

# Do freshwater mussels exist on the Tiwi Islands?

Richard C. Willan<sup>1</sup> and Hugh A. Jones<sup>2</sup>

<sup>1</sup>Museum and Art Gallery of the Northern Territory,  
GPO Box 4646, Darwin, NT 0801, Australia  
Email: [richard.willan@nt.gov.au](mailto:richard.willan@nt.gov.au)

<sup>2</sup>NSW Department of Planning, Industry and Environment,  
PO Box A290, Sydney South, NSW 1232, Australia

## Abstract

Exhaustive searches through collections and literature indicates that apparently no member of the freshwater mussel family Hyriidae exists on the Tiwi Islands, off the central Northern Territory coastline. Nor apparently does any hyriid exist on Cobourg Peninsula on the adjacent mainland of western Arnhem Land. These absences are despite seemingly suitable habitats being present on these large nearshore islands and landmass at the present time. Other hyriids do exist on nearshore islands in northern Australia and elsewhere in Australasia. The reasons for these absences are discussed briefly, with the most likely being a more arid climate during the Last Glacial Maximum drying out the streams and wetlands in the region.

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## Introduction

The only family of freshwater mussels in Australia, Hyriidae, consists of six genera (*Alathyria*, *Cucumerunio*, *Hyridella*, *Lortiella*, *Velesunio* and *Westrallunio*) with approximately 20 species (McMichael & Hiscock 1958; McMichael 1967; Smith 1992; Walker *et al.* 2014). Conventional literature posits that hyriids “are found in all parts of mainland Australia” (McMichael & Hiscock 1958: 487; Walker 1981a; Smith 1998; Walker 1998), as well as (northern) Tasmania, New Guinea, the Solomon Islands, New Zealand and South America (McMichael & Hiscock 1958; Boss 1982; Walker 1981a; Smith 1992, 1998; Bogan & Roe 2008; Graf *et al.* 2015). Clearly such generalisations do not take the permanent inland deserts into account, but hyriids exist wherever suitable river systems – or even semi-permanent water holes – are present. In general, the distribution of individual species is determined, more or less, by the geography of the river systems (Iredale 1943).

Only three genera of the Hyriidae are present in the northern Australian region (termed the Leichhardtian Fluvifaunal Area by McMichael & Hiscock (1958) and McMichael & Iredale (1959)), which extends westward from Queensland, across the north of the continent, to the Kimberley region of Western Australia – *Velesunio* (which is more widespread and more abundant in the habitats in which it exists), *Alathyria* and *Lortiella*.

In July and August 2018, the junior author visited the Museum and Art Gallery of the Northern Territory (MAGNT) to study the collection of hyriids (Figure 1), both

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the species present in the mollusc collection and their distributions. During the course of this research both authors were surprised to notice that there were no records of hyriids from the Tiwi Islands. Following this visit we sought information from other sources (mostly museums and databases) in Australia and overseas to decide if this were a genuine absence or merely a lack of sampling. In doing so, we also enquired about records for the Cobourg Peninsula, which is the closest major geographical feature on the Australian mainland coast to the Tiwi Islands.

## Enquiries and Results

We undertook the following investigations to decide if any freshwater mussels existed at present, or historically, on the Tiwi Islands or Cobourg Peninsula:

- On 9 August 2018, RCW approached Vince Kessner, the person with the greatest knowledge on the non-marine molluscs of the Northern Territory. Mr Kessner had managed the health clinic at Milikapiti, on Melville Island, for some years and knows the Tiwi fauna very well. On the same day, Mr Kessner replied that no hyriids were present.
- On 9 August 2018, through Kate Hadden, RCW approached the 10 senior landholders from the Tiwi Islands, all of whom were on the Executive Committee of the Tiwi Land Council, and who were present at an environmental forum in Darwin. Kate kindly asked these elders if they had seen hyriids and showed them the relevant illustrations in McKay (2017). On 22 August 2018, Ms Hadden replied that no hyriids were known by these Tiwi people.
- On 9 August 2018, RCW asked Dr Mandy Reid, Collection Manager, Malacology, The Australian Museum, if that institution had any hyriids from the Tiwi Islands in its collection. On 29 August 2018, Dr Reid replied that none were present.
- On 3 September 2018, RCW asked Dr Suzanne Williams, Head of Invertebrate Division, Natural History Museum, London, whom to approach to ask if that institution had any hyriids from the Tiwi Islands in its collection. Dr Williams referred the enquiry to Dr Tom White, presently the Curator responsible for bivalves. Dr White scanned the early registers and the collection for us. On 9 October 2018,



**Figure 1.** Specimens of *Velesunio* cf. *angasi* from Oenpelli Billabong (western Arnhem Land), which is apparently close to the point at which all freshwater mussels cease to exist on the central coast of the Northern Territory. Museum and Art Gallery of the Northern Territory, P1076. Shell lengths 79.4, 57.3 mm. (MAGNT)

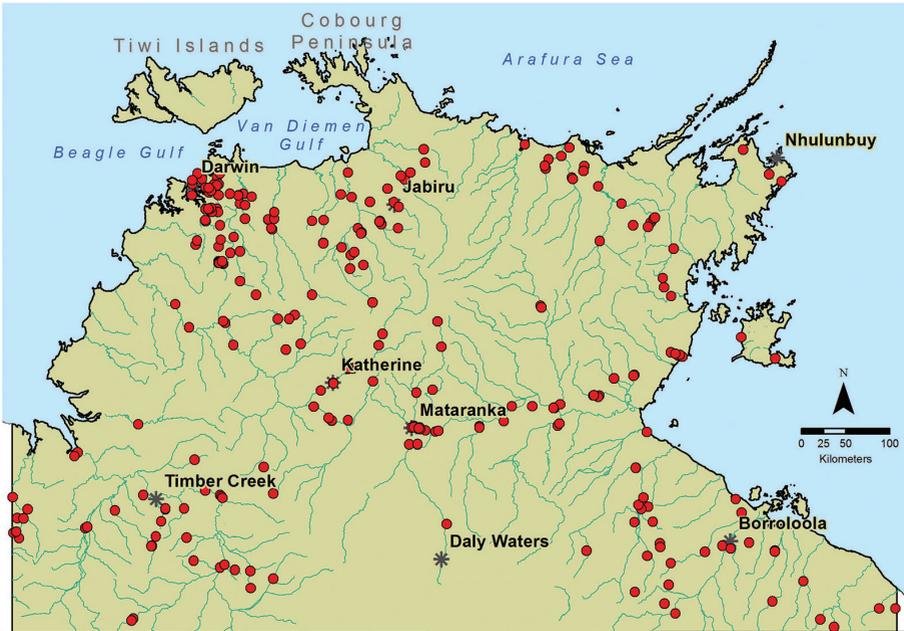
Dr White replied that he was unable to find any relevant specimens. Moreover, he tried various other approaches, such as looking for the names of Tiwi rivers or early settlements (such as Fort Dundas), but to no avail.

- On 20 March 2019, RCW asked Alan Withers, Senior Ranger, Garig Gunak Barlu National Park, Cobourg Peninsula, if he or his wife, Emma, who is an ardent shell collector, if they had seen hyriids and showed them the relevant illustrations in McKay (2017). On 21 March 2019, Mr Withers replied that neither he, nor Emma, had ever seen hyriids on Cobourg Peninsula, despite having spent 19 years there.
- On 6 May 2019, HAJ consulted the OZCAM (Online Zoological Collections of Australian Museums) database, which provides access to records from molluscan collections in Australian museums (CHAFC 2019). The result of this enquiry is that the OZCAM database contains no records of hyriids from the Tiwi Islands or Cobourg Peninsula.
- On 6 May 2019, HAJ consulted the Mussel Project (*MUSSEL $\phi$* ) database, which is a compilation of freshwater mussel collections held by 17 major museums around the world (Graf & Cummings 2018). The result of this enquiry is that the *MUSSEL $\phi$*  database contains no records of hyriids from the Tiwi Islands or Cobourg Peninsula.

## Discussion

All our enquiries lead to the conclusion that there are no freshwater mussels (Hyriidae) on either the Tiwi Islands or Cobourg Peninsula (Figure 2). This is surprising as both the islands that comprise the Tiwis are large – Melville having a land area of 5786 km<sup>2</sup> and Bathurst having a land area of 654 km<sup>2</sup>. In fact, the former is the second largest island off the Australian mainland after Tasmania (64,419 km<sup>2</sup>) and Bathurst is the fifth largest following Groote Eylandt (2285 km<sup>2</sup>). As mentioned above, freshwater mussels definitely do live on some islands. Examples of Australian nearshore islands known to support hyriids are (northern) Tasmania (McMichael & Hiscock 1958) and Groote Eylandt (MAGNT P.43248 = 2 specimens collected live from Lake Angurrkburna in September 2009). Examples of islands beyond Australia that also support hyriids are Misool Island (western New Guinea) and the Solomon Islands group (Walker *et al.* 2013). Despite aquatic faunal surveys having been conducted on the Tiwi Islands (Larson 1998; PWCNT 1998; Woinarski & Baker 2002), there are no records of freshwater mussels from the Tiwi-Coburg region. So it seems the absence is genuine and not just the result of inadequate collecting or surveying.

The closest that freshwater mussels exist to the Tiwi Islands is the northern coast of Darwin Harbour (approx. 12.333°S, 130.883°E), which is 43.5 km over water (i.e. Beagle Gulf) to the south. The closest that freshwater mussels exist to Cobourg Peninsula is Oenpelli Billabong (approx. 12.333°S, 133.050°E), which is 95 km over land to the southeast (Figure 1).



**Figure 2.** Geographic distribution of freshwater mussels (Hyriidae) for the Top End of the Northern Territory based on all verified specimen lots held by the Museum and Art Gallery of the Northern Territory and the Australian Museum.

Given that the Tiwi Islands (and also Cobourg Peninsula) are theoretically large enough to support freshwater mussels, there are three immediate hypotheses to account for this absence – either the habitats are unsuitable, or there is an absence of fishes to act as suitable host for the mussel’s parasitic larva, or there has been significant sea-level change that eliminated them and they have not recolonised.

The Tiwi Islands, particularly Melville Island, have several permanent streams. The major system is the northern drainage, in which are found the largest streams. The southern drainage has shorter, smaller streams (Larson 1998). For Melville Island, the rivers on the northern coast are Kilu-impini Creek, Maxwell Creek, Tjipiri River, Goose (Andranangoo) Creek, Jessi (Aliu) River and Johnston (Tuanungku) River, and (on the southern coast) is Takampirmili Creek. In addition, there are wetlands on both islands, some of which are spring-fed. None of these water systems is reported to be saline.

Salinity is known to be a factor limiting the occurrence of freshwater mussels; Klunzinger *et al.* (2015) showed that *Westralunio carteri* was almost never found at sites where mean salinity was greater than  $1.6 \text{ gmL}^{-1}$ . This, the only species of hyriid in southwestern Australia, has undergone a 49% reduction in its range in less than 50 years due primarily to secondary (i.e. anthropomorphic) salinisation and its conservation status now qualifies it for listing as Vulnerable under the International Union for the Conservation

of Nature's rankings. However, neither primary nor secondary salinity could currently explain the absence on the Tiwi Islands and Cobourg Peninsula.

Freshwater mussels are unique amongst molluscs in requiring a host to complete larval development. The larva (termed a glochidium) needs to pass through a brief parasitic stage on a fish (Walker 1981b; Smith 1998). The glochidium attaches to the external surface or gills of the host. The host may have an immunity to glochidial attack and absorb the larva. If not, then the glochidium becomes encysted in the epidermis of the host and remains there for one to two weeks, depending on water temperature, undergoing metamorphosis into a juvenile mussel (Humphrey & Simpson 1985). It then excysts and drops to the bottom to develop.

Therefore, it is crucial for a glochidium larva to locate a suitable fish. The most widespread mussel species occurring in the Top End of the Northern Territory, *Velesunio angasi*, is a host generalist and completes its development on at least 19 species of freshwater fishes (Humphrey & Simpson 1985). Though the fish fauna of the Tiwi Islands has received very little scientific study, it would appear to be significantly depauperate compared to the adjacent coast (Larson 1998). In particular, there is apparently only one species of plotosid (eel-tailed catfish) (*Neosilurus ater*), and there are apparently no terapontids (grunters) (Larson 1998); both groups of fishes being widespread, abundant and speciose on the adjacent mainland. The absence of the grunters is highly unusual. The habitats available on the Tiwi Islands would suggest that, at least, the Spangled Perch (*Leioptherapon unicolor*) and the Sooty Grunter (*Hephaestus fuliginosus*) should be present. The former is ubiquitous elsewhere in the Leichhardtian Fluvifunal Area, where it inhabits all coastal and inland freshwater creeks and rivers of northern Australia; from the upper Burdekin River in Queensland to the Daly River in the Northern Territory (Larson 1998; Gomon & Bray 2019; Wikipedia 2019; M. Hammer, pers. comm.). Nevertheless, several species of freshwater fish occur in Tiwi Island streams that are suitable hosts for freshwater mussels – melanotaenids (rainbowfishes), atherinids (hardyheads), ambassids (glassfishes), and a number of eleotrids (gudgeons) (Larson 1998; Humphrey & Simpson 1985).

As *Velesunio angasi* is ubiquitous in almost the entire range of freshwater habitats in the Top End (Walker 1998), it would appear that neither a lack of suitable habitat nor a lack of suitable host fishes is responsible for the absence of freshwater mussels on the Tiwi Islands and Cobourg Peninsula. However, it is quite possible that freshwater habitats for hyriids were scarce or absent on the Tiwi Islands around the time of the Last Glacial Maximum. This was a period when the northern Australian climate was significantly drier than at present (Hope 2005). At the beginning of the Holocene, the shift to the modern, monsoon-driven climate coincided with a rapid rise in sea level, isolating the Tiwi Islands and thus preventing colonisation of streams and wetlands on these islands from mainland source populations. Another (less likely) explanation for the absence of mussels on the islands is that for much of the Holocene, sea levels along sections of the northern Australian coastline were somewhat higher than at present (estimates range

from 1–2 m) and they remained higher in the Darwin region until about 2000 years ago (Nott 1996). These elevated sea levels during the Holocene may have drowned out freshwater habitats on the islands. Either a rapid rise in sea level to a considerable height or a gradual rise to a more moderate height would have resulted in seawater incursion into coastal waterways and the increase in salinity would have been lethal to freshwater mussels. Not only would the sea levels have risen, but the temperature of the water would also have risen or fallen considerably as a consequence. Thus, the Tiwi Islands might have been influenced by localised higher water temperature that kept the water levels high (Andrew Rawson pers. comm.).

## Acknowledgements

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