW SOUTH WALES

The Hunter River Valley Area

The complete sequence of Permian rocks in the Lower Hunter Valley has a total thickness of approximately 17,000 ft. Many exposures of marine sediments are found containing an abundant and representative fauna.

The sequence of the Permian rocks in the Lower Hunter River Valley, with revised nomenclature, is as follows :—

Group				Formation	Lithology
				ft.	
Newcastle Coal Measures	...	...	...	1,200	Conglomerate, sandstone shale and coal seams.
Tomago Coal Measures...	...	...	...	1,860	Shale, sandstone and coal seams.
Maitland (Upper Marine) Group	{	Mulbring Sub-Group	...	1,200	Shales and shaly mudstones. (†† at base).
		Branxton Sub-Group—			
		Muree	...	200	Sandstone and sandy mudstone, calcareous in part.††
		Belford	...	1,450	Essentially sandy shales.††
		Fenestella Shale	...	20—100	Yellowish shales with abundant <i>Fenestella</i> .††
		Elderslie	...	1,450	Sandstones and sandy shales with massive basal sandstone.††
Greta Coal Measures	...	...	...	200	Fine conglomerate, sandstone, shale and coal seams.
		Farley	...	985	Sandy shales and mudstones. Ravensfield Sandstone (200 ft) at base. (†† top).
Dalwood (Lower Marine)	{	Rutherford	...	1,170	Sandy shales, shales and mudstones.
		Allandale	...	1,000	Mainly calcareous mudstones. Allandale Conglomerate at base.
		Lochinvar	...	2,600	Shales, mudstones, sandstones, amygdaloidal basalt, reddish-brown shale at base. (†† base).

†† — Distribution of erratics.

HUNTER RIVER VALLEY

In the Hunter River Valley both the Maitland and Dalwood Groups attain their greatest development in the lower part of the valley and then thin rapidly to the north and to the west.

The fauna of the Dalwood (Lower Marine) Group and the Maitland (Upper Marine) Group of the Hunter River Valley and their equivalents in New South Wales, present strong affinities with beds of similar age in Tasmania and Queensland, but to a lesser extent in Western Australia.

A study of the Permian gastropods of New South Wales has indicated very clearly the presence of two outstanding zones, or life horizons, with a considerable development of species and with abundant representation.

The older of the two zones is represented at Harper's Hill, where in the Allandale Formation a rich gastropod fauna occurs in an andesitic tuff overlying the Allandale Conglomerate. The shells are beautifully preserved with excellent ornamentation.

The gastropods mainly restricted to the Allandale Formation at Harper's Hill and its equivalents are:

- Keeneia platyschismoides* Etheridge
- Keeneia trochiforme* sp. nov.
- Cyclocena anomphala* gen. et. sp. nov.
- Planikeeneia insculpta* gen. et. sp. nov.
- Planikeeneia depressum* (Dana)
- Planikeeneia minor* sp. nov.
- Paromphalus ammonitiformis* (Etheridge)
- Pleurocinctosa allandaleensis* gen. et. sp. nov.
- Rhabdocantha alta* (Dana)
- Rhabdocantha cornucapella* sp. nov.
- Rhabdocantha adunca* sp. nov.
- Rhabdocantha intermedia* sp. nov.
- Rhabdocantha irregularis* sp. nov.
- Rhabdocantha ungula* (Etheridge)

The shells of *Keeneia platyschismoides* and *Keeneia trochiforme* are fairly abundant and of large size. Johnston (1888: pl. xviii, figure 4) illustrated a gastropod from the Huon Road, near Hobart, Tasmania, as *Platyschisma ocula* (Sowerby), which from the figure appears to be conspecific with *K. trochiforme*. In a recent communication, Mr. M. Banks, of the University of Tasmania, informed me that the Huon Road beds are in his opinion equivalent, in part, with the Berridale Limestone of that State and possibly with some part of the Maitland (Upper Marine) Group, possibly the Braxton Sub-group, of the Hunter River Valley. This species is apparently restricted to the Allandale Formation in New South Wales and further information regarding its exact relationship with the Tasmanian shell will be of interest. Other restricted species found at Harper's Hill consist of *Cyclocena anomphala* gen. et. sp. nov., an outstanding thick-shelled form; *Paromphalus ammonitiformis* (Etheridge), and small shells of *Planikeeneia minor* gen. et. sp. nov., and *P. insculpta* sp. nov.

Dun (1913: 8) described a moderately small shell from the Tasmanite Spore Beds of the Mersey River, Tasmania, as *Keeneia twelvetreesi*. The holotype of this species is missing, but the description and illustration indicates a very close relationship to *Planikeeneia insculpta* sp. nov., from Harper's Hill. I am informed by Mr. Banks that the Tasmanite beds, originally thought to be equivalent, in part, to the Maitland (Upper Marine) Group, is now considered by him to be probably equivalent to some horizon low in the Dalwood (Lower Marine) Group of the Hunter River Valley. Miss I. Crespín, Commonwealth Palaeontologist, Mineral Resources Bureau, recently found that the foraminifera of the beds supported this correlation.

Gastropods of the genus *Rhabdocantha* are comparatively rare in the Allandale Formation at Harper's Hill and except for a specimen of *R. alta* (Dana), doubtfully recorded from Ulladulla, (Shoalhaven Group), have not been found elsewhere.

Other species described from Harper's Hill, but not restricted to that locality, include *Keeneia ocula* (Sowerby) and *Pleurocinctosa allandaleensis* gen. et. sp. nov. The former species is abundant at Harper's Hill, but ranges through the sequence in diminished numbers both in the Hunter Valley and the South Coast. It regains its numbers temporarily in the Gerringong Volcanics at Wollongong and Gerringong. It is also plentiful at Rylstone in the Capertee Group.

A poorly preserved gastropod from an interesting fossil occurrence on the slopes of Loder's Mountain, about seven miles east of Willow Tree, was identified by me and listed (Hanlon 1948a: 289) as *Platyschisma ocula* (Sowerby). A re-examination of the specimen showed it to be slightly larger than typical examples of *Keeneia ocula* (Sowerby), but agrees well with shells from Harper's Hill.

The Loder's Mountain fossil locality occurs in the top of the Lower Stage of the Willow Group, which Hanlon (1948a: 288) considers, with the Werrie Stage, is the equivalent of the Dalwood Group of the Hunter River Valley. *Eurydesma* is also found at Loder's Mountain, but as it is now known to occur in zones both in the Maitland and Dalwood Groups, its presence in the Lower Stage of the Willow Group is not in itself evidence of Dalwood age.

The Upper Stage of the Willow Group is correlated with the Greta Coal Measures while the overlying Borambil Group is considered the equivalent, in part, with the Tomago Coal Measures and the Mulbring Formation. Fossils from the Lower Stage of the Borambil Group, identified by me, were recorded by Hanlon (1948: 282).

A zone of calcareous shale, about 9 in thick, found in the road cutting at Harper's Hill, is literally crowded with the small turreted shells of *Pleurocinctosa allandaleensis* gen. et. sp. nov. This species first appears in the underlying Lochinvar Formation, where in shales about 1,280 ft from the base of the Dalwood Group it is found in abundance.

In the Manning-Macleay Province, on the North Coast of New South Wales, *Pleurocinctosa allandaleensis* is fairly abundant in the Pecten Sandstone and Mudstone Horizon of the Tait's Creek Formation at Yessabah, and in the Linoproductus Horizon of the Warbro Formation at Kimbriki on the Manning River. The shells of the species are very similar to those from the type locality except for a slightly heavier ornamentation.

The Permian rocks of the Manning-Macleay Province consist of nearly 3,000 ft of sediments and are known as the Macleay Group. Voisey (1951 : 64) divided the group into three formations which, in descending order, are the Warbro Formation, 1,640 ft, the Yessabah Formation, 1,260 ft, and the Tait's Creek Formation, 500 ft. He stated that there were certain similarities in the strata and fauna with the Dalwood Group of the Hunter Valley and that the two sequences are of the same general age. The occurrence of *P. allandaleensis* in the Warbro and Tait's Creek Formation indicates a correlation with the Allandale and Lochinvar Formations. A complete list of the abundant and fairly comprehensive fossils of the Macleay Group determined by me is given in two papers by Voisey (1936, 1939a).

It is the opinion of Voisey (1951 : 67) that the absence of *Linoproductus springsurensis* (Booker) and *Cladochonus nicholsoni* (Etheridge) in the Hunter Valley sequence and their abundance in the Manning-Macleay Province suggests a land barrier south of the Manning River. There is a surprising absence in the Macleay Group of the unique and abundant gastropod fauna of the Allandale Formation.

A single specimen (a mould) from Portions 195 and 196, Parish Curlew, County Pottinger, in the Gunnedah-Curlew district (Hanlon 1949 : 244) was incorrectly identified by me as *Ptychomphalina morrissiana* McCoy. The specimen possibly represents a new genus and species, but is insufficiently preserved for description. It is slightly larger than typical specimens of *Pleurocinctosa* and has definite spiral ornamentation. A comprehensive series of fossils from the same locality and recorded by Hanlon (1949 : 244—5) is characteristic of the Maitland Group. *Terrakea* and *Strophalosia* are the dominant genera.

Marine sediments in the Gunnedah-Curlew district are represented by the Porcupine Formation, the equivalent possibly of the Mulbring Formation or the higher part of the Branxton Sub-Group. The overlying Gladstone Formation is also considered by Hanlon (1949 : 245) to be possibly the equivalent in part of the Maitland Group. Marine deposits of Dalwood age are not found in the Gunnedah-Curlew area.

In the Narrabri district the Permian rocks consist of the Greta Coal Measures and the Maitland Group. Hanlon (1950 : 304) named the marine sediments the Barra Group. Fossils are known from three localities, the most important being an outcrop in Portion 80, Parish Eulah, from which Dun (1909 : 190) recorded *Ptychomphalina*. Specimens of *Ptychomphalina morrissiana* McCoy, now referred to *Pleurocinctosa triflata* (Dana), were collected (Hanlon 1950 : 305) from Portion 78, Parish Eulah. Imperfect specimens of what is possibly this species are also recorded from Jeogla (Voisey 1950), and from the top of the Upper Division of the Drake Group in the Drake-Boorook district, a fairly high-spired form of the genus *Pleurocinctosa* is known from several moulds.

It is surprising that gastropods are so rare in the Permian rocks of the Drake-Boorook area. None has previously been recorded even though there is a great development of fossils in the Upper Division. These are recorded by Voisey (1936 : 160—164).

The Lower Division of the Drake Group consists mainly of volcanic rocks and marine fossils are found only in the andesitic and trachytic tuffs at the top of the sequence. Fossils are not abundant and the dominant genera are *Thamnopora* and *Cladochonus*.

The Drake Group is possibly the equivalent, in part, of the Maitland (Upper Marine) Group and the Dalwood (Lower Marine) Group of the Hunter Valley. Voisey (1936 : 164) suggests that the Silverwood Fault Block Group (Queensland), the Drake Group and the Macleay Group may in a broad sense be correlated with one another and all are considered by him to be of Dalwood age.

In the Breeza district, marine sediments are restricted to shales and interbedded limestones which have received the name Watermark Formation (Hanlon 1949 : 252). Fossils collected in the Parish of Breeza within Portion 144 and the south-western corner of Portion 155, include *Keeneia ocula* (Sowerby).

The involute gastropods of the genus *Warthia* occur in considerable numbers in the Ravensfield Sandstone which forms the base of the Farley Formation of the Dalwood Group. This horizon is only 15 to 20 ft thick and the abundant marine fossil fauna is restricted mainly to pebbly bands which occur through it. The dominant forms are a pelecypod, *Edmondia*, and *Warthia* spp., notably *W. micromphala*.

(Dana) and *W. perspecta* sp. nov. These species then appear only sporadically through the sequence, but regain their numbers at Wollongong in the Gerringong Volcanics. An interesting occurrence of *Warthia perspecta* sp. nov., is near Farley, where two perfectly preserved specimens associated with a goniatite, *Adrianites* (*Neocrinites*) *meridionalis* Teichert and Fletcher, were collected from a few hundred feet above the base of the Branxton Sub-Group in the Elderslie Formation. Superficially the goniatite and the gastropods are identical, the former however, having ornamentation and suture lines.

The fossil fauna of the remainder of the Farley Formation contains forms characteristic of both the Dalwood and Maitland Groups and their equivalents. Gastropods are not plentiful and are usually of smaller size, a feature continuing to a great extent through most of the strata of the Maitland Group.

CRANKY CORNER BASIN

The Dalwood (Lower Marine) Group at Cranky Corner is represented by 820 ft of sediments and, as pointed out by Booker, has thinned out in a distance of about 15 miles from Branxton from nearly 6,000 ft. The following section is as measured by Booker (1950) during a visit to the area with the author—

	ft.
Mudstones, sandstones and conglomerates... ..	300
Coarse tuffaceous sandstones containing marine fossils. (Eurydesma Horizon).	120
Bluish shaly mudstones with numerous marine fossils, chiefly Fenestellidae.	300
Coarse sandstones with plant remains	100

The Maitland Group has an approximate thickness of 300 ft consisting mainly of a hard massive sandstone, probably the equivalent of the Elderslie Formation of the Branxton Sub-Group. The only marine fossils so far found consist of several species of *Conularia*. Booker (1950) considers that the thickness of the Maitland Group at Cranky Corner as stated by Walkom (1913 : 151) and Raggatt (1938) is excessive. In his opinion the Murce Formation is absent or unrecognizable and the Mulbring Formation (Crinoidal Shales) is also not represented.

The Eurydesma Horizon and associated tuffs and sandstones are correlated with the Allandale Formation and the basal sandstones and contained fossil plants are thought to be the equivalent of that found at the base of Lochinvar Formation. The Eurydesma Horizon at Cranky Corner is an amazing example of an ancient shell-reef, consisting as it does of an almost solid mass of *Eurydesma* shells. Gastropods are well represented, but do not include the wide variety of species found at Harper's Hill. The horizon can be traced almost continuously round the Cranky Corner Basin.

MUSWELLBROOK

At Muswellbrook the marine deposits are restricted to a thickness of from 1,263 to 2,635 ft and are representative of the Mulbring Formation and the Branxton Sub-Group. Marine fossils have been found in these rocks including specimens of *Eurydesma* from near the base of the Branxton Sub-Group indicating a correlation with the Eurydesma Zone at Wattle Ponds Creek and Loders' Dome. This zone is the Belford Formation of the Branxton Sub-Group. Gastropods from Muswellbrook have been identified as *Walnichollisia pygmaea* sp. nov., and *Platyschisma rotundatum* Morris, species also found in the Capertee Group of the Western Coalfield, the Shoalhaven Group and the Gerringong Volcanics of the South Coast district.

The Central Highlands

The marine sediments of the Maitland and Dalwood Groups of the Hunter River Valley thin very rapidly towards the west as well as to the north. Booker (1953 : 20) states that sediments referable to the Dalwood (Lower Marine) Group are not found beyond the Loder Bore, about 8 miles south-west of Singleton. The thinning of the Maitland (Upper Marine) Group continues through the valley of the Goulburn to the Western Coalfield in the Central Highlands where it is represented by the Capertee Group (Rayner and McElroy 1956).

This group is of varying thickness with a maximum thickness of about 500 ft and it has a wide horizontal distribution. The basal beds consist of a coarse conglomerate, in which a rich and interesting marine fauna is found at Rylstone where, north of the township, several outcrops rest unconformably on rocks of Upper Devonian age. The comprehensive nature of this fauna was not known until Mr. Walter Nicholls of Rylstone presented to the Australian Museum a large collection of fossils which he had collected during many years in the district. The dominant forms are mainly large species of pelecypods, gastropods and brachiopods. The only previous published record of Permian fossils from Rylstone is that of *Conocardium* (Fletcher 1943 : 231). Additional new species of pelecypods remain to be described and will be dealt with in a later paper.

The gastropods from Rylstone are—

Walnichollsia subcancellata (Morris)
Walnichollsia pygmaea sp. nov.
Platyschisma rotundatum (Morris)
Strotostoma rylstonensis gen. et sp. nov.
Strotostoma inflata sp. nov.
Mourlonopsis strzeleckiana (Morris)
Pleurocinctosa trifilata (Dana)
Warthia perspecta sp. nov.
Keeneia ocula (Sowerby)

Several other localities for marine fossils in the Western Coalfield have been recorded by Harper (1908: 61). The marine sediments at Rylstone appear to be the equivalent, in part, of the Branxton Sub-Group of the Hunter Valley, and the Gerringong Volcanics of the Illawarra District.

Burratorang Valley

In the past little attention has been devoted to the occurrence of Permian marine deposits in the Burratorang Valley. Recent field-work by officers of the Geological Survey of New South Wales has resulted in several localities being found where a comparatively rich fossil fauna is preserved. The marine horizon is about 120 ft thick and consists mainly of a silty sandstone interbedded with shale bands. The fossils, mainly pelecypods, occur almost exclusively in a basal bed of conglomerate.

Bundanoon Gully

An outcrop of marine rocks of Permian age is exposed in the Bundanoon Gully, 700 ft below the site of Tooth's old sawmill, 2 miles south of Bundanoon Railway Station. The rock is a fairly coarse, iron-stained conglomerate and is similar in lithology to the fossiliferous rocks of the Capertee Group at Rylstone. The fossils, including gastropods, indicate a correlation with the Rylstone beds and the Gerringong Volcanics.

The only extensive collection of fossils from Bundanoon Gully is one made in 1913 by the late Mr. W. W. Thorpe and now in the Australian Museum. Apart from a paper on some unique pelecypods (Etheridge 1918: 222) the fauna has received no attention.

The South Coast Province

Marine rocks of Permian age which are the equivalent, in part, of the Maitland (Upper Marine) Group are exposed as they emerge from below the Cumberland Basin, slightly north of Wollongong. The marine sediments are thereafter found outcropping on the coast south to South Durras where they rest unconformably on rocks of probable Ordovician age. They extend inland to the edge of the Southern Highlands where they outcrop on the Sassafras tableland 2,700 ft above sea-level.

Most of the numerous and extensive exposures of marine sediments are richly fossiliferous and contain a wide variety of species. Complete lists of fossils found at most of the localities in the South Coast Province have been recorded by Harper (1915).

In the Explanatory Notes to the Wollongong 4-mile sheet, published by the Bureau of Mineral Resources, Joplin, Hanlon and Noakes (1953) reviewed the Permian rock units of the Illawarra District as far south as Nowra. The complete sequence is given in detail with the exception of the Ulladulla Mudstone and the overlying Conjola Beds. These are the most southern outcrops.

The complete sequence, with the revised nomenclature as given by the above authors, is as follows:—

Group	Rock Unit
Gerringong Volcanics	Cambewarra Latite. Max. 600 ft. Marine fossils in tuff.
	Saddleback Latite. Max. 250 ft. Non-fossiliferous.
	Broughton Tuff—
	Jamberoo Tuff Member, 180—510 ft.
	Bumbo Latite, 30—500 ft. (non-fossiliferous).
	Kiama Tuff Member, 120 ft.
	Blow Hole Latite, 140 ft. (non fossiliferous).
Shoalhaven Group	Westley Park Tuff Member, 40 ft.
	Broughton Tuff (undifferentiated in the south), 350—760 ft.
	Berry Shale, 720 ft.
	Nowra Sandstone, 250 ft.
	Wandrawandian Siltstone, 550 ft.
	‡‡ Conjola "Beds", 1,400 ft.
	‡‡ Ulladulla Mudstone, 100 ft.

‡‡ These two lower units of the Group are added to the sequence. The estimated thicknesses are as given by David (1950: 347).

The Gerringong Volcanics and the Shoalhaven Group are correlated with the Maitland Group of the Hunter River Valley, but correlation of the sub-divisions is still uncertain. The South Coast rocks show a marked contrast in lithology to those of the Hunter Valley. Conglomerates and glacial beds are not prominent, but shales and mudstones are most conspicuous with tufts and lava flows well represented.

In the Wollongong area argillaceous sandstones and shales containing a rich fossil fauna are exposed at a number of localities. These may represent different horizons in the Jamberoo Tuff Member, although McElroy (unpublished thesis) has suggested a thickness of at least several hundred feet for one single fossiliferous horizon which has been traced to near the southern boundary of Lake Illawarra. The uppermost beds are characterised by numerous large pelecypods, including *Cleobis grandis* Dana, associated with other typical Permian species. Towards the base of these beds the genus *Terrakea* is dominant.

The underlying Kiama Tuff Formation is a distinct horizon only over the area of the Bumbo Latite. South and west it becomes incorporated in the Trachytic Tufts. Although marine fossils have been collected from several localities near Kiama fossils are generally considered to be rare.

The Westley Park Tuff loses its tuffaceous character at about 40 ft below its surface and grades into argillaceous sandstones and shales. Fossils are plentiful and at Black Head, Gerringong, and other nearby localities a rich and varied fauna has been recorded by Harper (1950: 107). A quarry near Broughton Village has yielded many well preserved specimens of brachiopods and pelecypods. Gastropods are represented by *Walnichollsia pygmaea* sp. nov., *W. subcancellata* (Morris), *Keeneia ocula* (Sowerby) and *Platyschisma rotundatum* Morris. The sediments possibly belong to the Westley Park Tuff.

It was pointed out earlier in this paper that a considerable development and variety of gastropods is very noticeable in the Allandale Formation, Dalwood (Lower Marine) Group, in the Hunter River Valley. A second enrichment of gastropods in the Permian sequence is found in the Gerringong Volcanics of the South Coast, the most important localities being Wollongong, Jamberoo and Gerringong. These gastropods are—

- Walnichollsia subcancellata* (Morris)
- Walnichollsia pygmaea* sp. nov.
- Platyschisma rotundatum* Morris
- Mourlonopsis strzeleckiana* (Morris)
- Strotostoma rylstonensis* gen. et sp. nov.
- Keeneia ocula* (Sowerby)
- Pleurocinctosa trifilata* (Dana)
- Warthia stricta* (Dana)
- Warthia undulata* (Dana)
- Warthia perspecta* sp. nov.
- Planikeenia occasa* sp. nov.
- ?*Planikeenia minor* sp. nov.

The above species resemble very closely those recorded from the Capertee Group at Rylstone and, to a lesser extent, those found in the Bundanoon Gully. It is suggested that the deposits at these three localities were laid down contemporaneously.

As mentioned earlier in this paper it is considered that *Mourlonopsis strzeleckiana* (Morris) and *Platyschisma rotundatum* Morris, in all probability do not occur outside the limits of the Maitland Group and its equivalents, even though they were recorded by early authors from the Allandale Formation at Harper's Hill. *Walnichollsia subcancellata* (Morris) and *W. pygmaea* sp. nov. are not uncommon in the Gerringong Volcanics, the Shoalhaven Group, the base of the Capertee Group, the Branxton Sub-Group and at Bundanoon, near Moss Vale. In the Branxton Sub-Group, both species have been collected at Branxton, possibly in the Elderslie Formation, and from the Belford Formation at Muswellbrook an incomplete shell is thought to be *N. pygmaea* sp. nov.

Strotostoma inflata gen. et sp. nov., and *S. rylstonensis* sp. nov., are found in the conglomerate of the Capertee Group at Rylstone, and the latter species is also represented in the Gerringong Volcanics, the Shoalhaven Group, and possibly the Muree Formation of the Branxton Sub-Group.

The bicarinate shells of *Pleurotomaria morrissiana* M'Coy, renamed in this paper as *Pleurocinctosa trifilata* (Dana), are found in a definite zone in the Westley Park Tuff at Gerringong where the rock is literally crowded with shells. The species is widely distributed, but is rather sporadic throughout the rest of the Maitland Group and its equivalents.

The rocks of the Shoalhaven Group on the South Coast, although rich in fossils, contain a rather poor and limited gastropod fauna. In most cases the specimens are poorly preserved steinkerns and definite specific determinations are difficult.

The Berry Shale, consisting mainly of grey shales and siltstones, is the topmost formation of the Shoalhaven Group. It overlies the Nowra Sandstone near Berry and is also found outcropping at Nowra Hill, south of Nowra.

The underlying Nowra Sandstone is found outcropping in the Nowra area. The boundary between it and the underlying Wandrawandian Siltstone has been only incompletely mapped, but it has been suggested that the Nowra Sandstone lenses out into siltstone on the coast south of the Shoalhaven River. Laseron (1910 : 196) states that it displays great difference from both of the other formations in the type of sediment and its contained fossil fauna.

The extent and knowledge of the boundaries of the Wandrawandian Siltstone is still mainly conjectural. In the vicinity of Tomerong and east to the north coast of Jervis Bay siltstones predominate. Laseron (1910 : 195) found that at Burrier, on the lower Shoalhaven River, a fossiliferous horizon is overlain by gritty sandstones and a series of finely laminated shales and sandstones all of which are barren of fossils. He is of the opinion that the Wandrawandian "Series" originated under littoral conditions and the beds as a result show considerable variation over short distances. A rich fossil fauna, mostly restricted to the lower horizons, has been collected from localities including Burrier, Grassy Gully, Sugar Loaf and Yalwal Creek. More than 60 species were recorded by Laseron (1910) from these localities and his collection is now in the Australian Museum.

Following recent field-work on the South Coast with Mr. L. R. Hall, of the Geological Survey of New South Wales, it is suggested that the Wandrawandian Siltstone may extend south to Berrara where on the coast it is represented by highly fossiliferous mudstones and sandstones.

The underlying Conjola Beds are mainly conglomeratic and pass upwards into coarse pebbly sandstones. They are exposed mainly around Conjola and, it is thought, do not extend any great distance to the south. Harper (1915 : 231) records exposures of these beds underlying the Wandrawandian Siltstone in the Yalwal and Ettrema Gorges.

During recent field-work an exposure of the Conjola Beds was found on the road into Red Head on Portion 180, Parish Conjola, County St. Vincent. The outcrop consists of about 120 ft of a coarse pebbly sandstone and is approximately 500 ft above sea-level. The headlands at Red Head were also found to consist of a Permian basalt and the "Upper Marine" sediments mapped by Harper (1915) are not present. He recorded "Dyke No. 5" on the north side of the point at sea-level, the intrusion being referred to as bluish-black basalt.

The fossils found in the coarse sandstone at Portion 180 are not particularly well preserved and, in most instances, are in the form of steinkerns. The dominant genera are *Myonia*, *Edmondia*, *Stutchburia*, *Chaenomya*, *Warthia* and an abundance of *Astartila*. Harper (1915 : 236) recorded a list of somewhat similar genera from near Conjola, together with specimens of *Cleobis grandis* up to 8 in in length.

THE ULLADULLA MUDSTONE

This formation consists of the basal beds of the "Upper Marine Series" on the South Coast and extends from South Durras to north of Ulladulla, a distance of approximately 40 miles. The beds consist for the most part of tuffaceous mudstones, sandstones, conglomerates and shales. Numerous glendonites are present in the beds at Ulladulla, together with glacial erratics of considerable size. The beds are rich in fossils throughout the greater part of their vertical extent.

The Ulladulla Mudstone is not well known and there is still much uncertainty regarding its thickness, and junction with the overlying Conjola "Beds". Harper (1915 : 231) only identified the beds between Kioloa and Ulladulla and he stated that at the latter locality they have a thickness of 100 ft. David (1950 : 347) suggests that the Ulladulla Mudstone continues north beyond Jervis Bay before disappearing beneath younger strata. In the opinion, however, of Mr. L. R. Hall and myself, the field evidence indicates that the Ulladulla Mudstone passes beneath the Conjola "Beds" a few miles north of Ulladulla. It is also considered that the fossiliferous sediments outcropping along the coast north of Red Head are members of the Wandrawandian Siltstone.

Recent field-work, carried out over the extent of the Ulladulla Mudstone as it outcrops on the coast, has indicated that the thickness of the beds has been under-estimated. Harper (1915 : 231) suggested that a gradual thickening of the sediments is constant in a northerly and easterly direction, the general dip being half a degree to the north-west. He also referred to the characteristic rolling of the strata and the formation of very localised anticlines and synclines.

A brief description of the beds, in ascending order, follows :—

South Durras—Ulladulla Mudstone rests with strong unconformity on probable Ordovician rocks—

	ft.
Basal strong conglomerate	12
Slate breccia	6
Sandstone and conglomerate	20
Slate breccia	12
Sandstones and shales	10

(Strike 320°—350°. Dip 6—14° N.E.)

Wasp Point—Mudstones appearing above sandstones with *Eurydesma*, etc.

(Strike 325°—350°. Dip 8—13° N.E.)

Point Upright—Mudstones overlain by sandstone with abundant *Eurydesma*, 60 ft.

(Strike 340°. Dip 3° E.)

Pebbly Beach—Mainly mudstones with traces of fossil casts.

(Strike and dip similar to Point Upright).

O'Hara Head (South)—Mudstones, sandstones and conglomerate. *Edmondia* zone in mudstone. *Stutchburia* and *Chaenomya* present.

O'Hara Head (1 m N. of O'Hara Head South)—Sandstone and mudstones with *Chaenomya*.

(Strike 355°. Dip 10° E.)

Willinga Point—Sandstone and conglomerate; grits and sandy shales; breccia. *Chaenomya* zone.

Crampton Island—Sandstones and mudstones. Fossils rare.

Lagoon Head—Sandstones and mudstones. Abundant fossils.

(Dip north of east—not measured.)

Warden's Head—Mudstones with abundant fossils.

(Strike 350°. Dip 6° W. On southern end of headland reversal of dip by virtue of small flat anticline.)

It would appear from the limited investigations carried out between South Durras and Ulladulla that an estimated thickness of at least 1,000 ft for the Ulladulla Mudstone is more correct than the low figure suggested previously. There are at least 100 ft of sediments from the base of the Ulladulla Mudstone to the *Eurydesma* Zone at Point Upright and to the north these beds disappear below overlying strata. An interesting feature in this formation is the number of narrow zones which are characterised by numerous shells of various genera. The most important is the *Eurydesma* Zone mentioned later in this paper.

CONCLUSIONS

A study of the Permian gastropods of New South Wales has proved several important points. It must be recognised first of all that gastropods are easily influenced by changes of physical conditions within certain areas. They are susceptible to environment and because of this are developed to a great extent in comparatively narrow limits within a sequence.

Conditions during the accumulation of the conglomerates and agglomerates found at the base of the Allandale Formation at Harper's Hill, were eminently favourable to the growth of the gastropod fauna. Outstanding are the large and thick-shelled forms found in association with the great accumulations of *Eurydesma*. Their subsequent and sudden burial under a great thickness of contemporaneous volcanic ash resulted in fossil material so beautifully preserved that even the finest ornamentation is revealed.

A second and younger development of gastropods occurred in the topmost beds of the Gerringong Volcanics (Upper Marine Series) at Wollongong, Jamberoo, Gerringong and other localities. A similar fauna is recognised at the base of the Capertee Group at Rylstone (Western Coalfield), and at Bundanoon in the Central Highlands, and a correlation of these three horizons is suggested.

Apart from these two well marked zones the distribution of gastropods in the Permian sequence is sporadic. Considerable thicknesses of sediment are almost devoid of them and when they are found they are generally in the form of steinkerns and rarely well preserved. Another feature is that the gastropods in the two well-defined zones are mainly large shells whereas there is a noticeable diminution in the size of the shells in the remaining horizons.

Gastropod species are restricted in their vertical range and to a large extent in their horizontal distribution and they have not materially assisted in an attempted close correlation of the sub-divisions of the "Upper Marine" rocks of the South Coast and those of the Maitland (Upper Marine) Group of

the type locality in the Hunter River Valley. The sediments of the Shoalhaven Group of the South Coast consist mainly of intermittent sandstones, shales and mudstones, which contain a rich fossil fauna, but the gastropods are largely impoverished and poorly preserved. They show however certain relationships with species from the lower formations of the Branxton Sub-Group in the Hunter River Valley.

On the South Coast at Point Upright, a well marked zone of the pelecypod *Eurydesma* was recently recorded by me (Hill 1955 : 101). The zone is exposed on the cliff-face about 60 ft above the rock-platform and is not met with again to the north where only occasional specimens of *Eurydesma* have been recorded from higher in the sequence. The shells first appear lower in the sequence at Wasp Point about 2 miles to the south where they are fairly abundant but not to the same extent as at Point Upright.

It is considered that this horizon, approximately 100 ft above the base of the Ulladulla Mudstone, should be correlated with the Eurydesma Horizon found in the Hunter Valley at Wattle Ponds Creek, Loder's Dome and at Muswellbrook. These localities are low in the Belford Formation of the Branxton Sub-Group. If this correlation is accepted it means that the Fenestella Shale Formation and the Elderslie Formation, approximately 1,550 ft of sediments, are not represented on the southern margin of the Permian sequence.

On lithological grounds the Berry Shale and the Nowra Sandstone of the Shoalhaven Group have in the past been correlated with the Mulbring and the Muree Formations of the Hunter Valley respectively. It is doubtful, however, whether these formations are represented on the South Coast.

As mentioned earlier in this paper the Gerringong Volcanics, the basal beds of the Capertee Group and the rocks exposed in the Bundanoon Gully, would appear to be contemporaneous on the evidence of the gastropod fauna. A similar fauna is also recognised at Glendon in the Hunter River Valley from species recorded by early authors. There is some doubt regarding the exact geographical position of this locality, but it is almost certain that the sediments are representative of the Belford Formation. The Capertee Group in the Western Coalfield attains a maximum thickness of 650 ft and is generally considered to be the equivalent of the Branxton Sub-Group, in part.

In attempting correlations between the Permian rocks of the South Coast and their equivalents in the Maitland Group of the Hunter River Valley, it is interesting to note the sedimentation revealed by the Kulnura Bore. This bore was put down at Kulnura, west of Gosford, and it proved that the Permian deposits in the middle of the Sydney Basin consist almost entirely of a succession of shales, sandstones and occasional limestones. The facies change is so great that it is impossible to attempt any definite correlations with the known Permian succession to the north or south.

The marine sediments in the Kulnura Bore occur at depths from 3,775 to 4,490 ft, and from 4,667 to 6,279 ft. The Greta Coal Measures are represented by freshwater deposits between the depths at 4,490 to 4,667 ft, while the "Upper Marine" sediments have a thickness of only 715 ft.

It would appear from the available evidence that the complete sequence of Permian marine rocks of the South Coast is the equivalent of the Belford Formation of the Branxton Sub-Group, which in the type locality of the Hunter Valley has a thickness of 1,450 ft. Even when it is realised that the thickness of the Permian rocks of the South Coast is emphasised by the many interbedded volcanic tuffs and lava flows, this conclusion is one which is open to doubt. The suggestion, however, is a tentative one, as it is recognised that a great deal of detailed mapping is still necessary before even the limits and thicknesses of the Permian sub-divisions are known on the South Coast. This work, together with further investigations on the western margin of the Sydney Basin and a more detailed study of the complete fossil fauna, would materially assist in correlations.

NEW NAMES

Cyclosena anomphala gen. et sp. nov.

Keeneia trochiforme sp. nov.

Mourlonopsis strzeleckiana (Morris)

Planikeeneia insculpta gen. et sp. nov.

Planikeeneia minor sp. nov.

Planikeeneia occasa sp. nov.

Platyceras farleyensis sp. nov.

Platyschisma branxtonensis sp. nov.

Pleurocinctosa allandalensis gen. et sp. nov.

Pleurocinctosa elegans sp. nov.

Rhabdocanthus aduncus gen. et sp. nov.

Rhabdocanthus intermedia sp. nov.

Rhabdocanthus irregularis sp. nov.

Strotostoma inflata gen. et sp. nov.

Strotostoma rylstonensis sp. nov.

Walnichollsia pygmaea gen. et sp. nov.

Warthia perspecta sp. nov.

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REFERENCES

- Bowsher, A. L. 1955. Origin and adaptation of Platyceratid Gastropods. *Contr. Palaeont. Kans.*, Lawrence. Art. 5.
- Booker, F. W. 1950. *Rep. Dep. Min. N.S.W.*, Sydney, 1949: 64—66.
- , 1953. Unpublished thesis.
- Branson, C. C. 1948. Bibliographic Index of Permian Invertebrates. *Mem. geol. Soc. Amer.*, Washington. 26.
- Campbell, K. S. W. 1953. The Faunas of the Permo-Carboniferous Ingelara Beds of Queensland. *Pap. Dep. Geol. Univ. Qd.*, Brisbane.
- Carne, J. E. 1908. Geology and Mineral Resources of the Western Coalfield. *Mem. geol. Surv. N.S.W.*, Sydney Geol. 6.
- Chronic, John 1949. In Newell, N.D., Chronic, John, and Roberts, T. G. Upper Palaeozoic of Peru. New York. (see also *Mem. geol. Soc. Amer.*, Washington, 1953: 58.
- Conrad, T. A. 1842. Descriptions of new species of organic remains belonging to the Silurian, Devonian and Carboniferous systems of the United States. *J. Acad. nat. Sci. Philad.* 8.
- Dana, J. D. 1847. Descriptions of fossil shells of the exploring expedition under the command of Charles Wilkes, U.S.N. . . . *Amer. J. Sci.*, New Haven. 54.
- , 1849. In United States Exploring Expedition during the years 1838—1842, under the command of Charles Wilkes, U.S.N. 10. Geology.
- David, T. W. E. 1950. The Geology of the Commonwealth of Australia. (Arnold: London).
- David, T. W. E. and Sussmilch, C. A. 1931. Upper Palaeozoic Glaciations of Australia. *Bull. geol. Soc. Amer.*, Rochester, N.Y. 42.
- Dun, W. S. 1913. Marine Fossils from the Tasmanite Spore Beds of the Mersey River. *Tas. Dept. Mines, Geol. Rec.* 1.
- Etheridge, jr., R., 1878. A Catalogue of Australian Fossils. (Cambridge University Press).
- , 1880. Report on a collection of fossils from the Bowen River Coalfield and the limestone of the Fanning River, Northern Queensland. *Proc. R. phys. Soc. Edinb.* 5.
- , 1889. Remarks on fossils of Permo-Carboniferous age from North-West Australia, in the Macleay Museum. *Proc. Linn. Soc. N.S.W.*, Sydney.
- , 1892. See Jack and Etheridge.
- , 1894. Palaeontologia Novae Cambriae Meridionalis: Occasional descriptions of New South Wales Fossils. *Rec. geol. Surv. N.S.W.*, Sydney. 4.
- , 1896. *Ibid.* 5. (1).
- , 1898. *Ibid.* 5, (4).
- , 1902. A New Permo-Carboniferous genus (*Keeneia*) of the Pleurotomaridae, and a *Straparollus* in New South Wales. *Rec. Aust. Mus.* Sydney, 4.

REFERENCES—continued.

- , 1918. Pelecypoda from the Permo-Carboniferous of Bundanoon. *Rec. Aust. Mus.*, Sydney, 11.
- , 1919. Occasional Descriptions of New South Wales Fossils. *Rec. Aust. Mus.*, Sydney, 12.
- Fletcher, H. O. 1943. The Genus *Conocardium* from Palaeozoic Rocks. *Rec. Aust. Mus.*, Sydney, 21.
- , 1955. Symposium on Contributions to the Correlation and Fauna of the Permian of Australia and New Zealand. (Reviewed by D. Hill). *J. Geol. Soc. Aust.* 2.
- Forod, A. H. and Crick, G. C. 1897. Catalogue of the Fossil Cephalopoda in the British Museum (Nat. Hist.) 23.
- Frech, F. 1896. Review of R. Etheridge, Jnr., Palaeontologia Novae Cambriae Meridionalis Rec. Geol. Sur. N.S.W. 1894, 4. *Neues Jb. Miner., Mh.*
- Girty, G. H. 1908. The Guadalupian Fauna. *Prof. Pap. U.S. geol. Surv.*, Washington, 58.
- Grabau, A. W. 1931. The Permian of Mongolia. *Nat. Hist., N.Y.* 4.
- , 1936. Early Permian Fossils of China ii. *Mem. geol. Surv. China, Pekin.* Ser. B, 8.
- Grange, M. J. 1854. In Dumont d'Urville's *Voyage au Pôle Sud.* Geol. 2.
- Hall, J. 1859. Natural History of New York. *Geol. Sur.* New York, 3.
- Haniel, C. 1915. Die Cephalopoden der Dyas von Timor. *Pal. v. Timor* 3.
- Hanlon, F. N. 1948. Geology of the North-Western Coalfield, Pt. 1. *J. roy. Soc. N.S.W.*, Sydney. 81 (1947).
- , 1948. Geology of the North-Western Coalfield, Pt. 2. *J. roy. Soc. N.S.W.*, Sydney. 81 (1947).
- , 1948. Geology of the North-Western Coalfield, Pt. 3. *J. roy. Soc. N.S.W.*, Sydney. 81 (1947).
- , 1949. Geology of the North-Western Coalfield, Pt. 4. *J. roy. Soc. N.S.W.*, Sydney. 82 (1948).
- , 1949. Geology of the North-Western Coalfield, Pt. 5. *J. roy. Soc. N.S.W.*, Sydney. 82 (1948).
- , 1949. Geology of the North-Western Coalfield, Pt. 6. *J. roy. Soc. N.S.W.*, Sydney. 82 (1948).
- , 1950. Geology of the North-Western Coalfield, Pt. 7. *J. roy. Soc. N.S.W.*, Sydney. 82 (1949).
- , 1950a. Geology of the North-Western Coalfield, Pt. 8. *J. roy. Soc. N.S.W.*, Sydney. 82 (1949).
- Harper, L. F. 1905. The Geology of the Gerringong District. *Rec. geol. Surv. N.S.W.*, Sydney. 8.
- , 1915. Geology and Mineral Resources of the Southern Coalfield. *Mem. Geol. Sur. N.S.W. Geol.* 7.
- Haug, E. 1898. Etudes sur les Goniatites. *Mem. Soc. Geol. France.* 7.
- Hill, D. 1955. Contributions to the correlation and fauna of the Permian in Australia and New Zealand (Symposium reviewed). *J. Geol. Soc. Aust.* 2.
- Jack, R. L. and Etheridge, R. 1892. Geology and Palaeontology of Queensland and New Guinea. (Brisbane and London.)
- Jaquet, J. B., Card. G. W., and Harper, L. F. 1905. The Geology of the Permo-Carboniferous rocks in the south-eastern portion of New South Wales. *Rec. geol. Surv. N.S.W.*, Sydney. 8.
- Johnston, R. M. 1888. Systematic Account of the Geology of Tasmania. (Hobart).
- Joplin, G. A., Hanlon, F. N., and Noakes, L. C. 1953. Explanatory Notes to the Wollongong—4 mile Geol. Ser. (Bureau of Mineral Resources, Canberra).
- Jukes, J. B. 1847. Notes on the Palaeozoic Formations of New South Wales and Van Diemen's Land. *Quart. J. geol. Soc. Lond.* 3.
- Keyes, C. R. 1890. Synopsis of American Carbonic Calyptraeidae. *Proc. Acad. nat. Sci. Philad.*
- Knight, J. Brookes 1934. The Gastropods of the St. Louis, Missouri, Pennsylvanian Outlier: 7. The Euomphalidae and the Platyceratidae. *J. Paleont.*, Tulsa, Okla. 8.
- , 1936. Notes of Palaeozoic Gastropods. *J. Paleont.*, Tulsa, Okla. 10.
- , 1941. Palaeozoic Gastropod Genotypes. *Spec. Pap. geol. Soc. Amer.*, Washington. 32.
- Koninck, L. G. de. 1877. Recherches sur les Fossiles Palaeozoïques de la Nouvelles-Galles du Sud (Australie). *Soc. des Sci. Nat. Liège. Mem. Ser.* 2, 6—7. (Translation in *Mem. geol. Surv. N.S.W.*, Sydney, 1898. Pal. 6.
- Laseron, C. F. 1910. Palaeontology of the Lower Shoalhaven River. *J. roy. Soc. N.S.W.*, Sydney. 44.
- McCoy, F. 1847. On the Fossil Botany and Zoology associated with the coal in Australia. *Ann. Mag. nat. Hist.* London 20.
- McElroy, C. 1953. Unpublished thesis.
- Meek, F. B. and Worthen, A. H. 1868. Palaeontology. *Geol. Sur. Illinois.* 3.
- Mitchell, J. 1922. A New Gastropod (Fam. Euomphalidae) from the Lower Marine of New South Wales. *Proc. Linn. Soc. N.S.W.* Sydney, 47.
- Mitchell, T. L. 1838. *Three Expeditions into Eastern Australia.* (London).
- Morris, J. 1845. Descriptions of Fossils. In Strzelecki, "Physical Description of New South Wales and Van Diemen's Land". (London).
- Plews, H. T. 1858. On the Coalfield of New South Wales. *Mining Inst. J.* 6 (3).
- Raggatt, H. G. 1938. Unpublished thesis.
- , 1939. Department of Mines, New South Wales. (Unpublished Misc. Pap. 39/5160).
- Raggatt, H. G. and Fletcher, H. O. 1937. A Contribution to the Permian-upper Carboniferous Problem and an Analysis of the Fauna of the Upper Palaeozoic (Permian) of the North-West Basin, Western Australia. *Rec. Aust. Mus.* 10.
- Rayner, E. O. and McElroy, C. T. 1956. Explanatory Notes to the Sydney—4 miles Geol. Ser. (Bureau of Mineral Resources, Canberra).
- Reed, F. R. C. 1930. A New Permo-Carboniferous Fauna from Brazil. *Serv. Geol. Min. Brazil.* Mon. 10.
- , 1932. New Fossils from the Agglomeratic Slate of Kashmir. *Palaeont. indica.* N.S. 20: 1.
- Reid, J. H. 1929. Geology of the Bowen River Coalfield. *Qd. Geol. Sur. Pub.* 276.
- Schuchert, C. 1928. Review of the late Palaeozoic Formations and Faunas with special reference to the ice-age of Middle Permian times. *Bull. Geol. Soc. Amer.* 39.
- Sowerby, C. 1838. Fossils. In Mitchell, T. L., *Three Expeditions into the Interior of Eastern Australia* (London).

REFERENCES—continued.

- Strzelecki, P. G. de. 1845. *Physical Description of New South Wales and Van Diemen's Land*. (London).
- Teichert, C. 1953. A New Ammonoid from the Eastern Australian Permian Province. *J. roy. Soc. N.S.W.* 87.
- Teichert, C. and Fletcher, H. O. 1943. A Permian Ammonoid from New South Wales and a Correlation of the Upper Marine Series. *Rec. Aust. Mus.*, 21.
- Thomas, H. D. 1929. The late Palaeozoic Glaciation. *Nature*. 123.
- Voisey, A. H. 1936. The Upper Palaeozoic Rocks around Yessaban, near Kempsey, New South Wales. *J. roy. Soc. N.S.W.*, Sydney, 70.
- , 1936a. The Upper Palaeozoic Rocks in the Neighbourhood of Boorook and Drake, New South Wales. *Proc. Linn. Soc. N.S.W.* Sydney, 61.
- , 1939. The Geology of the Lower Manning District of New South Wales. *Proc. Linn. Soc. N.S.W.* Sydney, 64.
- , 1950. The Permian Deposits of Jeogla and Kangaroo Creek, N.S.W. New England University College *Sci. J.*
- , 1951. The Permian Rocks of the Manning-Macleay Province, N.S.W. *J. roy. Soc. N.S.W.* Sydney, 84.
- Waagen, W. 1880. Salt Range Fossils. Pt. 2. *Palaeont. indica* Ser. 13, 1.
- , 1891. Salt Range Fossils. *Palaeont. indica*, Ser. 13, 4.
- Walkom, A. B. 1913. Stratigraphical Geology of the Permo-Carboniferous System in the Maitland-Branxton District. *Proc. Linn. Soc. N.S.W.* Sydney, 33.
- Wanner, J. 1922. Die Gastropoden und Lamellibranchiaten der Dyas von Timor. *Pal. von Timor*, 11 (xviii).
- Whitehouse, F. W. 1926. Notes on the Upper Palaeozoic Marine Horizons in Eastern and Western Australia. *Rep. Aust. N.Z. Ass. Adv. Sci.* Sydney, 18.

EXPLANATIONS OF PLATES

Unless otherwise stated Figures are approximately natural size.

Photography, unless otherwise stated, is by Mr. Howard Hughes, Australian Museum.

Plate 7

Rhabdocanthus altum (Etheridge)

1. Neotype, F.35587. Side view showing curvature, straight apertural margin and growth undulations. Figured Etheridge (1896 : pl. i, figure 1).
2. The neotype. Front view showing twisted apex.
3. A smaller specimen, F.35585, figured Etheridge (1896 : pl. i, figure 2).
4. Front view of figure 3.

Rhabdocanthus cornucapella (Etheridge)

5. Holotype, F.35588, showing transverse ridges and curvature. Figured Etheridge (1896 : pl. i, figure 3).
6. Holotype; another side view showing transverse ridges, longitudinal and transverse lirae.
7. Front view of the holotype, showing slightly twisted apex; the point is missing.

Rhabdocanthus adunca sp. nov.

8. Holotype, F.46400. Side view showing strongly incurved apex and ornamentation.
9. A front view of the holotype, showing lateral compression.

Rhabdocanthus intermedia sp. nov.

10. Holotype, F.26950. Side view showing curvature transverse ridges and ornamentation.
11. Front view of the holotype.

Rhabdocanthus ungula (Etheridge)

12. A plesiotype, F.46402. Side view showing almost straight ventral margin.

Plate 8

Rhabdocanthus ungula (Etheridge)

1. Holotype, F.35586. Side view showing conical form. Figured Etheridge (1896 : pl. i, figure 4).
2. Front view of holotype.
3. Apical view of holotype.

Rhabdocanthus irregularis sp. nov.

4. The paratype, F.30131 : side view.
5. Apical view of the paratype, showing expansion of shell and asymmetrical form.

Platyceras farleyensis sp. nov.

6. Holotype, F.30004. Side view showing coiled apex in contact with body whorl.

Strotostoma rylstonensis sp. nov.

7. A paratype, F.45392. Apical view showing reduced spire and enlarged body whorl.
8. An impression of the ornamentation from F.39625.
9. The holotype, F.40940. A side view of the body whorl showing ornamentation and basal extension.
10. Apical view of the holotype.
11. Paratype, F.39682, showing false umbilicus and obliquely distended aperture.

Plate 9

Rhabdocanthus irregularis gen. et sp. nov.

1. Holotype, F.27525. Side view showing growth undulations and general form.
2. Front view of holotype showing pointed and twisted apex.

Rhabdocanthus ungula (Etheridge)

3. A topotype, F.30146, showing conical form.
4. Front view of the same specimen.

Strotostoma rylstonensis gen. et sp. nov.

5. A small specimen, F.6430, from Gerringong. Characteristic ornamentation shown on small portion of penultimate whorl.

EXPLANATIONS OF PLATES—continued.

Plate 9—continued.

Strotostoma inflata gen. et sp. nov.

6. Paratype, F.44246. An oblique apertural view.
7. Holotype, F.45350. An apical view.
8. Side view of holotype showing inflation of body whorl.

Mourlonopsis strzeleckiana (Morris)

9. Apical view of a large specimen, F.21762, from Gerringong.
10. Side view of a steinkern, F.29735, from Wollongong, showing narrow slit-band.
11. Apertural view of a smaller specimen, F.21530, from Gerringong, showing inner and outer lips.

Plate 10

Cycloscena anomphala gen. et sp. nov.

1. Holotype, F.29777. An apical view.
2. Side view of holotype, showing ornamentation, peripheral carina and pointed apex.
3. Basal view of the paratype, F.46586.

Keeneia trochiforme sp. nov.

4. The holotype, F.46571. An apical view showing slight shoulders and steeply sloping whorl faces.
5. Side view of the holotype showing ornamentation.
6. Basal view of holotype.

Plate 11

Keeneia trochiforme sp. nov.

1. The paratype, F.46572. Apertural view showing portion of ornamentation and steeply sloping whorl faces. Slightly less than natural size.
2. Apical view of paratype. Less than natural size.

Pleurocinctosa triflata (Dana)

3. Two specimens, F.21535, from Gerringong. Note the third indistinct carina below the periphery of the body whorl. Enlarged.
4. A slightly oblique apertural view, showing moderately inflated lower half of body whorl. Enlarged.
5. An apertural view of a specimen, F.21395, from Gerringong. Well preserved columella lip. Enlarged.
6. Slab, F.21251, from Gerringong, showing usual mode of occurrence. Enlarged.

Pleurocinctosa allandaleensis gen. et sp. nov.

7. Topotype, F.27545, showing selenizone on unweathered portion of whorls. Enlarged.
8. Steinkern showing rounded whorls. Enlarged.
9. Slightly oblique apertural view of a topotype.

Plate 12

Pleurocinctosa elegans gen. et sp. nov.

1. Slab containing the holotype, F.46587, showing well differentiated whorls and tricarination. Enlarged.

Pleurocinctosa allandaleensis gen. et sp. nov.

2. A greatly enlarged apertural view of a topotype, F.27524, showing minute umbilicus and almost complete aperture.
3. Slab from a narrow zone in the Allandale Formation at Harper's Hill; mainly steinkerns and impressions.

Walnichollisia pyamaea gen. et sp. nov.

4. The holotype, F.46585. Apical view showing partly weathered ornamentation.
5. Basal view of holotype, showing spiral costae and wide umbilicus.
6. Apertural view of the holotype, showing very depressed spire.
7. Steinkern, paratype F.21634, from Wyro, near Ulladulla. A portion of shell on the apex shows characteristic ornamentation.
8. Impression, F.21256, showing well preserved spiral costae and finer transverse lirae of the ornamentation.

Plate 13

Walnichollisia subcanellata (Morris)

1. Specimen from Rylstone, F.43066, showing weathered ornamentation and selenizone above the periphery of the whorl. An oblique apical view, slightly reduced.
2. Apertural view of F.43066, showing rounded outer whorl face, selenizone and aperture. Natural size.
3. Flattened specimen, F.28310, from Branxton, showing ornamentation. Slightly reduced.
4. Apical view of a specimen, F.45348, from Rylstone. Natural size.
5. Basal view of F.45348, showing spiral costae and wide umbilicus. Considerably reduced.
6. Side view of F.45348. Extreme apical whorls missing. Considerably reduced.

Plate 14

Keeneia platyschismoides Etheridge.

1. F.7257, (holotype of Knight 1941: 163). Figured by Etheridge 1902: pl. xxxii, figure 2. An apertural view; apical whorls absent. Reduced.
2. Apical view of the holotype; note missing apex.

Planikeeneia minor gen. et sp. nov.

3. The holotype, F.46578. Figured by Etheridge 1898: pl. xix, figures 14—17, as *Platyschisma oculus* (Sowerby). An apical view showing ornamentation. Natural size.
4. Basal view of the holotype. Natural size.
5. Partly decorticated specimen, F.46589, from the type locality. An apical view.
6. Apertural view of F.46589, showing transversely produced aperture, angulate periphery of the body whorl and depressed spire.

Plate 15

Keeneia platyschismoides Etheridge

1. The syntype, F.7258, figured by Etheridge 1902: pl. xxxii, figure 1. A side view showing the strongly carinate periphery of the body whorl, sloping whorl faces and well developed shoulder below the upper shoulder. Considerably reduced.
2. Apical view of the syntype, F.7258. Considerably reduced.

EXPLANATIONS OF PLATES—continued.

Plate 15—continued.

Warthia perspecta sp. nov.

3. Side view of F.35733, figured by Etheridge 1894: pl. vii, figure 10, as *Goniatites (Prolecanites?) micromphalus* (Morris).
4. Anterior view of F.35733, showing inflated whorl and wide shallow sinus.
5. Side view of a specimen, F.39686, from Wollongong.
6. Anterior view of F.39686, slightly oblique, showing sinus.
7. Side view of a larger specimen, F.8215, from Wollongong.
8. Apertural view of F.8215, showing narrow and wide aperture.
9. Plaster cast of holotype figured by Dana 1849: pl. x, figures 6a, b. A side view.
10. Apertural view of the holotype.

Warthia stricta (Dana)

11. Side view of a specimen, F.1081, from Gerrington showing lateral margin of aperture and trace of the narrow sinus.
12. An anterior view of F.1081, showing lateral compression.
13. Plaster cast of the holotype, figured by Dana 1849: pl. x, figures 5a, b. A side view.
14. An apertural view of the holotype.

Plate 16

Platyschisma branxtonensis sp. nov.

1. The holotype, F.28297. An apical view showing regular coiling of the spire.
2. Side view of the holotype showing inflection of transverse lirae on the periphery of the body whorl.
3. Oblique apertural view of the holotype showing rounded whorls.

Warthia micromphala (Morris)

4. Side view of a specimen, F.8174, from Wollongong, showing characteristic wide transverse ridges.
5. Side view of another specimen, F.7936, from Wollongong, showing lateral margin of aperture and ridges.

Platyschisma rotundatum (Morris)

6. Oblique apical view of specimen, F.45323, from Rylstone. A steinkern.
7. A more depressed specimen, F.29925, from Branxton. An oblique apical view showing transverse thickenings of the shell.
8. Side view of a steinkern, F.2192, from Wollongong. The extreme apical whorls are missing.
9. An oblique apical view of F.2192.

Plate 17

Planikeeneia depressum (Dana)

1. The holotype, F.27084, of *Platyschisma allendalensis* Mitchell (1922: pl. xxxv, figures 1—2). An apertural view; considerably reduced.
2. Apical view of F.27084. The specimen is a steinkern and the apex of the spire is missing. Considerably reduced.

Planikeeneia insculpta gen. et sp. nov.

3. The holotype, F.29904. Apical view showing ornamentation. Natural size.
4. Apertural view of the holotype, showing depressed spire and portion of the thickened columellar lip. Natural size.
5. Basal view of holotype. Natural size.

Plate 18

Planikeeneia depressum (Dana)

1. Plaster cast, L.694, of the holotype, figured by Dana 1849: pl. x, figures 2a, b. An apical view showing transversely produced and flattened body whorl. Considerably reduced.
2. Apertural view of L.694, showing the depressed spire and flattened outer whorl face. Considerably reduced.

Planikeeneia ocasea gen. et sp. nov.

3. The holotype, F.28295. An apical view slightly enlarged.
4. Apertural view of holotype, showing thickened columellar and lower lip. Slightly enlarged.
5. The steinkern, F.6601, figured by Etheridge 1919: pl. xxviii, figure 9 as ?*Platyschisma rotundatum* var. *farleyensis*. Slightly enlarged.
6. Paratype, F.29869. An apical view.

Plate 19

Keeneia ocula (Sowerby)

1. The holotype, B.M.N.H. No. PG. 1061, figured by Sowerby 1838: pl. ii, figures 3—4 as *Trochus oculus*. Side view showing growth lines and outline of body whorl.
2. The holotype; apertural view.
3. The holotype. Basal view, showing thickening of the inner lip.
4. A topotype, F.27535. Apertural view showing inner lip and broken outer lip.
5. Apical view of F.27535, showing ornamentation and growth lines.
6. Enlarged portion of the body whorl of F.27535, showing the inflection of the lirae as they cross the whorl periphery.
7. The specimen figured by Morris 1845: pl. xviii, figure 1. (B.M.N.H. No. 96901). Side view showing growth lines and outline of body whorl.

Figures 1, 2, 3, 7: *British Museum photographs.*

Plate 20

Keeneia ocula (Sowerby)

1. The specimen figured by Morris 1845: pl. xviii, figure 1 (B.M.N.H. No. 96901). An apical view.
2. Side view of Morris's specimen. Only the shell of the outer lip is missing.
3. Basal view of B.M.N.H. No. 96901, showing the abraded inner lip.
4. The holotype, B.M.N.H. No. PG. 1061. Apical view showing the extent to which the specimen is weathered.
5. Apical view of a specimen, F.27539, from the type locality.
6. Basal view of F.27539.

Figures 1 to 4: *British Museum photographs.*

Plate 21

Paromphalus ammonitiformis (Etheridge)

1. Apical view of a plesiotype, F.30018. A steinkern. Natural size.
2. The holotype, F.7669, figured by Etheridge 1902: pl. xxxiii, figures 1—2. An apical view. Natural size.
3. Apertural view of the holotype, showing rounded outline of the whorl and shape of the aperture. Natural size.
4. A small plesiotype, F.28302, with original shell showing well preserved ornamentation. Natural size.
5. Greatly enlarged portion of F.28302, showing ornamentation.





























