DE DECKKER, P. 1977. The distribution of the "Giant" ostracods Family: Cyprididae Baird, 1845) endemic to Australia. Sixth Internat. Ostracod Symposium, 285-294, Junk, The Hague.

THE DISTRIBUTION OF THE 'GIANT' OSTRACODS (FAMILY: CYPRIDIDAE BAIRD, 1845) ENDEMIC TO AUSTRALIA

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Abstract

Australocypris, Mytilocypris and *Trigonocypris* can tolerate waters of wide ranging salinities (some species tolerate up to 112.5‰ salinity). These 'giant' ostracods are recorded in most parts of Australia, except in the centre and northern part of the continent.

It is suggested that their dispersal could come about by some of the continuously migrating waterfowl (often seen inhabiting brackish waters) carrying ostracods and ostracod eggs.

Introduction

A number of species of 'giant' ostracods (> 3 mm) of the tribe Mytilocypridini are widely, and often disjunctly, distributed in Australia. During field work, it was noticed that large flocks of waterfowl typically inhabit the same waters. Since it is possible that waterfowl are inadvertently responsible for the dispersal of ostracods, an analysis of the distribution of these ostracods, dispersal mechanisms of ostracods, and distribution of waterfowl and their possible role in dispersal of ostracods is presented.

Distribution of ostracods of the tribe Mytilocypridini

Most of the ostracods belonging to the tribe Mytilocypridini De Deckker, 1974 are grouped within three already known genera (*Mytilocypris* McKenzie, 1966, *Australocypris* De Deckker, 1974 and *Trigonocypris* De Deckker, 1976) (Table 1).

Table 1. List of occurrences of studied Mytilocypridinid Ostracods recorded in the literature and from my unpublished data.

Australocypris De Deckker, 1974.

A. *Australocypris hypersalina* De Deckker, 1974
- cut-off arm of Lake Eliza, S.A. (De Deckker, 1974)
- Lake Mitre, Vic.
- Lake near Nora Creina Bay, S.A. (De Deckker, 1974)
- Lake Robe, S.A. (De Deckker, 1974)
- Lake St. Clair, S.A. (De Deckker, 1974)
- Pond near Salt Works, 12 km E. of Langhorne Ck., S.A.
- Salt Lake, Beachport, S.A.
- shallow saline swamp near southern end of Lake Eliza, S.A. (De Deckker, 1974)
- small lake near Errington's Hole on way to the boundary, S.A. (De Deckker, 1974)
- small lake on opposite side of road to southern end of Lake Eliza, S.A. (De Deckker, 1974)
- south of The Coorong, S.A.
- St. Mary's Lake, Vic.

Table 1 ctd.

B. *Australocypris insularis* (Chapman, 1966)
- Birida, 8.5 km south of Salt Works, Shark Bay, W.A. (26°33'S 113°24'E) = Loc. 21
- Birida, 40 km west of Hamilton Homestead, Shark Bay, W.A. (26°33'S 113°55'E) = Loc. 23
- Birida, 12 km south of Salt Works, Shark Bay, W.A. (26°12'S 113°24'E) = Loc. 24
- Houtman's Abrolhos, West Wallabi Island, W.A. (Chapman, 1966)

C. *Australocypris robusta* De Deckker, 1974
- Lake Beeac, Vic. (De Deckker, 1974)
- Lake Gnarpurt, Vic. (De Deckker, 1974)
- Lake Gnotuk, Vic. (De Deckker, 1974)
- Lake Keilambete, Vic. (De Deckker, 1974)
- Salt Works, Turnbridge, Tas.
- Samphire Flats, Barrilla Bay, Tas. (= *A.* sp. De Deckker, 1974)
- south of The Coorong, S.A.

D. *Australocypris? rectangularis* n.sp.
- Centre Lake, Vic.

Trigonocypris De Deckker, 1976

A. *Trigonocypris globulosa* n. sp.
- Lake Buchanan, Qld.
- The Salt Lake, 80 km south of Tibooburra, N.S.W.

B. *Trigonocypris timmsi* De Deckker, 1976
- Pine tree Creek Lagoon, via Hughenden, Qld. (De Deckker, 1976)

C. *Trigonocypris* sp. De Deckker, 1976
- Fossil, Tertiary, Central Qld. (De Deckker, 1976)

Mytilocypris McKenzie, 1966.

A. *Mytilocypris henricae* (Chapman, 1966)
- Bulldozer Swamp, Rottnest Island, W.A.
- Currawong via Salt Creek, S.A.
- Lake Coradgill, Vic.
- Lake Linlithgow, near Hamilton, Vic. (Chapman, 1966)
- Lake Lomond, Vic. (F. Chapman's collection)
- Lake Purdigulac, Vic.
- Oldfield River, Rottnest Island, W.A.
- pond near Lake White, Vic.

B. *Mytilocypris mytiloides* (Brady, 1886)
- Blackmans Lagoon, NE Tas.
- Creek off Logans Lagoon, Flinders Island.
- Kangaroo Island (Brady, 1886)
- Lake Edward, S.A. (37°38'S 140°36'E)
- Lake Hopetoun, Vic. (Chapman, 1966)
- Lake Wallace, Vic. (Chapman, 1966)
- Sheepwash Lagoon, Vic. (38°08'S 141°11'E)
- White Lagoon, Tas. (42°04'S 147°28'E)

C. *Mytilocypris splendida* (Chapman, 1966)
- Collins' Lake, near Lake Yallaker, Vic.
- Lake Bolac, Vic. (Chapman, 1966)
- Lake Bookar, Vic. (Chapman, 1966)
- Lake Buchanan, Qld.
- Lake Colac, Vic.
- Lake Cooper, Vic. (Chapman, 1966)
- Lake Gnarpurt, Vic.
- Lake Kariah, Vic.
- Lake Learmouth, Vic. (Chapman, 1966)
- Muddah Lake, N.S.W.
- The Salt Lake, 80 km S. of Tibooburra, N.S.W. (30°08'S 142°07'E)
- Salt Works, Turnbridge,Tas.

D. *Mytilocypris tasmanica* McKenzie, 1966
- Calverts Lagoon, South Arm, near Hobart, Tas. (McKenzie, 1966)
- Boneo Swamp, Vic. Pleistocene

E. *Mytilocypris ambiguosa* n. sp.
- Barkers Swamp,Rottnest Island, W.A.
- Lighthouse Swamp, Rottnest Island, W.A.
- Pool near Lake Goldsmith, Vic.
- 5 km east of Ongerup, W.A. (M.A. Chapman's collection)

F. *Mytilocypris minuta* n. sp.
- Barkers Swamp, Rottnest Island, W.A.
- Currawong, via Salt Creek, S.A.
- Lake Preston, 50 km south of Perth, W.A.

G. *Mytilocypris praenuncia* (Chapman, 1936)
- Lake Bookar, Vic.
- Lake Coradgill, Vic.
- Lake Corangamite, Vic.
- Lake Kariah, Vic.
- Lake Keilambete, fossil
- small lake near Centre Lake, Vic.
- The Mallee, Vic. Pleistocene (Chapman, 1936)

H. *Mytilocypris* sp. Fossil
- Late Tertiary, Morwell Coal Seam, Geelong, Vic. (Waldman & Handby, 1968)

I. genus *Mytilocypris*
- Lake Modewarre, Vic. (Pollard, 1970)
- Murchinson River, W.A. (McKenzie, 1971)
- Swampy Lagoon, near Kilcunda, Vic. (McKenzie, 1971)

All are endemic to Australia. They are recorded from inland waters of wide ranging salinities (0 to 112.5‰); typically they live in at least slightly saline waters or in ephemeral lakes.

These ostracods are abundant in the western and south-eastern parts of Australia (including Tasmania, Flinders and Kangaroo Islands) but there are also records from Central Queensland (Fig. 1 & Table 1). There are only two records from New South Wales which could be due to lack of collecting in this state, but there are not many athalassic saline lakes that are accessible in the eastern parts, nor are there many accessible in South Australia. Similar comments apply to Queensland.

Outstanding examples of disjunct distributions are provided by *Mytilocypris henricae*, *M. mytiloides* and *M. splendida* (Table 1).

Dispersal mechanisms of ostracods

The sex ratio in all my samples of mytilocypridinid ostracods is unity, suggesting that this tribe lacks parthenogetic species. Hence for a species to populate a new water body successfully, either many specimens of both sexes or many eggs are needed. Eggs of mytilocypridinids (as for most cypridinids) can withstand desic-

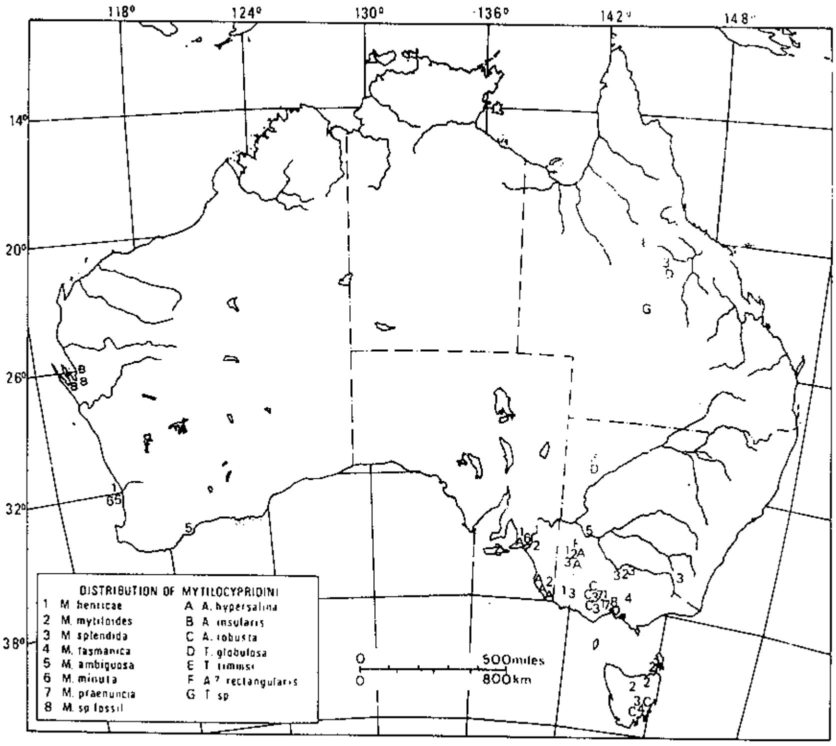

Fig. 1. Distribution of Mytilocypridinid Ostracods

cation. This is shown by their protective double-wall structure (McKenzie 1971) and proved by Sars who raised ostracods from dried mud.

Ostracods and ostracod eggs can be carried either by moist winds, or inside the alimentary canals of fishes (Kornicker & Sohn 1971) and birds (Proctor 1964 and Proctor & Malone 1965) or attached to the body of birds (Sandberg & Plusquellec 1974) visiting the waters in which the ostracods live.

In the Australian context, it is difficult to visualize that eggs or ostracods could be carried by moist winds for long distances (some localities of *Mytilocypris henricae* are separated by up to 2,400 km) across the dry centre, or from south to north or vice versa (in the case of *M. splendida*). Even if this was possible it would be an extreme coincidence for ostracods and their eggs to be dropped into a suitable environment i.e. a small saline lake.

Dispersal by fishes does not apply to species in the tribe Mytilocypridini, since the saline or ephemeral lakes they inhabit are endorheic.

The remaining agents of dispersal for mytilocypridinids are birds, especially migrating waterfowl. This has been suggested for other ostracods by many authors (Klie 1926, Sandberg 1964, Proctor 1964, Proctor & Malone 1965, Mckenzie 1971 and Sandberg & Plusquellec 1974).

Similarly, Baker (1945) reported that the distribution of freshwater snails in the West Indies corresponded to the migration pattern of birds which transported and distributed them. Further, Yen (1947) mentioned the modes of distribution of molluscs which are attached to the feet of wading birds and transported for long distances.

Distribution of waterfowl and their possible role in dispersal of ostracods

Among the 19 species of Australian waterfowl, 12 (Table 2) are found over most of the continent, particularly in northern parts. Most inhabit various types of water, ranging from fresh to saline, and are often seen migrating to new places when shortage of food occurs, or during drought or flood conditions. Norman (1971) studied the movement of the Black Duck, Mountain Duck and Grey Teal populations in South Australia. He concluded that the Grey Teal disperse widely in most directions, some up to 1000 km or more, and the Black Duck and Mountain Duck populations appear to contain a proportion which move long distances (even up to at least 500 to 1000 km).

It is known from stomach content analyses of these species (Frith 1967 and Frith et al. 1969) (Fig. 2) that ostracods are ingested by at least 7 of them. Two of these are plant feeders and hence must accidentally swallow ostracods while feeding; ingestion of ostracods (or at least of microinvertebrates) is probably more deliberate in the plant-animal feeders (see Table 2). With reference to the former situation, ostracods are known to attach their eggs to plant matter. The author has also observed *Australocypris robusta* laying eggs in empty gastropod shells as well as attaching them to algae in an aquarium.

These waterfowl could disperse mytilocypridinid ostracods in a number of ways:

(a) Ostracod eggs could be swallowed in one lake by the waterfowl and ejected

Table 2. Composition of food and presence of ostracods in gizzards of 12 species of Australian waterfowl (data after Frith, 1967 and Frith et al., 1969).

		Presence of ostracods in gizzards.
Plant feeder (<80% total volume	Black swan	
	Freckled duck	× (0.2%)
	Grey teal	
	Black duck	×
	Wood duck	
Plant-animal feeder (± 50–50% total volume	Hard head	×
	Blue-billed duck	×
	Pink-eared duck	×
	Shoveler	×
	Musk duck	×
	Chestnut teal	
	Mountain duck	

in the faeces of the bird in another lake if the animal has been travelling just after eating. As mentioned before, this could occur when the plant-feeder birds accidentally swallow ostracod eggs attached to plants. Proctor (1964) fed a wide variety of crustacean eggs, among which were 5 species of ostracods (4 of which belong to the family Cyprididae) and recovered them from the lower digestive tract of both domesticated and wild ducks. These have been hatched and raised to maturity. Similarly, Proctor & Malone (1965) fed the eggs of 2 cypridids to mallard ducks and recovered them from the faeces of the birds. Both species grew from these eggs but it was noticed that the eggs of one species seemed capable of withstanding avian digestion processes better than the others. It is understood that many eggs have to be dropped in a lake in order to populate a new environment successfully, but this could easily be achieved as many eggs can be carried in the faeces of only one bird.

(b) Ostracods could also be egested by the waterfowl, especially by the plant-animal feeders. Kornicker & Sohn (1971) said that none of the ostracods they fed to fishes in their experiment was defecated alive. This could well be the case for the mytilocypridinids, being larger in size and therefore easily crushed inside the birds or damaged by the digestive fluids. However, some of the carapaces enclosing and protecting many eggs could be defecated and eggs would be hatchable if dropped in slightly saline waters.

However, I have seen many specimens of *Mytilocypris splendida* (Chapman 1966) collected by Dr. E. F. Riek from the stomach of a trout in Lake Learmouth, Victoria. These were in a perfect state of preservation and contained eggs inside their carapaces. Sandberg & Plusquellec (1974) mention specimens of an ostracod taken from the stomach of a duck showing little evidence of valve dissolution.

(c) Ostracods and their eggs could be carried for long distances from one lake to another attached to feathers and the waterfowl's legs. (While collecting ostracods in some lakes where they were abundant, I often found that after putting my arm in the water, a few ostracods stayed attached to the hairs of my arm. Occasionally, the ostracods were surrounded by a bubble of water allowing them to stay moist as they closed their carapaces in order to avoid drying up). McKenzie & Hussainy (1968) tested some ostracods by leaving them for 9 days on moist filter paper protected by 2 petri dishes. After that period of time, the ostracods were seen returning to normal activity after immersion in lake water. This would support the idea that ostracods could easily be transported among the feathers of the waterfowl or

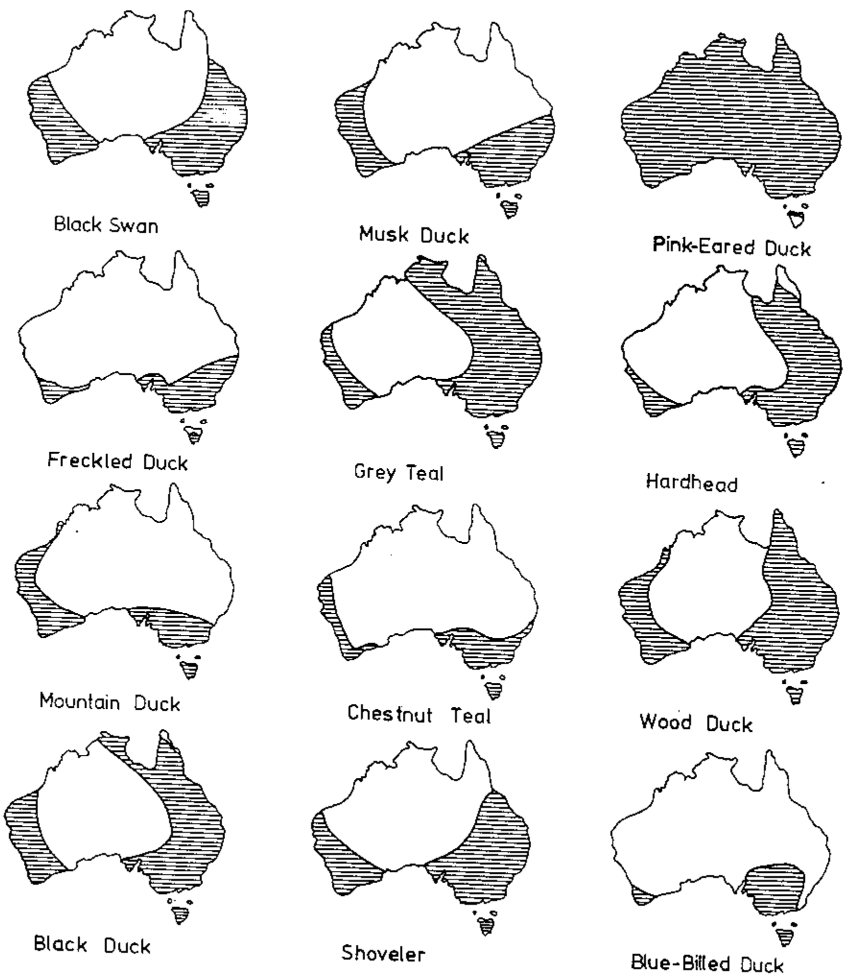

Fig. 2. Maps showing the distribution (in shaded) for 12 species of the Australian Waterfowl. (Data from Frith 1967 and MacDonald 1973.)

in a mud cake attached to the bird's legs without suffering desiccation and therefore being transported into a new body of water.

For example, to explain the presence of *Mytilocypris splendida* at an altitude of 990 m in Muddah Lake near Cooma, N.S.W., one could say that this ostracod would probably have been carried there by waterfowl (e.g. Mountain Duck).

Conclusions

It has been suggested for some time that ostracods and their eggs could be transported by means of moist winds, fishes and migrating waterfowl. The former two agents are considered rather unlikely in Australia for the mytilocypridinid ostracods which often inhabit saline waters. The migrating waterfowl, often visiting such waters and having the same geographical distribution as the mytilocypridinids, could be acting as dispersal agents for these ostracods, this being achieved in the following ways:

- ostracod eggs could be egested by the waterfowl and dropped in another lake within the faeces of the birds;
- ostracods and their eggs could be carried attached to the bird's legs and feathers prior to and during flight and deposited later in another body of water.

Finally, similar conclusions could be drawn for the distribution of *Diacypris*, a small ostracod from saline waters in Western Australia, South Australia, Victoria and Tasmania.

Acknowledgements

Dr. B. V. Timms read the manuscript and kindly suggested improvements. I also wish to record my thanks to Drs. I.A.E. Bayly, P.S. Lake, B.V. Timms who provided me with mytilocypridinid ostracods and to Mr. G.L. Dean-Jones who helped in the collection of samples.

References

Baker, F.C.1945. The molluscan family Planorbidae. Univ. of Illinois Press, Urbana, pp. 1-530.

Bayly, I.A.E. & Williams, W. D. 1973. Inland Waters and Their Ecology (Longman, Australia).

Chapman, F. 1936. Cypridiferous limestone from the Mallee. Rec. Geol. Surv. Vic. 5 (2):296-298.

Chapman, M. A. 1966. On Eucypris mytiloides (Brady) and three New species of Eucypris Vavra (Cyprididae, Ostracoda). Hydrobiologia 27:368-378.

De Deckker, P. 1974. Australocypris, a new ostracod genus from Australia. Aust. J. Zool. 22:91-104.

De Deckker, P. 1976. Trigonocypris, a new ostracod genus from Queensland. Aust. J. Zool. 24:145-157.

Frith, H. J. 1967. Waterfowl of Australia. Angus & Robertson, Sydney.

Frith, H. J., Braithwaite, L. W. & McLean, J. L. 1969. Waterfowl in inland swamp in New South Wales. II. Food. CSIRO Wild. Res. 14:17-64.
Klie, W. 1926. Ostracoda, Muschelkrebse. In: Schulze, P., Biologisches der Tiere Deutschlands 22 (16):1-56.
Kornicker, L. S. & Sohn, I. G. 1971. Viability of ostracode eggs egested by fish and effect of digestive fluids on ostracode shells-ecologic and paleontologic implications. Bull. Centre Rech. Pau SNPA 5 suppl.:125-135.
MacDonald, J. D. 1973. Birds of Australia. Reed, Sydney.
McKenzie, K. G. 1971. Palaeozoogeography of freshwater Ostracoda. Bull. Centre Rech. Pau SNPA 5 suppl.:207-237.
McKenzie, K. G. & Hussainy, S. U. 1968. Relevance of a freshwater cytherid (Crustacea, Ostracoda) to the Continental Drift Hypothesis. Nature 220 (5169):806-808.
Norman, F. I. 1971. Movement and Mortality of Black Duck, Mountain Duck and Grey Teal in South Australia, 1953-1963. Trans. R. Soc. S. Aust. 95 (1):1-7.
Proctor, V. W. 1964. Viability of Crustacean Eggs recovered from Ducks. Ecology, 45:656-658.
Proctor, V. W. & Malone, C. R. 1965. Further evidence of the passive dispersal of small aquatic organisms via the internal tract of birds. Ecology 46:728-729.
Sandberg, P. A. 1964. The ostracod genus Cyprideis in the Americas. Stockh. Contr. Geol. 12:1-178.
Sandberg, P. A. & Plusquellec, P. L. 1974. Notes on the anatomy and passive dispersal of Cyprideis (Cytheracea, Ostracoda). Geoscience and Man 6:1-26.
Yen, Teng-Chien. 1947. Distribution of fossil fresh-water mollusks. Geol. Soc. Amer. Bull. 58:293-298.

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Discussion

Löffler: The coeca of waterfowl provide storage of duration stages up to 10 days, that is, much longer than any digestive tract passage would provide for. (See: Löffler, H. & Leibetseder, J. 1965 Daten zur Dauer des Darmdurchganges bei Vögeln. Zool. Anz. 177 (5/6):334–340.)
Kornicker: The high diversity of species of this group in Australia suggest fragmentation of an ancestral population once widespread there. The present species evolved in geographically isolated ponds after fragmentation of the original ancestral species. Dispersal by ducks may be a late occurrence and could account for sympatric species, but not for the high diversity of species in Australia.
De Deckker: You just summarized what I tried to say: the occurrence of sympatric species today is caused by the ever migrating waterfowl which carry ostracods from one place to another. The high diversity of mytilocyprinidinid species is surely caused by fragmentation and isolation of an ancestral population which occurred on vast areas of the Australian continent like the Murray Basin, the Darling-Warrego Basin and Lake Eyre Basin which were intermittently wetter than today during the Late Tertiary and Early Quaternary.
Neale: One reason why I preferred the rice seed hypothesis to the transference of ostracods by bird hypothesis is that whilst there is a dearth of information on bird

migration in S.E. Asia, my impression is that migration follows a general north-south direction rather than an east-west one. Does this accord with your data in the Australian area ?

De Deckker: I think that waterfowl in Australia has a rather complex movement pattern. These birds are mostly found in the wetter coastal areas of the continent and only disperse inland, in all directions, when rain and flooding conditions occur, thus creating new temporary habitats.

Whatley (to Neale): Herons and similar birds are quite as likely to transport ostracods as anatids. Herons, throughout much of the world, undergo fairly widespread longitutinal migrations, particularly in times of drought or flooding.