A REVIEW OF THE FOSSIL FRESHWATER MUSSELS (MOLLUSCA, PELECYPODA) OF AUSTRALASIA.

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(Plates xiii-xiv; one Text-figure.)

[Read 26th September, 1956.]

Synopsis.

The named and described fossil freshwater mussels are reviewed as a preliminary to a study of the evolution of the recent Australasian forms of this group. Of the twenty-two names found in literature which have been applied to fossils believed to be freshwater mussels, five have never been described, while two names based on figures without descriptions probably do not apply to freshwater mussels at all. Of the remaining fifteen names, two belong to recent species and a third is considered to be a synonym of a recent species. Of the twelve described forms known only as fossils, five are attributed to recent genera, three belong in the fossil genus *Unionella* Etheridge, and three new generic names are provided for the remainder. A new species is described from New Zealand, and a new name provided for the New Zealand species, *Unio inflata* Hutton, which is preoccupied. It is suggested that further work on this group will reveal a number of new species, and with more knowledge these forms will be of greater value in stratigraphical correlation.

Fossil freshwater mussels have been recorded from Australia and New Zealand during the past century, but no palaeontologist to date has attempted to monograph or even list all the recorded forms. This is not surprising, for an examination of the literature reveals a state of complete confusion. In the following pages an attempt is made to collate the available information and to indicate as precisely as possible the status and relationships of the described and named forms, based on a study of the fossil material available and a knowledge of the recent fauna.

Further knowledge of this group will have to await a comprehensive review for which a great deal of material must be examined, type specimens must be located and studied, and a thorough search of the literature made. It must be pointed out, however, that no such review will be of any value unless due reference to recent species is made. Nearly all the named forms from this region have been placed in the genera *Unio* Philipsson and *Anodonta* Lamarck, the former if hinge teeth were visible, the latter if they were not visible. As Modell (1942) has pointed out, these genera are today precisely defined groups of species, definitely not Australian, and are not "dumping grounds" for miscellaneous fossil forms.

Knowledge of the fossil species is of great importance in order that a thorough understanding of the past history and phylogeny of the recent forms can be obtained, and if the fossil species were better known they might prove more important in stratigraphical correlation. At the moment, the presence of freshwater mussels indicates only that the beds in question are freshwater, and post-palaeozoic.

In the present review the species or specific names are treated more or less in chronological order. This order is based on their first usage in literature as far as could be determined from the references which I have located. It is interesting to note that Etheridge, Jr. (1879), in connection with the description of *Unio aucklandicus wilkinsoni* gave the first list of recent species described from or attributed to Australia.

For the convenience of those who have not access to this scattered literature, the species descriptions are, for the most part, reprinted from the original. Where possible, I have examined specimens and attached further notes if necessary. In some cases,

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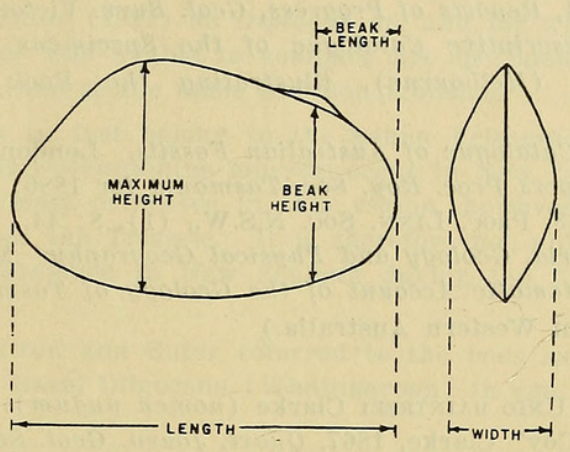
where the original description was inadequate or entirely lacking, additional information based on the figures has been given. The dimensions here given are based, wherever possible, on the type specimens, but in some cases are obtained from the figures and should be regarded as approximate only. The measurements used have been found the most satisfactory for expressing the important features of form in this group and are illustrated in Text-figure 1.



Text-fig. 1.—Dimensions of Freshwater Mussel Shells. Beak height is measured from the hinge line to the ventral margin, and does not include the height of the beaks above the hinge line. In the tables of dimensions, the abbreviations T.L., B.L., and M.H. are used for Total Length, Beak Length, and Maximum Height respectively.

I would like to thank especially Mr. H. O. Fletcher for help and advice on several points; Mr. E. D. Gill for the loan of the several specimens in the collection of the National Museum of Victoria and for valuable information on *Unio dacombii*; and Dr. C. A. Fleming and the Director of the New Zealand Geological Survey for the loan of material from that collection, especially the holotype of *Unio inflatus* Hutton.

Unio dacombii Selwyn (*nomen nudum*).

Unio dacombii "McCoy" Selwyn, 1861, *Geology of the Colony of Victoria*; *Catalogue of the Victorian Exhibition, 1861*, p. 186. *Type Locality*: Middle Jurassic Coal, Valley of the Wannon River, Victoria.

Remarks.

Before giving the long list of references to this name, some comments as to the discovery of the fossil and the status of the name are necessary. During the year 1859 Mr. E. Dacomb, of Portland, Victoria, apparently discovered a fossil freshwater mussel while sinking a shaft near Coleraine and forwarded the specimen to A. R. C. Selwyn, who in turn gave it to Professor F. McCoy. The latter informed Selwyn that he proposed to name it *Unio dacombii* and it was intended for publication in McCoy's *Prodromus of the Palaeontology of Victoria.*

Mr. E. D. Gill, Palaeontologist at the National Museum of Victoria, kindly investigated at my request to see if McCoy had ever described this shell. After a thorough search of the literature he concluded that the species had not been described in print, although a letter in the McCoy papers at the National Museum revealed that the manuscript description was prepared in 1879 and was to have been published in a forthcoming Decade of the *Prodromus*. No type specimen could be located in the National Museum collection, and it probably does not exist today.

Tenison Woods (1883) noted that the fossils discovered during the borings were recorded in the local papers, the *Geelong Advertiser* and the *Portland Guardian*, of various dates in 1859. At Mr. Gill's request, the research section of the Melbourne Public Library searched the newspapers mentioned, but found no description of *Unio dacombii.*

As a consequence of the absence of type material or description, nothing can be said about the nature of the species, the name remaining a *nomen nudum*. The following list of references to the name *Unio dacombii* was compiled in the main by Mr. Gill.

Selwyn, 1862, *Reports Relative to the Geological Survey of Victoria*, 1861, No. 2: 13.

Selwyn and Ulrich, 1867, Notes on the Physical Geography, Geology and Mineralogy of Victoria. *Official Record, Intercolonial Exhibition of Australasia 1866-1867, Intercolonial Exhibition Essays*, No. 3: 145-236.

Brough Smyth, 1874, *Reports of Progress, Geol. Surv. Victoria*, p. 35.

Ulrich, 1875, *A Descriptive Catalogue of the Specimens in the Industrial and Technological Museum (Melbourne), illustrating the Rock System of Victoria.* Melbourne. p. 82.

Etheridge, 1878, *A Catalogue of Australian Fossils.* London. p. 113.

Etheridge, 1881, *Papers Proc. Roy. Soc. Tasmania* for 1880: 19.

Tenison Woods, 1883, Proc. Linn. Soc. N.S.W., (1), 8: 44.

Murray, 1887, *Victoria, Geology and Physical Geography.* Melbourne. p. 96.

Johnston, 1888, *Systematic Account of the Geology of Tasmania.* Hobart. p. 156. (Erroneously listed from Western Australia.)

Unio daintreei Clarke (*nomen nudum*).

Unio daintreei "McCoy" Clarke, 1867, *Quart. Journ. Geol. Soc. London*, 23: 10.

Remarks.

This name is apparently an error for *Unio dacombii* "McCoy" Selwyn and may have been published through confusion with the fossil plant *Taeniopteris daintreei* McCoy, 1860, which was found at the Wannon River with *Unio dacombii* and was validly described in McCoy's *Prodromus*. *Unio daintreei* has apparently not been used again.

(?) Velesunio huttoni, nom. nov. (Plate xiii, figs. 1-3.)

Unio inflata Hutton, 1873, *Catalogue of the Tertiary Mollusca and Echinodermata of New Zealand in the collection of the Colonial Museum*, p. 25, sp. no. 66. *Type Locality*: Morley Creek, Southland, New Zealand. (Not *Unio inflatus* Studer, 1820; not *Unio inflatus* D. H. Barnes, 1823; not *Unio inflata* Cristofori and Jan, 1832; not *Unio inflata* Hecart, 1833, *fide* Sherborn.)

Unio inflata Hutton, 1887, Proc. Linn. Soc. N.S.W., (2), 1: 229.

Diplodon inflatus (Hutton), Suter, 1915, *New Zealand Geol. Surv. Palaeont. Bull.* No. 3, Pt. 2: 56, Pl. 1, figs. 1, *a* and *b*.

Diplodon sp. Suter, 1921, *New Zealand Geol. Surv. Palaeont. Bull.* No. 8: 94.

Description. (After Suter.)

"Shell rather small, oval, ventricose, inequilateral, concentrically striated, the umbones much corroded. Beaks at about the anterior third of length, directed forwards, and incurved, inflated. Anterior end short narrowly rounded, the dorsal margin slightly convex. Posterior end about twice as long as the anterior, and more broadly convex, the dorsal margin straight, slowly descending, basal margin broadly rounded. Sculpture consisting of fine and close, somewhat unequal concentric striae, interrupted by more conspicuous periods of rest; the umbones corroded, smooth, with a few diverging ridges produced by pressure upon the thin pliable layer. Hinge unknown."

Remarks.

Through the courtesy of Dr. Charles Fleming, Senior Palaeontologist, Geological Survey Branch, D.S.I.R., New Zealand, I have been able to examine the holotype of this species, which was thought to have been lost (Suter, 1921), but is still in the collection of the Geological Survey.

It is well described by Suter, as reprinted above, and little more can be said about the holotype. Additional material referable to this species has been loaned by Dr. Fleming, from two localities in the Ohai Valley, Southland. None of the specimens examined has perfect beaks, but even in the best of them there is no trace of beak

sculpture. Suter wrote "umbones . . . smooth", but this cannot be positively stated. None the less the shells recall in shape and variability the recent species of *Velesunio* from Australia, and on this basis, coupled with the apparent absence of sculptured beaks, the species is tentatively referred to the genus *Velesunio* Iredale.

The variation in shape is mostly due to elongation of the posterior end of the shell, as well as some variation in the slope of the dorsal margin, but the latter is probably due to distortion and breakage in some cases. One of the series from the Ohai Valley is the lot recorded by Suter (1921) as *Diplodon* sp. and for which he had proposed a manuscript name. Suter was unable to compare his specimens with the holotype of *Unio inflata* at the time, and so the name was not published.

If this species does in fact belong to the genus *Velesunio*, it is of considerable interest, as no species of velesunionine mussels occur in New Zealand today. The subfamily is probably the most primitive in this region, however, and appears to have existed in Australia since the Triassic. It is therefore not unlikely that a species of *Velesunio* could have developed in New Zealand during the Tertiary and since have become extinct.

Geological Age.—Hutton and Suter referred to the beds as Miocene, but Fleming informs me that all are Basal Oligocene (Whaingaroan) in age.

Dimensions.

Specimen(s).	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	M.H./T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Holotype	49	16	32	31	64	27	27
New Birchwood Mine, Ohai Valley. Mean of 9 specimens	50	11	22	32	64	25	21
Above Smith's No. 6 Coal Seam, Ohai Valley. Mean of 2 ..	58	13	23	33	57	27	28

Hyridella aucklandica (Gray).

Unio aucklandica Gray, Hutton, 1873, *Catalogue of the Tertiary Mollusca and Echinodermata of New Zealand in the collection of the Colonial Museum*, p. 25, sp. no. 65.

Diplodon menziesi aucklandicus (Gray), Suter, 1913, *Manual of the New Zealand Mollusca*, p. 941.

Remarks.

Hutton (1873) recorded the recent species *Hyridella aucklandica* (Gray) from a coal formation at Dunstan, Otago, but was doubtful as to the exact identity, as the specimen was poorly preserved. His brief description, without figures, is totally inadequate to determine the nature of the species which he had. Suter (1913), when describing the recent freshwater mussels of New Zealand, stated that this species (which he referred to the genus *Diplodon* Spix) occurred fossil "in the lignite beds of Dunstan, Otago, probably older Pliocene". Suter (1915) does not list the species in his Catalogue of the Tertiary Mollusca, so the age of the beds appears to be uncertain.

The location of Hutton's specimen is unknown. However, included in the material loaned by the New Zealand Geological Survey is a series of impressions in a fine indurated shale from quartzose coal measures on the Kawaran River, near Cromwell, Otago, belonging to the Taranaki Series of Miocene age. Two freshwater mussel species appear to be represented, including forms very similar to *H. aucklandica* and *H. menziesi*, two of the recent New Zealand species. One of the impressions is rather like the Australian species, *Hyridella depressa*, but could be a form of *H. menziesi*.

The form described by Etheridge as a variety of *U. aucklandicus* is treated next as a full species of the genus *Hyridella*.

HYRIDELLA WILKINSONI (Etheridge Jr.). (Plate xiii, fig. 4.)

Unio aucklandicus var. *wilkinsoni* Etheridge Jr., 1879, *Annual Report Dept. Mines*, New South Wales, for 1878, p. 169, Pl. 3, fig. 5. *Type Locality*: Home Rule Lead, Gulgong Goldfield, New South Wales, at a depth of 126 feet from the surface.

Unio aucklandicus var. *wilkinsoni* Etheridge Jr., Wilkinson, 1887, *Notes on the Geology of New South Wales*, 2nd ed., p. 76.

Description. (After Etheridge.)

"Shell oblongovate, very inequilateral, expanding a little posteriorly; anterior side very short and rounded; posterior side obliquely truncated and obscurely bi-angled; umbones quite anterior, decorticated and depressed; epidermis yellowish olive, delicately thread-striated on the posterior side, but almost quite smooth and shining on the anterior side and body of the shell; anterior muscle scars deep and well defined; pallial line well marked in the anterior portion.

"*Observations*: The state of preservation of the specimen does not permit of a more detailed description than the above, and as we have merely the exterior exhibited to us, the dental formula cannot be given. The characters of the anterior muscular impression and the pallial line are revealed by the accidental removal of the shelly matter, more especially in the left valve. During fossilization a slight amount of crushing has taken place. Otherwise the original form of the shell is perfectly well preserved."

To this can be added the following, based on a fine example of this species from the Victorian Pliocene or Pleistocene at Langi Logan Goldmine. The specimen is from the National Museum collection, No. P.16766.

Dorsal margin slightly elevated behind the beaks, then curving ventrally; posterior margin evenly rounded; ventral margin slightly sinuate in the middle; beaks situated at about one-sixth of the total length from the anterior end.

Remarks.

Etheridge, in describing this species, listed all the known recent species of freshwater mussels from Australia and concluded that it was most nearly related to *Unio aucklandicus* (Gray). Although the latter is a New Zealand species, it does resemble *wilkinsoni* in form, and is a member of the genus *Hyridella* Swainson. The form of the fossil shell leaves no doubt that it is a species of *Hyridella*, closely related to present-day forms, even though the key criterion for that genus, the beak sculpture, is not discernible. In fact it is very similar to the present-day species *Hyridella drapeta* (Iredale), to which *wilkinsoni* may well be ancestral. *H. aucklandica* could also have been derived from this source, as it seems likely that the New Zealand mussel fauna arose by a series of introductions from the Australian mainland.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	M.H./T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Holotype (from figure), left valve	50	15	30	22	44	18	?
Right valve	53	15	27	26	49	24	?
Langi Logan Goldmine. N.M.V. P.16766	60	10	17	27	45	23	?
H. drapeta I. Manning R., N.S.W. (A.M.). Mean of 5..	66	15	23	37	56	32	21

Hyridella wilkinsoni is a little more elongate than typical specimens of *H. drapeta* from New South Wales and Victoria, though it is approached by some northern populations. The name *wilkinsoni* has many years' priority over *drapeta*, and partly

for this reason the fossil is here admitted as a full species rather than a phyletic subspecies, because of the nomenclatural confusion which would result if the latter rank were given it.

Apparently only one specimen, the holotype, was found, and Etheridge was at the British Museum at the time of its description, but the type is apparently not in that collection. It cannot be located in the collection of the N.S.W. Geological Survey, so its whereabouts remain unknown.

Geological Age.—Etheridge gave the age of the Home Rule deep lead as Pliocene, though it may be older than this, possibly Oligocene. The Victorian specimen is of either Pliocene or Pleistocene age.

PROHYRIA, gen. nov.

Type species, Unio johnstoni Etheridge Jr., 1881.

Description.

Medium-sized to large freshwater mussels of the subfamily Velesunioninae, the anterior end moderately to markedly swollen, the posterior end drawn out into a bluntly rounded rostration, which is of maximum length at a position in the middle of the height of the shell; hinge well developed, with large cardinal teeth.

Remarks.

This genus is erected for two species of Australian fossil freshwater mussels, the type species *Unio johnstoni* from the Tertiary of the Launceston Basin, Tasmania, and *Unio eyrensis* Etheridge from the Triassic at Leigh's Creek, South Australia. Although there is an enormous time gap between these two occurrences, this is of little importance in freshwater mussels, which from all evidence evolve very slowly. The genus does not occur today, although there is a vague resemblance in form to the New Guinea species, *Microdontia anodontaeformis* Tapparone Canefri, and it is possibly genetically related. It must be remembered that taxonomic characters in the freshwater mussels are few and far between, and that fossilization renders particularly obscure those which are of most value, the hinge characters, muscle scars, and beak sculpture. Thus fossil genera will always be rather insecurely based, and must depend on similarities of form, which could be quite misleading.

PROHYRIA JOHNSTONI (Etheridge Jr.). (Plate xiii, figs. 6, 7.)

Unio johnstoni Etheridge Jr., 1881, *Papers & Proc. Roy. Soc. Tasmania* for 1880, pp. 20-21, figs. "1 & 2" (two figs. at top of first plate, unnumbered). *Type Locality*: Tamar River, between Whirlpool Reach and Georgetown, Tasmania.

Unio sp. Johnston, 1874, *Papers & Proc. Roy. Soc. Tasmania* for 1873, p. 47, Pl. 2, fig. 11.

Unio johnstoni Etheridge, Johnston, 1887, *Papers & Proc. Roy. Soc. Tasmania* for 1886, p. 134.

Unio johnstoni Etheridge, Johnston, 1888, *Systematic Account of the Geology of Tasmania*, Hobart, p. 274, Pl. 34, figs. 1 and 1*a*.

Description. (After Etheridge.)

"Shell transversely elongated, acuminated towards the posterior; anterior end convex and very gibbous; posterior end bluntly pointed, and gradually acuminated from the anterior end; anterior margin obliquely rounded downwards; posterior margin narrow and rounded; hinge line straight, gradually descending from the umbones towards the posterior end; ventral margin gently rounded or convex, entire, no sinuation; flanks of the shell most convex at a point on the anterior end midway between the beaks and the ventral margin, whence the sides rapidly decline to the latter, gradually flattening towards the pointed posterior end; diagonal ridge inconspicuous, rounded; posterior slope small; umbones large, broad, becoming somewhat flattened by decortication; shell substance moderately thick; surface coarse and rough on the anterior end, with strong, prominent, concentric lines of growth, which gradually flatten out into laminae on the posterior end; bent upwards at the rounded diagonal ridge; no sign of radiatory lines; dental and muscular characters unknown."

Five specimens of this well-characterized species are available in the collection of the Australian Museum, Nos. F.117, F.1653, and F. 17462-64, all from the Launceston Basin. They contribute little in the way of descriptive material, apart from the important fact that the beaks appear to be unsculptured. This indicates an affinity with the subfamily Velesunioninae, and agrees with the condition found in *Unio eyrensis* Etheridge.

Remarks.

Etheridge based this species on material found in the Milligan collection of fossils in the British Museum and considered Johnston's earlier record of *Unio* sp. from the Tertiary Muddy Creek beds on the West Tamar River to be the same form.

One of the Australian Museum specimens shows that the posterior end of the shell becomes very acuminated and this suggests that this species lived in a muddy environment. The present species differs from the other species in the genus, *Prohyria eyrensis*, in being more swollen anteriorly and more finely acuminate posteriorly.

The holotype of *P. johnstoni* is in the Milligan collection, British Museum No. 96928. Etheridge wrote "9628" in error.

Geological Age.—According to David (1950) the age of the beds is Oligocene.

Dimensions.

Specimen(s).	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	M.H./T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Holotype (from Etheridge, and figure)	97	22	23	51	52	43	45
A.M. F.117	126	25	20	64	52	58	55
A.M. F.1653	60	12	20	29	50	24	24
A.M. F.17462–64. Mean of 3..	84	20	24	44	55	39	34

* PROHYRIA EYRENSIS (Etheridge Jr.). (Plate xiii, figs. 8–12.)

Unio eyrensis "Tate" Etheridge Jr., 1892, (in) H. Y. L. Brown, Reports on the Coal-Bearing Area in the Neighborhood of Leigh's Creek, *South Australian Parliamentary Papers*, 1891, No. 158: 11, Pl. 3, figs. 1-3. *Type Locality*: Black Hills, near Leigh's Creek Railway Station, S.A.

Unio gregorianus "Etheridge m.s." Clarke, 1886, *Catalogue of Exhibits of the Queensland Court; Colonial and Indian Exhibition, London*, 1886, p. 165 (*nomen nudum*).

Unio gregorianus "Etheridge m.s." Etheridge Jr., 1892, (in) H. Y. L. Brown, Reports on the Coal-Bearing Area in the Neighborhood of Leigh's Creek, *South Australian Parliamentary Papers*, 1891, No. 158: 11 (*nomen nudum*).

Unio eyrensis "Tate" Etheridge Jr., 1892 (in) Jack and Etheridge, *Geology and Palaeontology of Queensland and New Guinea*, Brisbane, p. 389.

Unio eyrensis Etheridge, David, 1950, *Geology of the Commonwealth of Australia*, Vol. 1: 422 and 429.

Remarks.

This species was first described in 1892 from specimens received from Tate and H. Y. L. Brown, obtained at Leigh's Creek, South Australia. Etheridge adopted Tate's manuscript name "*eyrensis*". Previously, however, Etheridge had given a manuscript name (*Unio gregorianus*) to a specimen from the Bundanba Mine on the Ipswich Coalfield, Queensland. Clarke used this name in 1886 as a *nomen nudum*. When describing *U. eyrensis* for the first time, Etheridge commented on the occurrence of *U. gregorianus*, noting that it was close to *U. eyrensis*. He did not describe the Bundanba specimen as *gregorianus* at that place, and the name remained a *nomen nudum*. Etheridge later (1892, in Jack and Etheridge) described in detail a second occurrence

* Out of chronological order.

of *U. eyrensis*, the locality being the Bundanba Mine, Queensland, but made no reference to the name *Unio gregorianus* there. It seems certain, however, that this Queensland specimen was the same shell as that which had been previously referred to as *U. gregorianus*, and that name is here listed as a synonym. Apparently Etheridge had decided in the intervening period that the two forms were after all referable to the same species, and either overlooked, or deliberately omitted, any reference to his earlier manuscript name.

No figure was given of the Bundanba specimen, but the description suggests that it was in fact the same as *U. eyrensis*.

Description. (After Etheridge.)

"Shell elongately or transversely nasute, or triangularly wedge-shaped, decreasing rapidly in convexity towards the posterior end; umbonal region fairly gibbous and convex, but the flanks decreasing rapidly towards the ventral margin, within the cast a more or less pronounced sulcus extending from behind the umbones to near the centre of the ventral margin. Hinge line straight, ventral margin rounded, passing rather sharply upwards into the anterior and posterior margins. Anterior end small, somewhat acutely curved, posterior end narrow, obtusely pointed. Umbones eroded; ligament long, large, and strong; cardinal teeth large; lateral teeth strong, diverging downwards from the hinge line or dorsal margin. Anterior adductor impressions obliquely conical, but not superficially large, vertically striated, and bounded posteriorly by a strong, subdentate ridge; supplementary anterior scars not visible; posterior adductor impressions feeble. Sculpture of coarse irregularly concentric lines.

". . . In all the specimens there is evidence that the umbones were very much eroded, and the surface in one or two was covered by a coarsely lined 'epitheca'. The hinge teeth appear to have been of the usual characters, a large cardinal in each valve interlocking, and now represented by casts; and long lateral teeth indicated by slits along the impression of the hinge line possessing a slight oblique downward trend."

The description of the Bundanba specimen differed slightly; the length was more than twice the height, and the anterior end was slightly produced.

I have been able to examine a specimen of this species from the National Museum collection, No. P.16767, which possesses the characteristic shape of the genus *Prohyria*, to which this species is referred. An internal cast in the Australian Museum, No. F.9081, from the Tate collection, is possibly a paratype and, although the posterior end is fractured off, shows the characters of the hinge and anterior muscle scars well, and again is similar to *Prohyria johnstoni* in form. A further specimen from the National Museum may belong to this species. It is No. P.16764, from Lake Eyre, and appears at first sight to be more regular in shape than the other specimens, with the beaks more medially situated. However, this may be due to breakage, as the growth lines indicate that the shape of the young shell was more like the *Prohyria* form. This specimen has perfect beaks, which are quite smooth, confirming the Velesunionine nature of the species, if indeed the specimen belongs here.

Types.

The species was described while Etheridge was Palaeontologist at the Australian Museum and the New South Wales Geological Survey, but was based on specimens received from South Australia. Thus the types are probably in South Australia, but do not appear to be in the Museum collection. As mentioned above, the specimen in the Australian Museum is possibly a paratype, while the National Museum specimen No. P.16767 is also probably from the type series. The Bundanba specimen should be in the collection of the Queensland Geological Survey (see below under *U. ipsviciensis*).

Geological Age.—According to David (1950), the age of the Leigh's Creek series is Triassic. The Queensland specimen was from ironstone in brick-clay overlying coal at the Bundanba Mine. The coal belongs to the Ipswich Series (Triassic), but the beds overlying these, the Bundanba Series, are of Lower Jurassic age. David (1950) notes that *U. eyrensis* occurs in the Denmark Hill shales at the top of the Ipswich Series and also records *Unio* from the Bundanba series. Presumably the former is the Bundanba Mine *U. eyrensis*.

Dimensions.

Specimen(s).	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	Beak Height.	M.H./T.L.	Width.
	mm.	mm.	%	mm.	mm.	%	mm.
Holotype (from Etheridge, and figure)	85	20	24	45	33	53	39
A.M. F.9081	68+ (=85 est.)	16	19	45	35	53	37
N.M.V. P.16767	102	24	24	59	49	58	50

ALATHYRIA TAMARENSIS (Etheridge Jr.).

Anodonta tamarensis Etheridge Jr., 1881, *Papers & Proc. Roy. Soc. Tasmania* for 1880, pp. 22-23, figs. "3 & 4" (two figs. at bottom of first plate unnumbered). *Type Locality*: Tamar River between Whirlpool Reach and Georgetown, Tasmania.

Anodonta tasmanica [sic] Johnston, 1887 (err. pro *A. tamarensis*), *Papers & Proc. Roy. Soc. Tasmania* for 1886, p. 131.

Anodonta "tasmanica Etheridge" Johnston, 1888, *Systematic Account of the Geology of Tasmania*, Hobart, p. 274, Pl. 34, figs. 2 and 2*a*.

Unio tamarensis (Etheridge), Dennant and Kitson, 1905, *Rec. Geol. Surv. Victoria*, 1: 123.

Description. (After Etheridge.)

"Shell transversely-obliquely-oval, generally compressed, in marginal outline obliquely hatchet-shaped; anterior and posterior ends compressed, sharp at the margins; anterior outline (margin) rounded; posterior outline obliquely truncated in the upper portion, rounded in the lower; hinge line horizontal, straight; ventral margin rounded obliquely from the anterior end; beaks near the centre of the hinge, but, as regards the whole shell, more anterior, not inflated, but much decorticated; diagonal ridge and posterior slope to all appearances not defined; convexity of the shell not great, the most convex point being below the beaks, at about the middle of each valve; angle formed by the hinge line and truncated posterior margin = 143°. Shell substance much eaten; surface decorticated, but apparently covered with numerous concentric superimposed layers of epidermal matter, following the marginal outline of the shell. . . . With the hinge characters I am quite unacquainted, the reference to *Anodonta* being made purely on external resemblance."

Remarks.

I have seen no specimens of this species, but the shape of the shell, the size and general appearance leave little doubt that it is related to the present-day genus *Alathyria* Iredale, and it is consequently listed as such. It has nothing to do with *Anodonta*, which is a holarctic genus, of comparatively recent origin, which has never occurred in this region. Etheridge found the holotype of this species in the Milligan collection in the British Museum, along with *Prohyria johnstoni*, and it is apparently known only from the unique holotype. The occurrence in Tasmania of a species of *Alathyria* in Tertiary time is of interest, as that genus is at present confined to the mainland of Australia and occurs for the most part in the warmer parts of the continent. It is possible that the genus has become extinct in Tasmania owing to the progressive cooling of the southern regions of the continent since the beginning of the Tertiary.

The holotype is in the Milligan collection, British Museum No. 96929.

Geological Age.—According to David (1950), the age of the beds of the Launceston Basin is Oligocene. Mr. Gill informs me that there is evidence that these beds are older, probably of Eocene age.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	M.H./T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Holotype (from Etheridge, and figure)	91	30	33	57	63	49	32

UNIO MURRAYI Murray (*nomen nudum*).

Unio murrayi "McCoy" Murray, 1887, *Victoria, Geology and Physical Geography,* Melbourne, p. 96.

Remarks.

Murray writes as follows (p. 96): "Only two species of fossil fauna have been discovered in the Victorian Mesozoic rocks, viz. *Unio dacombi* (McCoy), found in the rocks of the Wannon, and *Unio murrayi* (McCoy), discovered in a piece of sandstone from near Loutit Bay." No record of such a species having been described can be found in the literature available to me. In the letter from McCoy in the National Museum (see above under *Unio dacombii*) the following is written: "The fossil specimen No. 3839 obtained by Mr. R. A. F. Murray and handed to me is an example of *Unio murrayi* (McCoy). This specimen is of great interest as the second example of a fossil of the animal kingdom from the Mesozoic coal-bearing formations of Victoria . . . . This . . . (with *Unio dacombii*) . . . will be figured and described in a forthcoming Decade of the Palaeontology of Victoria."

Mr. Gill has been able to locate the "type" specimen in the collection of the National Museum, No. P.16772-73, and it is identifiable by the No. 3839 on the specimen. Rather than validate the name by describing the specimen here, I prefer simply to state that it is a smallish species, rather similar to present-day forms of the genus *Velesunio*. It is, however, not very well preserved and it seems better to leave the name as a *nomen nudum* until better material is available. The relationship with *Velesunio* is doubtful, as the time gap between the age of the Victorian Coal Measures (Jurassic) and the present day is so great, and the taxonomic characters of *Velesunio* so negative that the resemblance could be due to convergence as much as genetic affinity.

Locality and Geological Age.—The specimen was found between Loutit Bay and Airey's Inlet in the Otway District, in a piece of sandstone. These rocks are of Lower Jurassic age according to Gill (personal communication).

PROTOVIRGUS, gen. nov.

Type species, Unio dunstani Etheridge Jr., 1888.

Description.

Mesozoic freshwater mussels of uncertain affinity, with very elongate shells, tapering posteriorly to a bluntly rounded posterior end; small to medium sized, the maximum height less than 48% of the total length; beaks apparently unsculptured, situated very much towards the anterior end, at between one-fifth and one-sixth of the total length; the maximum height of the shells at the position of the beaks, or just posterior thereto.

Remarks.

The shells described by Etheridge as *Unio dunstani* are very elongate freshwater mussels which differ from all other species, both recent and fossil, described from Australia. The occurrence, in New Zealand, of an undescribed Cretaceous species which is very similar in form to *U. dunstani* prompts me to erect the above new genus to include them. The name is based on the external resemblance in form to the present-day New Guinea genus *Virgus* Simpson, but is not intended to imply any direct genetic relationship.

PROTOVIRGUS DUNSTANI (Etheridge Jr.). (Plate xiv, fig. 8.)

Unio dunstani Etheridge Jr., 1888, *Mem. Geol. Surv. New South Wales*, Palaeontology, No. 1: 11-12, Pl. 1, figs. 11-19. *Type Locality*: Ironstone bands in the Wianamatta Shale, Gibraltar Tunnel, Bowral.

Description. (After Etheridge.)

"Shell narrow, very transversely elongated, thin and compressed throughout its length, approaching to linguliform. Cardinal margin very long and slightly arched, ventral margin comparatively straight, sharp and knife-edge like. Anterior end very much compressed, the margin rounded, posterior end thin, attenuated, and very much compressed towards the margins, which are obliquely rounded, the posterior-ventral angle being almost pointed. Umbones placed close to the anterior end, small, and laterally flattened; flanks of the shell almost flat, diagonal ridges and posterior slopes but very faintly developed, the latter very faintly concave, and lost in the compressed posterior end. Anterior adductor impression fan-shaped, situated very high up under the anterior cardinal margin; umbonal scars very strongly marked, two immediately behind the adductor scars in a line, and close under the cardinal margin, the others clustered on the flank; posterior adductors faint and shallow. Pallial line well marked, with the impression of fibre scars at the anterior end. Ornament of very closely set concentric lines, with irregular glossy growth laminae.

"Observations . . . . It possesses the unmistakable outline of one section of the genus *Unio*, represented by such forms as *Unio grayanus* Lea . . . ."

The types are in the Australian Museum, but little can be added to the description from them. The beaks appear to be unsculptured, but are not perfect in any of the specimens. Etheridge erred in one important fact; the size of the figures on Plate 1, figs. 13-16, is given as half magnification when it should have been two times. This reduces the size of the shells from about 120 mm. in length (according to Etheridge's plate) to about 30 mm.

Remarks.

This species is readily separable from the other forms found in the Wianamatta Series by its elongate shape. As Etheridge indicated, it resembles the recent species *Lanceolaria grayanus* (Lea) in shape as much as it does *Virgus* Simpson, but once again the resemblance is undoubtedly superficial. It is probable that all three forms are the products of similar, but independent sets of selective factors, possibly associated with life in muddy streams.

Etheridge failed to make a holotype, the specimens in the Australian Museum, Nos. F. 35780, 35765, 35776, 35777, 35779 and 35693, being syntypes. The largest and most perfect specimen (Etheridge's figure No. 13) is here selected as lectotype (No. F.35776).

Geological Age.—The species occurs in the transition beds between the Hawkesbury Sandstone and the Wianamatta Group, which are considered to be Upper Triassic in age.

Dimensions.

Specimen(s).	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	M.H./T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Lectotype	37	7	19	12	32	11	5
Lectoparatypes. Mean of 4 ..	28+	6	21	12	43	10	5

PROTOVIRGUS FLEMINGI, sp. nov. (Plate xiv, figs. 1-3.)

Description.

Shell elongate, length from 2½ to 3 times the maximum height; beaks very anterior, situated about 20% of the total length from the anterior end. Anterior margin regularly rounded, ventral margin almost straight or slightly convex; dorsal margin behind the

beaks falling away gradually towards the ventral margin; posterior margin sharply rounded; the shell rather wedge-shaped in lateral aspect. Surface of the shell smooth; beaks apparently unsculptured; shell surface marked with fine lines of growth. Shell apparently thin, compressed; hinge ligament prominent. Hinge teeth and muscle scars unknown.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	M.H./T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Holotype	58	11	19	20	35	18	?
Paratype N.Z.G.S. 5264 ..	53	11	21	20	38	17	?
Paratype N.Z.G.S. 5394 ..	52+	12	24	25	<48	20	?

The width of the shells cannot be measured, as the types are all embedded in a hard, slaty matrix (with the valves spread open in the holotype), but the shells seem to have been fairly compressed, probably not more than 10 or 15 mm. in total width of adjoined valves.

Types.

The holotype consists of counterparts of both valves, the outer surface only being visible. It is portion of lot No. 5364 in the collection of the New Zealand Geological Survey. A paratype is also present in the same lot, and consists of a perfect left valve. The specimens are in a fine slate and come from the Morgan Mine, Rewanui, Mawheranui Survey District. Additional paratypes are from lot No. 5394, New Zealand Geological Survey, from the Paparoa Coal Measures, Morgan East Dip, Liverpool Colliery.

Geological Age.—Dr. Fleming, to whom this fine species is dedicated, informs me that these beds are part of the Paparoa Group, of Upper Cretaceous age (approximately Lower Senonian).

Remarks.

Only a few well-preserved specimens are available, but they are so vastly different from all other New Zealand species that they demand description. The age of the fossils (Upper Cretaceous) is not too different from that of the Wianamatta species *P. dunstani*, which is Upper Triassic. The New Zealand species is considerably larger than the best available specimen of *P. dunstani*, but the latter probably grows to a larger size than the isolated specimens suggest. *P. flemingi* is more tapering in form than *P. dunstani*, which shows relatively little taper.

The Cretaceous *P. flemingi* is possibly a derivative of *P. dunstani*. The latter species may well have persisted through into Jurassic time in Australia. Unfortunately the Jurassic forms known from Victoria are undescribed and only *Unio murrayi* has been examined. It is possible that one of these *nomina nuda* was based on a species of *Protovirgus*.

It should be noted that one specimen associated with the Liverpool Colliery paratypes of *P. flemingi* (NZGS 5394) appears quite different, recalling some of the recent hyridelline species. It is not described here, however, for lack of sufficient material.

Genus Unionella Etheridge Jr.

Unionella Etheridge Jr., 1888, *Mem. Geol. Surv. N.S.W.*, Palaeontology, No. 1: 12.
Type species by original designation, *U. bowralensis* Etheridge Jr., 1888.

Remarks.

Etheridge (1888) described four species of small freshwater bivalves from the Wianamatta "Shales" of the Sydney district. Of these, one species is very different and has been treated above under the name *Protovirgus dunstani*. The other three are all fairly similar, small species, but Etheridge placed one of them tentatively in *Unio*,

though he was doubtful of its precise affinities, and the other two in a new genus, *Unionella*. Re-examination of all the type material of these three species has convinced me that they all belong to the one genus, and for this *Unionella* is available. It should be noted that the name has been missed by Neave and other recorders, and anticipates Haas' *Unionella* for recent forms. However, I am not sure that there are in fact three distinct species, especially in view of the fact that all three forms occur together in the one horizon. The forms differ slightly in shape and degree of obesity, but basically are rather similar. In fact, it is probable that Etheridge himself confused at least one of the shells (one of his types of *U. bowralensis* being closer to *U. wianamattensis*). It seems likely, on the basis of a knowledge of the variability of present-day freshwater bivalves, that all three are polymorphs or perhaps different ecophenotypes of one biological species. Furthermore, I am not at all sure that the shells have anything to do with the freshwater mussels. Etheridge was in some doubt as to their affinities, suggesting either Unionidae or Cyrenidae (= Corbiculidae), but he did state that they apparently did not possess the distinguishing features of the palaeozoic genera *Carbonicola* McCoy and *Anthracosia* King (Anthracosiidae). Study of some of the literature on this family has led me to the belief that they are in fact members of the same lineage. The Wianamatta shells bear a striking resemblance to some of the species figured in Trueman and Weir's (1946-54) monograph of this group, and the hinge characters seem to agree fairly well. Unfortunately the family Anthracosiidae in England and Europe is essentially Carboniferous. However, allied genera assigned to the family are recorded from Russia and also from the Karoo System of South Africa. The age of these beds appears to be late Permian, and the South African forms figured by Amalitsky (1895) are remarkably similar in form to the Wianamatta species, though they appear to differ in hinge characters. I cannot, at the present time, take this study any further, but wish to put forward the suggestion that *Unionella* is in fact a relict group of Anthracosiidae, which apparently flourished in Eurasia during late Palaeozoic time, but also became established in the southern continents towards the close of the Permian. Although it is not recorded from the Australian Permian, it may have only reached this portion of Gondwanaland at the beginning of the Triassic, by which time the group had become extinct in Europe.

It is also of interest to note that the variation observed in communities of Carboniferous Anthracosiidae is frequently as great as that which separates the three species named from the Wianamatta Group, and this lends strength to the hypothesis that *Unionella* includes but one variable species. However, the forms are described separately here for the sake of completeness, and it must be left to someone else to determine their true nature.

Description.

In describing the genus Etheridge commented as follows: "The undoubtedly eroded condition of the umbones indicates either Unionidae or Cyrenidae as their natural resting place; but with no genus in either family do they otherwise agree. The single condition of the adductor muscular impression and the faintly marked state of the posterior clearly separate the present shells from *Unio*, to which they are, however, related through the umbonal muscular scars and the exterior ligament. The absence of lateral teeth, which I believe do not exist in the present genus, shows a transition towards *Anodonta*, but there are no other characters in common . . . . The hinge structure, although not wholly known, is still sufficiently apparent to separate *Unionella* from any of the Cyrenidae. I have not been able to actually isolate a hinge line, but in numerous cases where the umbones have been dissolved and the anterior end of the shell decorticated, we are presented with the following features: Posterior to the umbones the hinge is perfectly straight; but in front of them there is a constant flexure, or double flexure, which seems to indicate the presence of cardinal teeth. I cannot, however, account for this appearance in any other way . . . . In some instances there is probably little difference between the dental formula of . . . *Unio* . . . and the structure observed in the Bowral shells. The eroded state of the umbones is so very

marked in both the typical species, so much so in some individuals as to almost expose the interior cavity of the shell and render the umbonal muscular scars outwardly perceptible."

The following brief generic diagnosis is based on all three species:

Shells small, somewhat swollen, slightly or not at all winged posteriorly; the posterior ridge more or less prominent; beaks situated towards the anterior end, swollen, unsculptured; hinge with one cardinal tooth in each valve, fitting into a socket in the opposite valve. The maximum height about 50% of the total length. Shell surface not sculptured, marked only with fine growth lines, sometimes with prominent rest marks.

UNIONELLA WIANAMATTENSIS (Etheridge Jr.). (Plate xiv, figs. 4-5.)

Unio wianamattensis "Etheridge" Wilkinson, 1887 (*nomen nudum*), *Notes on the Geology of New South Wales*, 2nd ed., p. 76.

Unio wianamattensis Etheridge Jr., 1888, *Mem. Geol. Surv. New South Wales*, Palaeontology, No. 1: 10, Pl. 2, figs. 1-4.

Type Locality: Messrs. Goodlet and Smith's Brick Quarry at Crown Street, Waterloo, and Surry Hills.

Description. (After Etheridge.)

"Shell ovate-obliquely oblong, laterally compressed, thin. Dorsal margin or hinge line straight posteriorly, angulated at the anterior end, but in its entire length not as long as the shell; ligament small, and projecting but little above the dorsal margin. Ventral margin nearly straight, with a slight sinus at the middle. Anterior end small, very much compressed, and with the margin rounded; posterior end compressed, the margin obliquely truncated. Umbones small, obtuse, and ill defined, sometimes eroded; diagonal ridge well marked, although not strong; the flanks of the valves decrease rapidly in convexity from this ridge to the ventral margin, but an almost imperceptible sinus traverses them upwards from the ventral marginal inflection. Posterior slopes small, steep, and not concave. Internal characters of the cardinal margin unknown. Pallial line not deeply impressed. Small, deep, muscular pits, more or less arranged in a semicircle, occupy the umbonal cavity; anterior and posterior adductor impressions unknown. Surface with fine concentric ridges, subdivided by distant subimbricating growth laminae, the whole covered with a very regular and beautiful microscopically and longitudinally wrinkled epidermis."

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L. / T.L.	Maximum Height.	M.H. / T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Lectotype F.35775	16	4	25	8	50	7	5
Lectoparatype F.35773 ..	15	4	27	8	53	7	4
U. bowralensis, syntype F.35767	16	4	25	9	56	8	5

Remarks.

As indicated above under the remarks on the genus, this species, though classified tentatively by Etheridge in *Unio*, seems to belong with the other small species in *Unionella*. The type series of this form came from Waterloo, but included among the separated specimens are some which are closer to *U. bowralensis*. Also, as mentioned above, one of the syntypes of *U. bowralensis* is much closer to the *wianamattensis* form and is included below in the table of dimensions.

Little further can be added to Etheridge's description; the hinge characters are still unknown.

No holotype was selected for this species, the syntypes being numbers F.35773, F.35775, F.35781 in the collection of the Australian Museum. Of these, No. F.35775 is the most perfect isolated specimen, and is here selected as lectotype, and is the specimen figured on Plate 2, figs. 1, 2 and 3. Other specimens are available from Croydon, but the specimens from Surry Hills recorded by Etheridge are not present.

Geological Age.—The beds from which this species was taken are among the transition beds between the Hawkesbury Sandstone and the Wianamatta Group, and are of Upper Triassic age.

UNIONELLA BOWRALENSIS Etheridge Jr. (Plate xiv, fig. 6.)

Unionella bowralensis Etheridge Jr., 1888, *Mem. Geol. Surv. New South Wales*, Palaeontology, No. 1: 13, Pl. 1, figs. 21-23, Pl. 2, figs. 8-14.

Type Locality: Ironstone bands in the Wianamatta Shale, Railway Cutting near Gibraltar Tunnel, Bowral, New South Wales.

Description. (After Etheridge.)

"Shell short, somewhat nasute, moderately convex, compressed and rather sharply produced posteriorly. Cardinal margin to some extent arched, ligament small, short; ventral margin slightly convex. Anterior end shorter and much more gibbous than the posterior; margin rounded. Posterior end small, obtusely pointed; margin rounded, obliquely so above. Umbonal region and body of the shell gibbous, and rapidly declining to the ventral margin. Umbones depressed and inconspicuous; at times much eroded; diagonal ridge rounded, inconspicuous; posterior slope hardly differentiated from the general body of the shell. Anterior adductor impressions deep; umbonal scars extending in a line from the anterior adductor into the umbonal cavity, and there clustered. Ornament of fine concentric lines, with distant laminae of growth.

"Obs. . . . This, the most abundant form at Bowral, is distinguished from (*U. carnei*) by its much shorter and nasute outline. The cardinal margin is shorter and the upper part of the posterior margin more obliquely directed. The flanks of the shell also appear to be more evenly rounded."

Remarks.

This form, the type species of *Unionella*, is the most distinct of the three and is characteristically swollen anteriorly, with the posterior-ventral portion of the shell produced to an almost sharp point. As mentioned above, it is included among the syntypes of *U. wianamattensis*. Little further can be added to Etheridge's description from the material available in the Australian Museum. This includes the syntypes, Nos. F.35763, F.35767 (= *U. wianamattensis*), F.35768, F.35769, F.35770, F.35771, F.35772, F.35774, and a block of specimens of this species and *Protovirgus dunstani*, F.35693. No holotype was selected, and I therefore select specimen No. F.35770 as lectotype. This is the specimen figured on Plate 2, figure 12, and is perhaps the most typical of this form; beside this, it also shows the hinge characters of the species well. The latter, which are mentioned in the genus description, consist of a large cardinal tooth in each valve, fitting into an opposing socket in the opposite valve.

Geological Age.—This species occurs at the same horizon and locality as *Protovirgus dunstani*, and the beds are of Upper Triassic age.

Dimensions.

Specimen(s).	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	Beak Height.	M.H./T.L.	Width.
	mm.	mm.	%	mm.	mm.	%	mm.
Lectotype	13	4	31	7	6	54	5
Lectoparatypes. Mean of 4, F.35771, 768, 769 and 765 ..	10	4	40	7	5	70	5

UNIONELLA CARNEI Etheridge Jr. (Plate xiv, fig. 7.)

Unionella carnei Etheridge Jr., 1888, *Mem. Geol. Surv. New South Wales*, Palaeontology, No. 1, 14, Pl. 1, fig. 20, Pl. 2, figs. 5-7.

Type Locality: Ironstone bands in the Wianamatta Shale, Railway Cutting near Gibraltar Tunnel, Bowral, New South Wales.

Description. (After Etheridge.)

"Shell quadrangular-oblong, longer than high, thick, produced posteriorly. Cardinal margin long, erect, and straight, but not as long as the shell; ligament small, short. Ventral margin straight. Anterior end small, the margin rounded; posterior end produced, somewhat obliquely truncated, and slightly produced ventrally. Umbonal region and body of the shell towards the posterior broad and gibbous; umbones depressed and rather incurved, usually very much eroded, placed at about one-fourth from the anterior end; diagonal ridge very prominent and strongly marked; sharp towards the umbones; posterior slope wide and flattened, or inclined to the concave, becoming straight-walled under the erect cardinal margin. Anterior adductor impression elongately triangular, strongly marked; posterior impression on the diagonal ridge; umbonal scars similar to those of the last species (*U. bowralensis*), and very strongly marked. Ornament consisting of very fine regular lines, with distant laminae of growth, but the former sharply sinuous or deflected in the region of the anterior adductor.

"Obs.—The quadrangular outline, erect and straight hinge line, and very marked diagonal ridge are characters not met with in the preceding species.

"A peculiar inflection of the fine ornamenting lines of the surface is observable in *U. carnei*. In front of the pronounced anterior cardinal muscular scars the strong ridge separating the latter from the body of the shell is represented outwardly by a slight depression of the surface or sinus. In passing over this, the fine linear ornament is waved or inflected, and becomes a very important feature of this species. Sometimes it is very marked, at others faint, but invariably present in one form or the other."

Remarks.

This form, which is larger and relatively longer than either *bowralensis* or *wianamattensis*, is represented by only three specimens in the material available, Nos. F.35764, F.35766 and F.35778 in the Australian Museum collection. One of these specimens (F.35778) is rather similar to *wianamattensis* in form, but the other two are characterized by the marked posterior ridge, the swollen form of the shell, and the elevation of the posterior dorsal margin.

All three specimens are syntypes, and of these, No. F.35766 is here chosen as lectotype, being the specimen figured on Plate 1, fig. 20, and the better preserved of the typical *carnei*.

Geological Age.—As in the last species, with which this form is apparently sympatric, the beds are of Upper Triassic age.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	M.H./T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Lectotype	18	5	28	9	50	7	8
Lectoparatype F.35764	18	6	33	9	50	8	8
Lectoparatype F.35778	17	3	18	8	47	7	7

"ANODONTA" GOULDII Johnston.

Anodonta gouldii Johnston, 1888, *Systematic Account of the Geology of Tasmania*, Hobart, p. 84, Pl. 34, fig. 5.

Remarks.

This species is mentioned by Johnston (p. 84) as coming from clay or sandy slate beds at Fingal, Tasmania, and is called *Anodonta gouldii* on that page. No description

is offered, but on Plate 34, along with other freshwater mussel species, *A. gouldii* is figured and the specific name is therefore valid. According to David (1950), the age of the Fingal Slates is either Upper Silurian or Lower Devonian, and they are therefore very much older than the earliest known fossil freshwater mussel.

The figure shows a shell which does resemble a freshwater mussel, but it is so poor that it could represent almost any bivalve. Many important details are not shown and little further can be said about the species until the type is located and examined. I feel sure that it will prove to belong to some other group of pelecypods, unless some error in locality or horizon has occurred.

The type is probably in the Tasmanian Museum, Hobart.*

"UNIO" ETHERIDGEI Johnston.

Unio etheridgei Johnston, 1888, *Systematic Account of the Geology of Tasmania*, Hobart, Pl. 34, figs. 4 and 4*a*, plate caption.

Remarks.

Once again Johnston has failed to describe a species which is figured and named in the plates of his Geology of Tasmania. This form does not receive even as much as a mention in the text, but the plate caption bears the species name and the locality—Launceston Tertiary Basin.

The shell does not look like a freshwater mussel at all, but is probably one of the large brackish water shells of the family Geloinidae, a tropical group which occurs today in the waters of northern Australia and elsewhere. Although this group does not occur in Tasmania today, it could well have done so under the warmer climatic conditions which existed during the Tertiary. Once again, examination of the type material, possibly preserved in the Tasmanian Museum,* is the only way that the nature of this form can be determined. In either case, the specific name is validly introduced, the figure theoretically constituting sufficient description.

MESOHYRIDELLA, gen. nov.

Type species, *Unio ipsviciensis* Etheridge Jr., 1892.

Description.

Small freshwater mussels of uncertain affinity, but possibly belonging to the subfamily Hyridellinae. Shells elongate-oval, not winged, moderately swollen. Dorsal margin behind the beaks more or less straight, then curving rather sharply downwards, and descending obliquely to form a rather blunt posterior end with the ventral margin. Beaks not elevated or swollen, heavily corroded, sculptural characters unknown. Shell surface marked with fairly strong growth lines. Hinge characters and muscle scars unknown.

Remarks.

This genus is erected on rather negative taxonomic characters, but is considered necessary as the resting place for the mesozoic species, *U. ipsviciensis* Etheridge, which does not seem to belong with any of the other described recent or fossil forms. The name is based on the vague resemblance which the species bears to some of the recent species of *Hyridella*, but should not be taken to imply any definite genetic affinity.

MESOHYRIDELLA IPSVICIENSIS (Etheridge Jr.). (Plate xiii, fig. 5.)

Unio ipsviciensis Etheridge Jr., 1892, (in) Jack and Etheridge, *Geology and Palaeontology of Queensland and New Guinea*, Brisbane, p. 388, Pl. 42, figs. 2 and 3.

Type Locality: Shaft of the Bremer Basin Colliery at a depth of 200 feet.

Unio sp. Etheridge, 1891, (in) H. Y. L. Brown, Reports on the Coal-Bearing Area in the Neighborhood of Leigh's Creek, *South Australian Parliamentary Papers*, No. 158: 11.

Unio sp. David, 1950, *Geology of the Commonwealth of Australia*, Vol. 1: 429.

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* The Director of the Tasmanian Museum has subsequently informed me that the types of these two species cannot be located in the collections of that Museum.

Description. (After Etheridge.)

"Transversely elongated, narrow, wedge-like, sub-acute posteriorly. Dorsal or cardinal margin short, much less than the length of the shell; ventral margin generally rounded, but straight towards the centre. Anterior end short and rounded; posterior end produced and obtusely pointed. Umbones small, quite anterior, and much eroded. No true posterior slope, but the flanks insensibly graduating into the posterior end. Surface roughened with corrugations."

I have been able to examine a specimen from the lower Jurassic siltstone of Korrumburra, Gippsland, Victoria, from the National Museum collection, No. P.16768–69, which seems to agree fairly well with the rather meagre description and poor figure of this species. The shell is not perfect and the corrosion of the beaks is too great to give any further information on the generic affinity of the species.

The other references cited in the synonymy include a specimen mentioned by Etheridge as *Unio* sp. in connection with the description of *Prohyria eyrensis* from Lake Eyre. This specimen, which was compared favourably with the "undescribed species from the Bremer Basin Coal Shaft at a depth of 200 feet" (i.e. *ipsviciensis*), was a somewhat distorted example taken from a bore core at Leigh's Creek, at a depth of 622 feet. It was about two inches in length, but crushed and firmly attached to the matrix, and Etheridge was unable to give any other characters. He did say, however, that it differed from *U. gregorianus* (= *Prohyria eyrensis*) and also from two other species (at that time, and still, undescribed) from the Rolling Downs formation. It seems likely that the specimen was an example of *M. ipsviciensis*, especially in view of the fact that another species, *P. eyrensis*, also occurs at Leigh's Creek and the Ipswich coalfield.

The type of *Mesohyridella ipsviciensis* has not been located. Etheridge makes no mention of the location of his specimen, but states in the introduction of the volume (p. xv) "the absence of such references will, in the great majority of instances, infer that the fossils are in the collection of the Queensland Geological Survey". Unfortunately that collection is packed away and is not available for study at the present time.

Geological Age.—The beds from which the type specimen came are at the top of the Ipswich Series, and are of Upper Triassic age. According to Gill, the Victorian specimen from Korrumburra is of Lower Jurassic age.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L. / T.L.	Maximum Height.	M.H. / T.L.	Beak Height.	Width.
	mm.	mm.	%	mm.	%	mm.	mm.
Holotype (from figure) ..	36	8	22	19	53	18	14
Korrumburra P.16768–69 ..	35	8	23	17	49	15	11

UNIO STIRLINGI Ferguson (*nomen nudum*).

Unio stirlingi Ferguson, 1909, *Mem. Geol. Surv. Victoria*, 8: 3.

Unio stirlingi David, 1950, *Geology of the Commonwealth of Australia*, Vol. 1: 467.

Remarks.

This name has been most elusive and after much searching the earliest reference I have found is Ferguson (1909), who simply mentions the species as coming from the Jurassic rocks of Victoria.

David (1950) repeats the usage by stating that "*Unio stirlingi* is not uncommon in the South Gippsland beds . . . ."

In neither place is any description or figure offered. The South Gippsland beds are of Middle Jurassic age.

A specimen from the National Museum collection, No. P.16774, is labelled *Unio stirlingi* and comes from Burnes or Burries Creek, the label being rather illegible. Neither Gill nor I have been able to find this locality on available maps. The specimen

is in poor condition and may or may not have anything to do with the original shell which was to be named *Unio stirlingi*. The fossil vaguely resembles some of the recent species of *Hyridella*.

VELESUNIO JAQUETI (Newton).

Unio jaqueti Newton, 1915, *Proc. Malac. Soc London*, 11: 230-231, Pl. 6, figs. 2-6. *Type Locality*: Lightning Ridge, New South Wales.

Unio sp., Newton, 1915, *Proc. Malac. Soc. London*, 11: 232, Pl. 6, fig. 1.

Unio sp., David, 1950, *Geology of the Commonwealth of Australia*, Vol. 1: 487.

Description. (After Newton.)

"Shell elongately oval, narrow; dorsal margin slightly sloping to posterior extremity; dorsal and ventral borders subparallel; umbones anterior, eroded; valves compresso-convex; posterior region produced and slightly narrowing at the end, anterior and ventral borders rounded; sculpture exhibiting concentric growth lines, crossed by numerous closely set fine radial striations."

Remarks.

Two opalized specimens of *Unio jaqueti* were described, both somewhat imperfect. A third specimen listed as *Unio* sp. appears from the shape to belong to this species also, and is so listed in the synonymy.

I examined Newton's types superficially at the British Museum and, apart from confirming the fact that the species could belong with the recent genus *Velesunio*, I can add little to the description. The shell is rather featureless, but recalls very much in outline the recent species *V. wilsonii*, which lives today throughout the arid regions of central and northern Australia.

This species extends the range of *Velesunio* back into the Mesozoic. However, I have no hesitation in so doing, for the genus today exhibits many features which mark it as a very primitive group. It is rather unspecialized in anatomical characters, and the lack of any trace of beak sculpture, as well as the simple hinge construction, suggests that it could be an ancient group which has survived in Australia through its long isolation. Furthermore, there is some resemblance between the recent species of *Velesunio* and the undescribed Jurassic species *U. murrayi* Murray.

The types came from both Lightning Ridge and White Cliffs, but the holotype, which is specimen No. L.21833 in the British Museum collection, is from Lightning Ridge, which should be regarded as the restricted type locality. The paratype was in the F. St. J. Thackeray collection, which is now in the British Museum.

Geological Age.—The age of the opal-bearing beds at Lightning Ridge and White Cliffs is Cretaceous, but, according to David (1950), their exact position in the Cretaceous sequence is doubtful.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	Beak Height.	M.H./T.L.	Width.
	mm.	mm.	%	mm.	mm.	%	mm.
Holotype	42	11	26	20	17	48	12
Paratype	37+ (=52 est)	17	33	22	20	42	15

HYRIDELLA WHITECLIFFSENSIS (Newton).

Unio whitecliffsensis Newton, 1915, *Proc. Malac. Soc. London*, 11: 231, Pl. 6, figs. 7 and 8. *Type Locality*: White Cliffs, New South Wales.

Unio sp., David, 1950, *Geology of the Commonwealth of Australia*, Vol. 1: 487.

Description. (After Newton.)

"Shell of small size, with moderately inflated valves, length about 1½ times the height; umbonal regions anterior, coarsely rugose or marked with strong widely V-shaped costae; anterior margin rounded, posterior side with an elongate, abrupt, oblique, and narrow angulate ridged area, in front of which the valve is slightly excavated. Sculpture beyond the V-shaped costal rugosities of the umbonal area consists of periodic growth-divisions, and numerous closely set, microscopical concentric striations, which at the posterior ridge become angulate, and take an upwardly oblique direction on the surface of the posterior area . . . . Umbones themselves . . . not present."

Remarks.

This species, like the last, was found in an opalized state but in this case is quite well preserved. The figure shows well the strong V-shaped sculpture on the beaks of this young specimen, which proves it to be closely related to the members of the subfamily Hyridellinae. There are two genera of recent Hyridelline mussels in Australia today, *Hyridella* and *Protohyridella*. The latter genus has the V-shaped sculpture extending well down the sides of the shell, while the former has the sculpture confined to the beaks. Considering the young age of the holotype of this species (as indicated by its size) it is not possible to say exactly to which genus the species belongs, but a brief examination of the type in the British Museum suggests the former as its correct resting place. Once again this takes the range of a recent genus back to the Cretaceous, and *Hyridella* is probably a more advanced group than *Velesunio*.

Whatever its correct generic affinity, there can be no doubt that the fossil species belongs with the Hyridellinae, which therefore must also be regarded as an ancient group. This suggests the possibility that the Triassic-Jurassic form described above as a new genus, *Mesohyridella*, may be ancestral to the true Hyridellinae of Cretaceous, Tertiary and Recent times.

The holotype is in the British Museum, in the F. St. J. Thackeray collection, No. L.26362.

Geological Age.—As in the last species, this form is of Cretaceous age.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L./T.L.	Maximum Height.	Beak Height.	M.H./T.L.	Width.
	mm.	mm.	%	mm.	mm.	%	mm.
Holotype	22	4	18	15	10	68	10

HYRIDELLA DEPRESSA (Lamarck).

Unio depressa Lamarck, Dennant and Kitson, 1903, *Rec. Geol. Surv. Victoria*, 1: 146.

Remarks.

In their table of Pliocene and Pleistocene fossils recorded from South Australia, Victoria and Tasmania, Dennant and Kitson record Lamarck's recent species *Hyridella depressa* from Coleraine. The two specimens on which this record is based are in the collection of the South Australian Museum, unregistered, from the Tate collection, *ex* Dr. J. C. Verco. They are labelled "*Rugoshyria cultelliformis*" (a subjective synonym of *H. depressa*) "from Victoria, Coleraine, Fossil, Dennant". They are quite well-preserved specimens, and can almost certainly, from their form, be assigned to the genus *Hyridella*. It is quite possible that they are in fact specimens of *H. depressa*, especially as that species occurs in Victoria today, and was undoubtedly living there during Pliocene and Pleistocene times.

A specimen in the National Museum collection, No. P.16765, supposedly from the Tertiary rocks at the Hopkins River, near Warrnambool, is rather poorly preserved, but appears to belong here also. Mr. Gill is in some doubt as to the correctness of the locality of this specimen.

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L. / T.L.	Maximum Height.	Beak Height.	M.H. / T.L.	Width.
	mm.	mm.	%	mm.	mm.	%	mm.
Coleraine (S.A. Museum)—							
Specimen 1	45	11	24	27	21	60	14
Specimen 2	48	11	23	25	23	52	19
H. depressa. Recent (A.M.).							
Mitchell R., Vict.	65	15	23	33	28	53	20

Velesunio ambiguus (Philippi).

Unio ambiguus Philippi, 1847, *Abbildung. neuer Conchyl.*, 3, *Unio*, Pl. 3, fig. 2, p. 7 (47) (Recent. *Type Locality*: Australia.)

Unio (*Hyridella*) *protovittatus* Hale and Tindale, 1930, *Rec. South Australian Mus.*, 4: 134, figs. 8 and 9. *Type Locality*: "Layer C" at Tartanga, Murray River Valley, South Australia.

Remarks.

The well-known species *Velesunio ambiguus* is undoubtedly the most common, most widespread, and most variable of the recent Australian freshwater mussels. Hale and Tindale (1930) described some shells from sub-recent Aboriginal deposits at Tartanga and nearby localities as a new species, *U. protovittatus*, on the grounds that the sub-recent shells were consistently thicker in shell substance than the recent *U. vittatus*. The latter name applies to one of the several variations of *V. ambiguus* and is characterized by a thin, relatively high shell (normal *V. ambiguus* possessing a moderately thick shell). The contrast between the thick-shelled sub-fossil mussels and the thin recent form is thus somewhat misleading. Furthermore, it is well known that shells of both land and freshwater molluscs which are buried in soil for many years become thickened by secondary deposition of calcium salts, and it seems likely that this accounts for some of the difference observed in the Tartanga shells.

Carbon 14 dating of the beds indicates an age of about 6,000 years (Tindale, personal communication). Dr. I. D. Hiscock, of the University of Queensland, has examined Hale and Tindale's type material and does not consider the form to be of taxonomic value. I therefore place it in the synonymy of *Velesunio ambiguus*.

The type specimens are in the South Australian Museum, registered No. P.178 (*fide* Hale and Tindale, 1930).

Dimensions.

Specimen.	Total Length.	Beak Length.	B.L. / T.L.	Maximum Height.	Beak Height.	M.H. / T.L.	Width.
	mm.	mm.	%	mm.	mm.	%	mm.
Holotype, *U. protovittatus* (from figure)	70	20	29	52	49	74	28
Recent *V. ambiguus* " vittatus " form. Murray R., S.A.							
Mean of 5 specimens ..	55	14	25	38	34	69	20

Conclusions.

It will be seen from the foregoing review that a great deal more material must be collected and studied before the fossil freshwater mussels of Australia and New Zealand are properly known. No fossils are known to date from the New Guinea region, though the recent fauna is apparently rich and is directly related to that of Australia.

In addition to the named forms listed here, a number of additional references to the finding of freshwater mussel fossils can be found in literature, but in these cases no scientific name has been used other than *Unio*, and they have not been dealt with here. Many such references can be found in David (1950). Some additional material is to be found in the several collections, and these may represent further new species. Thus there is a small *Unionella*-like form occurring in the Hawkesbury Sandstone at Brookvale, N.S.W., and a poorly preserved shell from Pleistocene rocks at Inverell, N.S.W., which appears quite different from any known species. The New Zealand Geological Survey collection contains some impressions of Tertiary forms which may or may not be the same as the recent New Zealand species. There is also the shell associated with the paratypes of *Protovirgus flemingi* from the Liverpool Colliery, which is quite unlike any other Cretaceous species.

However, it should be remembered that this essay is only a preliminary attempt to bring together the named forms, and it is quite likely that many references have been overlooked. It is to be hoped that a comprehensive study of the group will soon be made, as the resulting knowledge should prove of value to palaeontologist and neontologist alike.

It is hoped that an account of the evolutionary history and relationships of the freshwater mussels of the Australasian region, both fossil and recent, will soon be published.

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EXPLANATION OF PLATES XIII-XIV.

(Photographs by Howard Hughes, Australian Museum.)

Plate xiii.

All figures approximately two-thirds natural size.

Fig. 1. *Unio inflata* Hutton (= *Velesunio huttoni* McMichael.) Holotype. New Zealand Geological Survey.

Fig. 2. *Velesunio huttoni* McM. New Birchwood Mine, Ohai, New Zealand. New Zealand Geological Survey.

Fig. 3. *Velesunio huttoni* McM. New Birchwood Mine, Ohai, New Zealand. Specimen crushed dorso-ventrally, showing beaks, ligament. New Zealand Geological Survey.

Fig. 4. *Hyridella wilkinsoni* (Etheridge). Langi Logan Gold Mine, Victoria. N.M.V. P. 16766.

Fig. 5. *Mesohyridella ipsviciensis* (Etheridge). Korrumburra, Gippsland, Victoria. N.M.V. P. 16768-69.

Figs. 6, 7. *Prohyria johnstoni* (Etheridge). Tamar River, Tasmania. A.M. F.117.

Fig. 8. *Prohyria eyrensis* (Etheridge). Leigh's Creek, South Australia. Possible paratype. A.M. F.9081.

Figs. 9, 10. *Prohyria eyrensis* (?) (Etheridge). Lake Eyre, South Australia. N.M.V. P.16764.

Figs. 11, 12. *Prohyria eyrensis* (Etheridge). Leigh's Creek, South Australia. Possible paratype. N.M.V. P.16767.

Plate xiv.

Figures 1 to 3 approximately natural size; figures 4 to 8 approximately 1½ times.

Figs. 1, 2. *Protovirgus flemingi* McM. Holotype, counterparts. Morgan Mine, Rewanui, Mawheranui Survey District, New Zealand. New Zealand Geological Survey No. 5264.

Fig. 3. *Protovirgus flemingi* McM. Paratype. New Zealand Geological Survey No. 5264.

Fig. 4. *Unionella wianamattensis* (Etheridge). One of the syntypes of *Unionella bowralensis* Etheridge. A.M. F.35767.

Fig. 5. *Unionella wianamattensis* (Etheridge). Lectotype. Brick quarry at Crown Street, Waterloo. A.M. F.35775.

Fig. 6. *Unionella bowralensis* Etheridge. Lectotype. Gibraltar Tunnel, Bowral, N.S.W. A.M. F.35770.

Fig. 7. *Unionella carnei* Etheridge. Lectotype. Gibraltar Tunnel, Bowral, N.S.W. A.M. F.35766.

Fig. 8. *Protovirgus dunstani* (Etheridge). Lectotype. Gibraltar Tunnel, Bowral, N.S.W. A.M. F.35776.