

A NEW XIPHOSURAN GENUS FROM LOWER CRETACEOUS FRESHWATER SEDIMENTS AT KOONWARRA, VICTORIA, AUSTRALIA

by E. F. RIEK and EDMUND D. GILL

ABSTRACT. An excellently preserved xiphosuran, representing a new genus, *Victalimulus*, is preserved in freshwater strata with fish, insects, and plants from Koonwarra, Victoria. The new genus is similar both to the living *Limulus* and to the Mesozoic *Mesolimulus*. Both fossil genera are referred to the Limulidae. The preserved specimen is considered to be a mature adult that migrated from the sea in order to breed in fresh water.

XIPHOSURA are rarely preserved as fossils, so this well-preserved specimen from Koonwarra is an important addition to the history of this marine group. The appendages are preserved, although it is sometimes difficult to distinguish details because of superimposed impressions of other structures from both dorsal and ventral surfaces. The outlines of the overlapping lamellate opisthosomal appendages, with their hair fringes, are distinguishable through the more heavily sclerotized operculum. The apex of the opisthosomal axis is missing except for a part of the left apical lobe. A small fragment of the caudal style is preserved.

The specimen P22410-3 in the National Museum of Victoria, Melbourne, is from a road cutting on the South Gippsland Highway, at a point where road, railway, and river are close together, 1.5 miles east of Koonwarra, South Gippsland, Victoria. The specimen is preserved as clear impressions in siltstone. The fossil was found by James McQueen when working over a load of siltstone taken home for breaking up in search of fossils. Later, his reject material and the site were examined in the hope of finding the missing parts of the fossil, but without success.

Geology. Over 9000 ft of sediments were accumulated in the South Gippsland Basin. They consist of felspathic sandstones and siltstones, with occasional conglomerates and some thin bands of black coal. A soil horizon with silicified stumps in position of growth was observed in the Cape Patterson area exposed on a shore platform, but the formation is essentially a lacustrine one. No marine beds are known. The great thickness of sediments proves rapid subsidence, so it is not surprising to find slump structures, and evidence of subaqueous slides. Plant fossils (Carroll 1962) are common but others are rare. Before the present site was discovered, the only animals known from the basin were a dinosaur (represented by a claw), a lungfish (represented by a *Ceratodus* tooth plate), and a few indefinite fragments.

Palaeoecology. The xiphosuran is preserved in siltstone together with abundant plants, fish, phyllopod Crustacea (conchostracans and anostracans), and an aquatic insectan fauna in such unusual circumstances as to ensure excellent preservation. The insect fauna consists mainly of the nymphs of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Odonata (dragonflies and damselflies), and the larvae of nematocerosus

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Diptera (midges) and Coleoptera (beetles). This particular assemblage of immature insects could only occur in an uncontaminated freshwater habitat. The presence of a limulid in this environment suggests that it had migrated there for breeding; if so, it was mature. Such characters of *Victalimulus mcqueeni* that appear to be juvenile as compared with living limulids are therefore regarded as adult characters of the species.

CLASSIFICATION

Victalimulus clarifies much of the probable structure of *Mesolimulus* and other Mesozoic Limulacea. This, combined with the interpretation of the structure of *Austrolimulus flecheri* (Riek 1968) from the Triassic of Australia, necessitates the relegation of the genera of the Mesolimulidae to one or other of the families Palaeolimulidae and Limulidae.

Class MEROSTOMATA
Subclass XIPHOSURA
Superfamily LIMULACEA
Family LIMULIDAE

Limulidae auct.
Mesolimulidae Størmer 1952 (in part)

Diagnosis of family. Opisthosoma consolidated; segmentation and axial furrows of dorsal shield indistinct although indicated at least by apodemes. Ophthalmic ridges not meeting in front of cardiac lobe. Genal spines moderately to strongly produced, directed postero-laterally, posteriorly, or with their apices converging. Jurassic to present.

Included genera. *Limulus* (Quaternary), *Tachypleus* (Quaternary and Tertiary), *Carcinoscorpius* (Quaternary), *Mesolimulus* (Jurassic), *Psammolimulus* (Triassic), *Victalimulus* gen. nov. (Cretaceous).

Discussion of genera. Størmer (1952) established the family Mesolimulidae for three fossil genera from the Mesozoic which he considered showed more affinity to living Limulidae than to *Paleolimulus* (Paleolimulidae). The structure of all three genera is imperfectly known but at least one of the included genera does not conform with the definition of the family, and, in addition, this definition differs only slightly from that of the Limulidae.

Limulitella has the body form of *Paleolimulus*; indications that the ophthalmic ridges meet in front; genal spines laterally directed; distinct longitudinal axial furrows; relatively wide operculum; and narrow flat marginal zone to the doublure of the opisthosoma. The apparent absence of a free apical opisthosomal segment and transverse segmentation of the axis are probably due to inadequate preservation. The genus is transferred to the Paleolimulidae. When its structure is more adequately known, it may prove to be a synonym of *Paleolimulus*.

Psammolimulus has a very large genal spine, directed posteriorly, and a reduced opisthosoma that ends in a pair of spine-like projections. The free lobe apparently extends laterally beyond the main body of the opisthosoma. Although the lateral margins of the opisthosoma are not lobed there are short, stout, moveable spines. The

genus was compared with *Austrolimulus* by Riek (1968). However, the reconstruction of *Psammolimulus* by Meischner (1962) shows a distinctly different form of the genal spines and of the posterior region of the opisthosoma. *Psammolimulus* is a very distinct genus although in basic structure it is similar to *Limulus*, with all segments of the opisthosoma fused and without indications of the sutures. It is transferred to the Limulidae.

The structure of *Mesolimulus* is moderately well known. It appears to differ from living limulids in the development of more clearly defined axial furrows on the opisthosoma and shorter genal spines. These are attributes of juvenile living limulids. Some of the other observed differences may be due to the manner of preservation. The differences are so slight that *Mesolimulus* is considered to warrant only generic recognition. *Mesolimulus* is therefore transferred to the Limulidae. Størmer's (1952) diagnosis of the Mesolimulidae depends on their possession of a smaller range in size, less prolongation of genal angles, more distinct axial furrows, and of more anterior placement of the first pair of marginal opisthosomal spines than in the Limulidae, but these are only quantitative differences (as against qualitative ones) that we consider inadequate for the definition of a family. We do not agree that the position of the first pair of marginal spines is a valid difference.

Victalimulus, the new genus described from the Lower Cretaceous of Koonwarra, is intermediate in some characters between *Mesolimulus* and the living Limulidae, but in other characters this is not so. Separate generic status is considered warranted. The genus is referred to the Limulidae and compared with *Limulus* and *Tachypleus*.

Genus *Victalimulus* gen. nov.

Type species. Victalimulus mcqueeni sp. nov.

Diagnosis of genus. Limulid combining characters of *Mesolimulus* and *Limulus*, resembling *Tachypleus* and *Limulus* but with an opisthosomal doublure that evenly expands anteriorly whereas at least in *Limulus* the margins are parallel; lateral processes of opisthosoma long and tapering regularly; and genal lobes tapering regularly to apex.

Cardiac lobe of prosoma with a median crest bearing three protuberances or spines. Axial furrows bordering the cardiac lobe converging and almost meeting anteriorly. Ophthalmic ridge defined for a moderate distance anterior to the eye, and not converging strongly anteriorly. Outer margin of genal spine parallel to median axis of body. Opisthosoma with strongly convex margins; free lobe distinct. Axial furrows indicated by six pairs of relatively deep pits (apodemes) extended antero-mesally as distinct grooves. Marginal spines long, directed posteriorly. Prosoma with relatively wide, flat doublure that evenly widens anteriorly. Structure of appendages imperfectly known but comparable with *Limulus*.

EXPLANATION OF PLATE 33

Figs. 1-5. Holotype of *Victalimulus mcqueeni*. 1, P22410; slightly less than natural size. 2, P22411-12; reversed lighting, slightly less than natural size. 3, Detail of apodemes on opisthosoma; c. $\times 2$. 4, Hair fringes on opisthosomal appendages; c. $\times 3$. 5, Opisthosomal spines; c. $\times 2$.



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RIEK and GILL, Lower Cretaceous xiphosuran

Victalimulus mcqueeni sp. nov.

Plate 33

Holotype. Nat. Mus. Vict. P22410-3.

Description of holotype. As for the genus but with the following details: length along mid-line to opisthosomal apex, 8.7 cm (estimated because apex not complete); length of prosoma along mid-line, 5.0 cm; ditto to line joining ends of genal spines, 7.0 cm; width at bases of genal spines, 8.5 cm; greatest width of opisthosoma, 5.8 cm. As preserved, the specimen is slightly convex; the carapace was originally thin and vaulted.

Cardiac lobe of prosoma with median crest bearing three protuberances or spines, the posterior two being better defined (as preserved) than the anterior one. The anterior one was pressed forward during the flattening involved during fossilization, and so its less conspicuous nature is probably due to its position rather than indefiniteness in the original carapace. In specimens of *Limulus* available to us, these spines are very well defined in juveniles, but are indistinct in adults. The left genal angle of the prosoma is preserved. It tapers regularly to a sharp point. The internal margin of the genal lobe is comparable with that in *Tachypleus gigas* and notably less curved than in the living *Limulus polyphemus*.

The doublure of the prosoma widens evenly when followed anteriorly, whereas in *Limulus* the margins of the doublure are parallel until the inner edge begins to turn posteriorly. The outer margin of the doublure is displaced in the fossil from the outer margin of the prosoma over the mid-section of the right side, showing a weakness at this junction similar to that in the living *Limulus*.

On the margins of the opisthosoma, the lobes are relatively long (of the order of 7.0 mm) and in outline almost bilaterally symmetrical. The intercalated spines are distinctly shorter, c. 4 mm, whereas in *Limulus polyphemus* the lobes are asymmetric in outline (the anterior being significantly longer than the posterior) and the spines are much longer than the lobes at all stages of growth. In *L. polyphemus* the width of the spine base is about as wide as the lobe base in the anterior part of the opisthosoma, whereas in *Victalimulus mcqueeni* the spine bases are of the order of half the diameter of the lobe bases. The spines are crested, and possess flattened borders lateral to the crests, whereas in *L. polyphemus*, they are broadly, moderately, and evenly convex with linear lateral borders, i.e. they are not crested. The free lobe at the anterior left corner of the opisthosoma is preserved but partially obscured by the last (non-chelate) leg. It apparently extends beyond the hidden first lobe. On fragment P22413 is the left apical spine or lobe of the opisthosoma; it shows that the spine is terminally sharp, and both longer and much more laterally directed than in *L. polyphemus*. The axis of the opisthosoma carries three median spines similar to the anterior and posterior spines on the axis of *L. polyphemus*, but with an additional spine. In *L. polyphemus* there are three spines, the most posterior being that on the apex, which area is not preserved in the fossil species. In addition to the other two, there is present an extra smaller spine on the segment anterior to the middle spine of *Limulus*. The axes of the apodemes are directed obliquely to the mid-line, rather than aligned as they are in *Limulus*.

In *Victalimulus* the raised margin of the inner edge of the opisthosomal doublure is not completely preserved although the portion preserved indicates that the margin

is rounded and subparallel to the lateral margin whereas in *Limulus* this inner margin has straight lateral margins that each form a reasonably well-defined angle with the caudal margin.

The fragment of caudal spine (P22413) is similar to that in *Limulus* in being crested and having tapering margins, but it is too small for any significant comparison.

The apex of the left posterior appendage of the prosoma is preserved. Two subequal apical spines are present. They are about the same length as the interlobal spines of the opisthosoma (4 mm), and are sharply crested. The flattened digging spines reached the apex of the terminal segment. Only indications of the more anterior appendages are to be seen, but the chela of one of the more posterior walking legs on the left side is clearly preserved. The spinose gnathobase of the second pair of appendages is distinct on both sides. The very long marginal hair fringes of some of the overlapping foliaceous abdominal appendages are preserved on the left side.

Remarks. The specific name is in honour of James McQueen of Korumburra who found the fossil and presented it to the National Museum of Victoria. We are indebted to Mr. L. F. Costermans for recognizing the value of this fossil and advising James McQueen to take it to the National Museum. The photographs were prepared by Mr. John Green, Canberra.

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E. F. RIEK
CSIRO Division of Entomology
P.O. Box 109, Canberra City
A.C.T., 2601 Australia

EDMUND D. GILL
National Museum of Victoria

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