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MOLLUSCS OF THE MURRAY-DARLING RIVER SYSTEM

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ABSTRACT: The Murray-Darling River System, draining over a million km² from south Queensland to Victoria, is one of the major river systems of the world. However its low annual flow, the arid nature of much of its surrounding land and regular drought cycles combine to give the area a surprisingly depauperate fauna. The aquatic mollusc fauna of the rivers and flood plains consists of 24 species, which can be divided into those directly associated with the rivers and those found only in standing or low flow waters away from rivers. Almost all the species directly associated with the rivers show close affinities with widespread northern Australian species, whereas the remainder are mainly allied with the southeastern and east-central faunas. The terrestrial mollusc fauna of the flood plains consists of about 50 species, over a third of which are species introduced into Australia. In certain groups of this fauna there is also evidence of affinities with northern forms.

The Murray-Darling Basin has been looked on as a faunal region, particularly for aquatic fauna. It is suggested here that this river system should rather be regarded as a transportation corridor. Many of the fluviatile species and some of the terrestrial species show close affinities to, and are the southernmost members of, diverse groups found in northern Australia, and it is suggested that these southern extensions are caused by flood transport. Over a third of the terrestrial molluscs are species introduced into Australia and their distribution pattern strongly suggests introduction by human river traffic.

INTRODUCTION

The Murray-Darling River System, draining over a million km² of southern and central Australia from Queensland to Victoria is one of the major river systems of the world. However for a major drainage system it has a remarkably low annual flow. This is because of its comparatively small mountain catchment area, and the dry, arid nature of much of the country through which it flows. These conditions are further aggravated by regular severe drought cycles which can impose periods of extreme environmental stress on the biota. These factors combined result in a surprisingly depauperate fauna, when the size and habitat diversity of the system is taken into consideration.

The Murray-Darling is really two separate systems which join fairly close to their distal ends. One is fed from snow-melt and confined to the southeastern region of Australia. The other, fed from tropical monsoon water, runs from and through two biotic regions different from the southeastern region where the two systems join. This difference in water source and hence times of peak flow in the two sub-systems can cause backflows which provide a possible explanation for biotic interchange. McMichael and Iredale (1959) considered the Murray-Darling as a single faunal province for aquatic molluscs, the Mitchellian Fluvifaunula, citing three characteristic species, *Velesunio ambiguus, Alathyria jacksoni* and *Plotiopsis balonnensis*.

There have been no comprehensive studies of the molluscan fauna of the Murray-Darling System or even of the two separate sub-systems. Collections of molluscs have been acquired from many localities, particularly along the Murray, in conjunction with the distribution survey of non-marine molluscs of southeastern Australia (Smith & Plant 1973). However the only published work on the fauna has been either taxonomic treatise such as McMichael and Hiscock (1958), Gabriel (1939) or Iredale (1937b, 1943) which give some information on this fauna, or results of survey work for small regions within the system such as for the Mitta Mitta Valley (Smith, Malcolm & Morison 1977).

MAIN HABITAT TYPES

A number of main habitat types can be identified

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each containing a different molluscan faunal assemblage. The aquatic habitats are characterized by water source and quality, flow regime, sediment and nutrient load, bottom type and the presence or absence of aquatic vegetation. Terrestrial habitats are characterized by available moisture, type of vegetation and soil and rock type.

The principal aquatic habitats are the rivers and major tributaries themselves and their associated flood-filled lagoon and billabong systems. In the upper reaches of the source rivers where the bed slope is still great and the rate of flow fast, the streams are characterized by alternating riffle-rapid and pool systems, the dissolved oxygen is high and the suspended solid load usually low (Smith *et al.* 1977). Aquatic vegetation is usually present only in backwaters and the main benthic habitats are either between the stones in the boulder stretches or in the fine sediments of the pools. As the bed slopes decrease the rate of flow and stream carrying capacity drops and the rivers occupy deep meandering channels in alluvial silt. The bottom composition is mainly a fine silt and the suspended solid content of the stream is greatly increased, reducing light penetration. Because the width and depth of the rivers has increased, and they are also subject to periodic massive floods, large dead trees are carried by the streams. These become lodged as submerged snags, creating a hard surface substrate in localities otherwise devoid of such sites. The water quality in these sections of the rivers is lowered through an increase in dissolved salts due to soil leaching and the effects of irrigation.

Other permanent water habitats closely associated with the rivers on the flat land are the lagoons and billabongs formed from isolated old meanders of the rivers. These are replenished by overtopping in flood times, but for the rest are cut off from the main stream and become stagnant. They are enriched by stock excreta, run-off carrying pasture fertilizer, and by terrestrial and aquatic vegetation rotting down and forming highly productive eutrophic systems with massive production of algae and other aquatic vegetation and aquatic animals.

Similar in many ways to the lagoon systems are the marshes and dams also found on the flood-plains. These, too, are eutrophic systems showing high productivity. However they are not formed and fed by the rivers but are above and separate from the river systems. This means that no direct water transport of aquatic animals is possible between the river and the marshes and dams. There are also occasional saline lakes found away from the rivers in this area.

Another significant aquatic habitat is found in the flood zones of the rivers. An example is the Barmah Forest. In times of flood such areas are inundated and remain under water for many months, providing very large areas of high productivity aquatic habitat with a fine silt substratum and abundant hard surfaces. However, these areas are subject to periodic dry periods which prevent the establishment of aquatic flora and fauna that is incapable of withstanding such dry conditions.

A major aquatic habitat superimposed on the natural system in the last hundred years is found in the extensive irrigation systems of both the Murray and Darling Basins. These systems have large transport canals carrying river water to land above and beyond the normal flood influence of the rivers. The canals and channels provide large bodies of water in which aquatic fauna can develop, and these form large new aquatic habitats, altering the balance of the entire system.

The terrestrial habitats to be considered in this study are confined to the enlarged flood plains of the rivers. In the upper reaches these consist of areas of dry sclerophyll forest and marginal bush with large trees and deep litter. Forest areas, particularly of *E. camaldulensis*, also occur in the central and lower reaches, where fallen logs and deep leaf-litter provide favourable habitats for land molluscs. In the northern part of the area the flood plains are dry, arid areas with saltbush, spinifex and other semi-desert vegetation. In the southern region, after the two rivers have combined, the Murray River is bordered by high limestone cliffs which provide a totally different terrestrial habitat.

However the dominant factor influencing the character of much of the terrestrial habitat bordering the rivers is the modification of the environment by European man. Large areas of the river flats have been cleared for monoculture of introduced plants such as wheat, vines, citrus trees and conifers, and major centres of human habitation with exotic garden plants have been established. Irrigation raises the available moisture level in these habitats to an average throughout the year far above the normal level for the area. These centres are also localities where road, rail and river transport discharges cargo originating in far distant places, and hence a source of accidental introduction of exotic animals.

AQUATIC FAUNA

Twenty-four species of aquatic molluscs (see Appendix) have been recorded from the combined river systems and many are widespread throughout.

TABLE 1
DISTRIBUTION OF AQUATIC MOLLUSCS OF THE MURRAY-DARLING SYSTEM

SPECIES	STREAMS & IRRIGATION CHANNELS	LAGOONS	MARSHES	SALT LAKES
Vivipara (N.) hanleyi	+			
Potomopygus nigra	+			
Pupiphryx grampianensis	+			
Coxiella striata				+
Gabbia australis	+	+		
Plotiopsis balonnensis	+	+		
Lymnaea lessoni		+	+	
Lymnaea tomentosa		+	+	
Planorbarius corneus	+			
Physastra gibbosa		+	+	
Glyptophysa cosmeta		+		
Glyptophysa aliciae	+	+		
Bulinus (I.) hainesii	+	+	+	
Bulinus (I.) newcombi		+	+	
Gyraulus sp.	+			
Segnitila sp.		+	+	
Ferrissia (P.) petterdi	+	+	+	
Ferrissia (P.) tasmanica	+	+	+	
Velesunio ambiguus	+	+		
Alathyria jacksoni	+			
Alathyria condola	+			
Corbiculina angasi	+			
Pisidium casertanum	+	+	+	
Sphaerium sp.		+	+	

The fauna is most easily considered as four assemblages: (1) the rivers and streams; (2) the lagoons and associated systems; (3) the freshwater habitats separated from the rivers and (4) the salt lakes. The distribution of the species between these assemblages is set out in Table 1. The assemblage listed under the heading of streams and irrigation channels encompasses virtually all the flowing water in the system. However the species listed in this assemblage are not equally distributed throughout the system.

The two species of hydrobiids, *Potomopyrgus nigra* and *Pupiphryx grampianensis*, and the planorbiid, *Gyraulus* sp., are confined to the upland streams of northeastern Victoria. The two planorbiids *Bulinus* (*Isidorella*) *hainesii* and *Glyptophysa aliciae* are found in shallow backwaters and other localities with a good growth of aquatic vegetation in the southern section of the system. Similarly the two species of freshwater limpets, *Ferrissia* (*Pettancylus*) *petterdi* and *F.* (*P.*) *tasmanica*, and the pea shell *Pisidium casertanum* are also found in the shallow, high quality waters of the inflow streams in the southern section of the system. However this latter observation is probably a false picture due to a paucity of detailed collecting in the northern streams.

Most of the species listed for this assemblage have been collected from various parts of the irrigation systems connected with the rivers in Victoria, South Australia and New South Wales. The little basket shell, *Corbiculina angasi* has been reported (G. A. Buchanan, pers. comm.) as a fouling organism of reticulation pipes and sprinkler systems in the Mildura area, while large populations of *Plotiopsis balonnensis* have been collected from concrete channels around Mildura. The freshwater mussels are found in the large main water transport channels of the system. One interesting record is the introduced planorbiid, *Planorbarius corneus*, which has been recorded from one or two channels in the Sunraysia district of Victoria and New South Wales (Smith 1969).

The main interest in this assemblage is however the group of species thought of as typical of the Murray-Darling System (McMichael & Iredale 1959). These are *Vivipara* (*Notopala*) *hanleyi*, *Gabbia australis*, *Plotiopsis balonnensis*, *Velesunio ambiguus*, *Alathyria jacksoni* and *Alathyria condola*. These species are all members of families

and genera with a widespread distribution in northern and central Australia and, with the exception of *Velesunio ambiguus*, are the southernmost members of these groups. *Velesunio* also occurs in the coastal streams of Victoria and Tasmania and a fossil species of *Alathyria* has been recorded from the Eocene beds of the Launceston Basin in Tasmania (McMichael & Hisock 1958), though the genus is not represented there at the present time. However the distribution of all these forms is consistent with the idea that they are southern extensions of diverse northern Australian groups, transported south and east along the Murray-Darling System probably in times of flood.

The lagoon and marsh assemblages are very similar in character with many species in common. These common species reflect the habitat types of these communities: both are eutrophic with a heavy growth of aquatic vegetation. Such forms as the two *Lymnaea* spp., *Physastra gibbosa*, the two *Bulinus* spp., *Segnitila* sp., the two freshwater limpets and the two pea shell species fall into this category. However in addition the lagoon systems have several species, directly derived from the rivers, which are not present in the marsh systems. These are many of the species listed above as being typical of the river system. One species, *Glyptophysa cosmeta* has only recently been recorded from the Murray Basin (Smith & Burn 1976) and its capacity to aestivate as a method of overcoming the intermittent dry periods to which the flood zones are subject has been described.

There are several isolated salt lakes in the area and these support a single species of mollusc, *Coxiella striata*, especially adapted to that environment.

TERRESTRIAL FAUNA

The Murray-Darling System flows through three faunal regions of eastern and central Australia. These are the southeastern region, the east coast region and the central region. The terrestrial fauna of the various parts of the system is characteristic of those areas, with no evidence of any unified Murray-Darling fauna. However, as with the aquatic fauna, the present distribution of several terrestrial species can most easily be explained if one invokes transportation down the river corridors in times of flood.

The fauna of the upper reaches of the Victorian feeder streams is typical of the dry sclerophyll forest areas north of the Divide. It consists of one or two charopid species, the camaenid *Chloritobadistes victoriae* and the rhytidid *Rhytida* (?) *capillacea*, together with one or two introduced species. Down on the lower flood plains of the Murray Valley the fauna consists largely of several punctid species in the leaf litter, particularly around the base of *E. camaldulensis*. A great many introduced species of snails and slugs are seen in the man modified habitats and several, such as *Cernuella* (*Cernuella*) *virgata* and *Theba pisana*, are major pests of vine, orchard and grain crops in the irrigated areas. Sixteen species of introduced snails and slugs are recorded for the region. Most are pests and occur in large numbers in the irrigated and urban areas.

The terrestrial mollusc fauna of the upper reaches of the feeder streams west of the Divide in the Darling system of northern New South Wales and southern Queensland is very poorly known. The rhytidid *Strangesta* (?) *strangei* and the camaenid *Galadistes bourkensis* occur together with one or two charopids. The flood plains of the Darling system are dry and arid with saltbush and sparse vegetation. The mollusc fauna of this area is typical of the central Australian fauna with the camaenid genera *Sinumelon* and *Pleuroxia* predominating together with *Glyptorhagada* and *Meracomelon* in northeastern South Australia. Several pupillids are also common in this dry northern part of the system. Many of these forms are typical of central Australia and find their southern range limits in the lower reaches of the Murray-Darling System.

Three groups of land snails are of particular interest from the point of view of indicating possible effects on faunal distribution of the Murray-Darling System. These are the camaenids, the rhytidids and the pupillids. All these groups are in need of comprehensive taxonomic revision, but even without an up-to-date evaluation of the groups certain suggestions can be put forward about interrelationships.

In the family Camaenidae there is a wide radiation of subglobose species with slight granular sculpture and closed umbilicus typified by species belonging to the genera *Meriodolum* and *Galadistes* in the upper reaches of the Darling system. In shell structure and in some general anatomical feature they show similarities with the group of species belonging to the genera *Meracomelon* and *Sinumelon* found in central South Australia around the past and present lower reaches of the river.

The family Rhytididae has a group of medium to large species, referred to the genus *Strangesta*, inhabiting Queensland and northern New South Wales including the upper reaches of the Namoi and adjacent rivers. A species, *Strangesta* (?)

gawleri, found in the Lofty Ranges and around the lower Murray shows several similar features to the *Strangesta* group (Smith, unpublished). There are no similar species in southern New South Wales or Victoria.

The family Pupillidae is a widespread, common group in central Australia with two genera, *Gastrocopta* and *Pupoides* particularly prominent. Both these groups have their southern limit in the wide flood plains and limestone cliffs of the southern end of the Murray-Darling System.

DISCUSSION

The Murray-Darling River System is really two separate river complexes draining two totally different types of land areas in eastern Australia. These two rivers join close to their seaward end and flow as a combined stream for only a comparatively short distance relative to their total lengths. However, from the point of view of their associated fauna, the fact that they are separate systems that eventually come together has important implications. The rivers, fed by entirely separate and unrelated water sources, are both subject to periodic massive floods. Because one may be in flood while the other is at a low flow stage of its cycle there is the potential for considerable fauna dispersal between the two systems.

The area has often been considered as a single faunal province. Iredale (1937a) incorporated most of the Murray-Darling Basin in his Euronotian Faunula of land shells and McMichael and Iredale (1959) designated the aquatic molluscs of the Basin the Mitchellian Fluvifaunula. Five species of aquatic molluscs are here considered endemic to the Murray-Darling System but there are no endemic terrestrial mollusc species. The species considered endemic to the Murray-Darling System are:

Vivipara (*Notopala*) *hanleyi*
Plotiopsis balonnensis
Glyptophysa cosmeta
Alathyria jacksoni
Alathyria condola

The molluscan faunas of the various parts of the system are more closely related to the molluscan assemblages in areas adjacent to those parts. The molluscan assemblage of the Murray Basin is typically southeastern Australian in composition, that of the upper reaches of the feeder streams of the Darling system is typical of the eastern Australian fauna and that of the lower Darling typical of central Australia.

While the molluscs of the Murray-Darling System do not appear to form a faunal unit, several species do represent the southern-most range distributions of widespread, diverse northern Australian groups. Groups such as the Viviparidae and Thiaridae are found in the river systems of much of Queensland, Northern Territory and northwestern Australia. However in the southern regions they are confined to the Murray-Darling System, with their southern limit the freshwater boundary of the lower Murray. Certain genera of land molluscs show a similar picture with widespread northern groups and related groups occurring in the lower Murray Valley but with no close relatives in the remainder of the southeastern Australian faunal region. Though much more detailed taxonomic revisionary work needs to be undertaken to confirm the relationships, these observations suggest that the Murray-Darling System has had a significant influence on the distribution of animals in eastern Australia. It is suggested that the Murray-Darling System should be considered a transportation corridor, bringing about, by means of the periodic massive floods to which the system is subject, the distribution of several molluscan species from northern and to a lesser extent southeastern Australia in the Lower Murray Valley.

Over the past hundred and fifty years, European settlement has brought about major habitat changes in the Murray-Darling System with river flow control, land clearance and the establishment of large areas of urbanization and monoculture of introduced plant species. To service this development river, rail and road transport systems have been established. These activities have caused the widespread dispersal of introduced snails and slugs to the point where these species are now the dominant molluscs, particularly in the Murray Valley where many have reached plague proportions.

ACKNOWLEDGMENTS

This work was partially supported by a grant from the Australian Biological Resources Study. Thanks are due to Ms. R. Plant and Ms. H. Malcolm of the National Museum, Victoria, for their assistance in collecting and collating data and to Mrs. L. Anderson for typing the manuscript.

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APPENDIX

Species list of the molluscs recorded from the Murray-Darling River System. **I** = *species introduced into Australia;* **E** = *species endemic to this river system.*

AQUATIC FAUNA

Family VIVIPARIDAE
(E) *Vivipara* (*Notopala*) *hanleyi* (Frauenfeld, 1862)
Family HYDROBIIDAE
Potomopyrgus nigra (Quoy and Gaimard, 1835)
Pupiphryx grampianensis (Gabriel, 1939)
Coxiella striata (Reeve, 1842)
Family BITHYNIIDAE
Gabbia australis (Tryon, 1865)
Family THIARIDAE
(E) *Plotiopsis balonnensis* (Conrad, 1850)
Family LYMNAEIDAE
Lymnaea lessoni (Deshayes, 1831)
Lymnaea tomentosa (Pfeiffer, 1855)
Family PLANORBIDAE
(I) *Planorbarius corneus* (Linne, 1758)
Physastra gibbosa (Gould, 1847)
(E) *Glyptophysa cosmeta* (Iredale, 1943)
Glyptophysa aliciae (Reeve, 1862)
Bulinus (*Isidorella*) *hainesii* (Tryon, 1866)
Bulinus (*Isidorella*) *newcombi* (Adams & Angas, 1864)
Gyraulus sp.
Segnitila sp.
Family ANCYLIDAE
Ferrissia (*Pettancylus*) *petterdi* (Johnston, 1879)
Ferrissia (*Pettancylus*) *tasmanicus* (Tenison-Woods, 1876)
Family HYRIIDAE
Velesunio ambiguus (Philippi, 1847)
(E) *Alathyria jacksoni* (Iredale, 1934)
(E) *Alathyria condola* (Iredale, 1943)
Family CORBICULIDAE
Corbiculina angasi (Prime, 1864)
Family SPHAERIIDAE
Pisidium casertanum (Poli, 1795)
Sphaerium sp.

TERRESTRIAL FAUNA

Family SUCCINEIDAE
Succinea (*Austrosuccinea*) *australis* (Ferussac, 1821)
Family PUPILLIDAE
Gastrocopta (*Australbinula*) *rossiteri* (Brazier, 1875)
Gastrocopta (*Australbinula*) *bannertonensis* (Gabriel, 1930)
Gastrocopta (*Australbinula*) *margaretae* (Cox, 1868)
Pupoides adelaidae (Angas, 1864)
Pupoides beltiana (Tate, 1894)
Pupoides ischna (Tate, 1894)
Family VALLONIIDAE
(I) *Vallonia pulchella* (Muller, 1774)
Family RHYTIDIDAE
Rhytida (?) *capillacea* (Ferussac, 1832)
Strangesta (?) *gawleri* (Brazier, 1872)
Strangesti (?) *strangei* (Pfeiffer, 1849)
Family CHAROPIDAE
Elsothera murrayana (Pfeiffer, 1864)
Stenopylis hemiclausa (Tate, 1894)
Pillomena dandenongensis (Petterd, 1879)
Gyrocochlea sp.
Family PUNCTIDAE
Paralaoma morti (Cox, 1864)
Laomavix collisi (Brazier, 1877)
Magilaoma penolensis (Cox, 1868)
Excellaoma retipora (Cox, 1867)
Paralaoma sp.
Family ARIONIDAE
(I) *Arion intermedius* (Normand, 1852)
Family ZONITIDAE
(I) *Oxychilus alliarius* (Miller, 1882)
(I) *Oxychilus cellarius* (Muller, 1774)
Family MILACIDAE
(I) *Milax gagates* (Draparnaud, 1801)
Family LIMACIDAE
(I) *Limax maximus* (Linnaeus, 1758)
(I) *Deroceras caruanae* (Pollonera, 1891)
(I) *Deroceras reticulatus* (Muller, 1774)
(I) *Lehmannia* (*Lehmannia*) *nyctelia* (Bourguignot, 1861)
(I) *Lehmannia* (*Limacus*) *flavus* (Linnaeus, 1758)
Family CAMAENIDAE
Chloritobadistes victoriae (Cox, 1868)
Meracomelon cassandra (Pfeiffer, 1864)
Sinumelon fodinalis (Bednall, 1892)
Sinumelon flindersi (Angas, 1864)
Exilibadistes sutilosa (Deshayes, 1850)
Semotrachia subsecta (Tate, 1879)
Meridolum gilberti (Pfeiffer, 1846)
Pleuroxia hinsbyi (Gude, 1916)

Galadistes bourkensis (Smith, 1891)
Glyptorhagada silveri (Angas, 1868)
Glyptorhagada kooringensis (Angas, 1877)
Family HELICIDAE
(I) *Helix* (*Cryptomphalus*) *aspersa* (Born, 1778)
(I) *Theba pisana* (Muller, 1774)
(I) *Cernuella* (*Cernuella*) *virgata* (Da Costa, 1779)
(I) *Candidula intersecta* (Poiret, 1801)
(I) *Cochlicella ventrosa* (Draparnaud, 1801)
(I) *Cochlicella acuta* (Muller, 1774)