



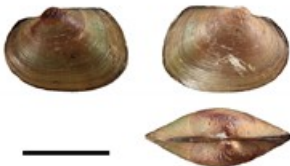
## *Westralunio carteri* Iredale, 1934

### Diagnostic features

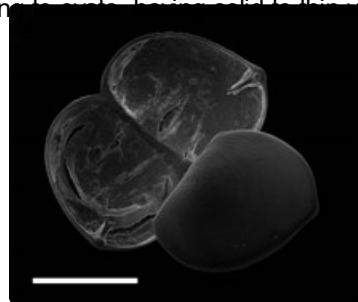
The shell is medium-sized, oblong to sub-ovate, being slightly thinner alve,



*Westralunio carteri* lectotype (adult length up to 100 mm). Photo: M. Reid.



*Westralunio carteri* juvenile, Yule Brook, south W. Australia. Scale bar 10 mm. Photo: A. F. Sartori.



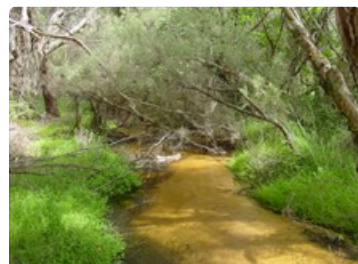
*Westralunio carteri* glochidia. Scale bar 200  $\mu$ m SEM photo: M. W. Klunzinger.



Distribution of *Westralunio carteri*.



Living *Westralunio carteri* with siphons extended. Photo: M. W. Klunzinger.



Yalyal Brook, SW Western Australia, a locality in which *Westralunio carteri* is found. Photo M. E. Klunzinger.



Victoria Reservoir, Darling Range, E of Perth, Type locality for *Westralunio carteri*. Photo: C. Whisson.

sculpture of collabral growth lines and a surface covered with a thick brown periostracum. Umbos of juveniles have v- to w-shaped sculpture, usually eroded in shells more than 30 mm long. The interior of valves is nacreous bluish to bronze to white, with copper blotches. The hinge has pseudocardinal teeth which are strongly grooved and serrated; lamellar teeth are usually smooth and blade-like. Anterior retractor muscle scars are deeply impressed. Posterior end of shell tends to be more rounded than *W. inbisi* and overall, shells of this species are more oblong and largerr than *W. inbisi*, but series of shells are needed to note differences. From Klunzinger et al. (2022), “Specimens of *W. carteri* are distinguished from other Australian *Westralunio* taxa by having shell series that are significantly larger and more elongated than *Westralunio inbisi inbisi* subsp. nov., but not different from *Westralunio inbisi meridiemus* subsp. nov. The species has 10 diagnostic nucleotides at COI (57 G, 117 T, 210 G, 249 T, 255 C, 345 G, 423 T, 447 T, 465 A, 499 T) and 13 at 16S (137 T, 155 C, 228 C, 229 T, 260 G, 290 A, 305 G, 307 T, 310 A, 311 C, 321 T, 330 A, 460 A), which differentiate it from its sister taxa, *W. inbisi inbisi* and *W. inbisi meridiemus* using ASAP and TCS species delimitation models.”

Anatomy: A supra-anal opening is absent. Larvae (glochidia) are brooded in the marsupia in the inner pair of demibranchs of ctenidia in females, inhalant and exhalant siphons are short but prominent and formed by the mantle edge which is open ventrally and fused posteriorly; inhalant siphon larger than exhalant and bears a variable number of prominent papillae and is heavily pigmented with black and orange blotches.

## Classification

*Westralunio carteri* Iredale, 1934

*Common name:* Carter's freshwater mussel

*Class* Bivalvia

*Infraclass* Heteroconchia

*Cohort* Palaeoheterodonta

*Order* Unionida

*Superfamily* Unionoidea

*Family* Hyriidae

*Subfamily* Velesunioninae

*Genus* *Westralunio* Iredale, 1934 (Type species: *Westralunio ambiguus carteri* Iredale, 1934)

*Original name:* *Westralunio ambiguus carteri* Iredale, 1934. In Iredale, T. (1934). The freshwater mussels of Australia. *Australian Zoologist* 8: 57-78.

*Type locality:* Victoria Reservoir in the Darling Ranges, 12 miles east of Perth, Western Australia.

*Synonym:* *Centralhyria angasi subjecta* Iredale, 1934; “*Westralunio carteri*” I Klunzinger et al., 2021; Benson et al., 2022.

## State of taxonomy

The last major taxonomic revision of Australian freshwater mussels was by McMichael & Hiscock (1958). Based on the available molecular results, Walker et al. (2014) pointed out that a reassessment of Australian hyriids is needed.

Molecular species delimitation modelling by Klunzinger et al. (2021) and Benson et al. (2022) recovered three distinct Evolutionarily Significant Units (ESUs) as “*Westralunio carteri*” I, “*Westralunio carteri*” II and “*Westralunio carteri*” III. Klunzinger et al. (2022) combined genetic data with morphometrical shape and shell measurement indices to formally describe “*Westralunio carteri*” I as *Westralunio carteri* Iredale, 1934; “*Westralunio carteri*” II as *Westralunio inbisi inbisi* sp. nov. and “*Westralunio carteri*” III as *Westralunio inbisi meridiemus* sp. nov.

The species is listed as VU – vulnerable on the IUCN Red List of Threatened Species, under the Commonwealth of Australia Environment Protection & Biodiversity Conservation Act 1999 and the Western Australia Biodiversity Conservation Act 2016.

## Biology and ecology

Mainly live in flowing freshwater rivers, streams and water supply reservoirs. Infaunal, living two thirds to almost fully buried in sand and sediment. Shallow burrower in silty sand/mud in streams and rivers. Suspension feeder. Dioecious. Females brood larva (glochidia) in marsupia in the inner pair of demibranchs. When released, glochidia become parasitic on fish gills or fins. After several weeks of undergoing metamorphosis on host fishes, glochidia become young mussels with a ciliated foot and two adductor muscles among other developments. They then detach from their host fish, dropping to the sediment to begin a suspension-feeding lifestyle.

## Distribution

Coastal rivers and streams of south-western Australia.

## Notes

## Further reading

Beesley, P. L., Ross, G. J. B. & Wells, A., Eds. (1998). *Mollusca: The Southern Synthesis. Parts A & B*. Melbourne, CSIRO Publishing.

Benson, J. A., Close, P. G. Stewart, B. A. & Lymbery, A. J. (2017). Upstream recolonization by freshwater mussels (Unionoida: Hyriidae) following installation of a fishway. *Aquatic Conservation: Marine and Freshwater Ecosystems* 28: 512–517.

Benson, J. A., Close, P. G. Stewart, B. A. & Lymbery, A. J. (2019). Freshwater tributaries provide refuge and recolonization opportunities for mussels following salinity reversal. *Science of the Total Environment* 683: 231–239.

Benson, J., Stewart, B., Close, P. & Lymbery, A. (2022). Evidence for multiple refugia and hotspots of genetic diversity for *Westralunio carteri*, a threatened freshwater mussel in south-western Australia. *Aquatic Conservation: Marine & Freshwater Ecosystems* <https://onlinelibrary.wiley.com/doi/abs/10.1002/aqc.3780>

Graf, D. L. & Cummings, K. S. (2019). Hyriidae Swainson, 1840. Pp. 214-217 in C. Lydeard & Cummings, K. S. *Freshwater Mollusks of the World: a Distribution Atlas*. Baltimore, John Hopkins University Press.

Haas, F. (1969) Superfamilia Unionacea (in) Das Tierreich, Lieferung 88, de Gruyter and Co. Berlin.

Iredale, T. (1934). The freshwater mussels of Australia. *Australian Zoologist* 8: 57-78.

Iredale, T. (1943). A basic list of the fresh water Mollusca of Australia. *Australian Zoologist* 10: 188-230.

Jones, H. A. & Byrne, M. (2014). Changes in the distributions of freshwater mussels (Unionoida: Hyriidae) in coastal southeastern Australia and implications for their conservation status. *Aquatic Conservation: Marine and Freshwater Ecosystems* 24: 203-217. *Tropical Natural History Supplement* 3: 112.

Klunzinger, M. W. (2011). Freshwater shrimp (*Palaemonetes australis*) may be involved in glochidia release from the freshwater mussel *Westralunio carteri*. *The Western Australian Naturalist* 28: 61-65.

Klunzinger, M., Beatty, S. & Lymbery, A. (2010). Acute salinity tolerance of the freshwater mussel *Westralunio carteri* Iredale, 1934 of south-west Western Australia. 17th International Congress of Unitas Malacologica, 18-24 July 2010. Phuket, Thailand (Conference abstract).

Klunzinger, M. W., Beatty, S. J., Morgan, D. L., Lymbery, R., Thomson, G. & Lymbery, A. (2011). Discovery of a host fish species for glochidia of *Westralunio carteri* Iredale, 1934 (Bivalvia: Unionoida: Hyriidae). *Journal of the Royal Society of Western Australia* 94: 19-23.

- Klunzinger, M. W., Beatty, S. J., Morgan, D. L., Thomson, G. J. & Lymbery, A. J. (2012). Glochidia ecology in wild fish populations and laboratory determination of competent host fishes for an endemic freshwater mussel of south-western Australia. *Australian Journal of Zoology* 60: 26-36.
- Klunzinger, M. W., Beatty, S. J., Morgan, D. L., & Lymbery, A. J. (2012). Distribution of *Westralunio carteri* Iredale, 1934 (Bivalvia: Unionoida: Hyriidae) on the south coast of south-western Australia, including new records of the species. *Journal of the Royal Society of Western Australia* 95: 77-81.
- Klunzinger, M. W., Beatty, S. J., Morgan, D. L., Lymbery, A. J. & Haag, W. R. (2014). Age and growth in the Australian freshwater mussel, *Westralunio carteri*, with an evaluation of the fluorochrome calcein for validating the assumption of annulus formation. *Freshwater Science* 33: 1127-1135.
- Klunzinger M. W., Beatty S. J., Morgan D. L., Pinder A. M. & Lymbery A. J. (2015). Range decline and conservation status of *Westralunio carteri* Iredale, 1934 (Bivalvia: Hyriidae) from south-western Australia *Australian Journal of Zoology* 63: 127-135.
- Klunzinger, M. W., Lopes-Lima, M., Gomes-dos-Santos, A., Froufe, E., Lymbery, A. J. & Kirkendale, L. (2020). Phylogeographic study of the West Australian freshwater mussel, *Westralunio carteri*, uncovers evolutionarily significant units that raise new conservation concerns. *Hydrobiologia* 848: 2951-2964.
- Klunzinger, M. W., Thomson, G. J., Beatty, S. J., Morgan, D. L., & Lymbery, A. J. (2013). Morphological and morphometrical description of the glochidia of *Westralunio carteri* Iredale, 1934 (Bivalvia: Unionoida: Hyriidae). *Molluscan Research* 33: 104-109.
- Klunzinger, M. & Walker, K. F. (2014). *Westralunio carteri*. The IUCN Red List of Threatened Species 2014: e.T23073A58526341. <http://dx.doi.org/10.2305/IUCN.UK.2014-3.RLTS.T23073A58526341.en>
- Lamprell, K. & Healy, J. (1998). *Bivalves of Australia, volume 2*. Leiden, Backhuys Publishers.
- Lymbery, A. J., Ma, L., Lymbery, S. J., Klunzinger, M. W., Beatty, S. J. & Morgan, D. L. (2021). Burrowing behavior protects a threatened freshwater mussel in drying rivers. *Hydrobiologia* 848: 3141-3152.
- McMichael, D. F. & Hiscock, I. D. (1958). A monograph of the freshwater mussels (Mollusca: Pelecypoda) of the Australian region. *Australian Journal of Marine and Freshwater Research* 9: 372-508.
- Smith, B. J. (1992). Non-marine Mollusca. Pp. i-xii, 1-408 in W. W. K. Houston. *Zoological Catalogue of Australia*, 8. Canberra, Australian Government Publishing Service.
- Sousa, R., Halabowski, D., Labecka, A.M., Douda, K., Aksenova, O., Bepalaya, Y., Bolotov, I., Geist, J., Jones, H.A., Konopleva, E. and Klunzinger, M.W. (2021). The role of anthropogenic habitats in freshwater mussel conservation. *Global Change Biology* 27: 2298-2314.
- Storey, A. W. & Edward, H. D. (1989). The freshwater mussel, *Westralunio carteri* Iredale, as a biological monitor of organochlorine pesticides. *Australian Journal of Marine and Freshwater Research* 40: 587-593.
- Stream Environment and Water (2021). Byford Railway Extension Targeted Fauna Survey for *Westralunio carteri* Carter's Freshwater Mussel. Prepared for GHD Pty Ltd. [https://www.epa.wa.gov.au/sites/default/files/PER\\_documentation2/Appendix%20H%20-%20Carter's%20Mussel%20Stream%20Environment%20and%20Water%2020200405%20BRE%20Targeted%20Fauna%20Survey\\_Rev0\\_Final%20-%2018%20January%202021.pdf](https://www.epa.wa.gov.au/sites/default/files/PER_documentation2/Appendix%20H%20-%20Carter's%20Mussel%20Stream%20Environment%20and%20Water%2020200405%20BRE%20Targeted%20Fauna%20Survey_Rev0_Final%20-%2018%20January%202021.pdf)
- Thorburn, D. (2020). Vasse Diversion Drain Upgrade Project *Westralunio carteri* Management Plan. Prepared for Water Corporation by Indo-Pacific Environmental, Duncraig East, WA. <https://yoursay.watercorporation.com.au/50705/widgets/276465/documents/185207>
- Threatened Species Scientific Committee (2018). Conservation Advice *Westralunio carteri* Carter's freshwater mussel. Canberra: Department of the Environment and Energy. Available from: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/86266-conservation-advice-15022018.pdf>.
- Walker, K. F. (2004). *A guide to the provisional identification of the freshwater mussels (Unionoida) of Australasia*. Albury, Murray Darling Freshwater Research Centre.
- Walker, K. F., Byrne, M., Hickey, C. W. & Roper, D. S. (2001). Freshwater Mussels (Hyriidae) of Australasia. Pp. 5-31 in G. Bauer & Wächtler, K. *Ecology and Evolution of the Freshwater Mussels Unionoida*. *Ecological Studies*. Berlin, Springer-Verlag.
- Walker, K. F., Jones, H. A. & Klunzinger, M. W. (2014). Bivalves in a bottleneck: taxonomy, phylogeography and conservation of freshwater mussels (Bivalvia: Unionoida) in Australasia. *Hydrobiologia* 735: 61-79.
- Wetland Research & Management (WRM) (2020). Bennett Brook Carter's Freshwater Mussel Targeted Survey. [https://www.epa.wa.gov.au/sites/default/files/PER\\_documentation2/MELD-PTAWA-GCOR-0382-App%20K%20-%20Bennett%20Brook%20Carter's%20Mussel.pdf](https://www.epa.wa.gov.au/sites/default/files/PER_documentation2/MELD-PTAWA-GCOR-0382-App%20K%20-%20Bennett%20Brook%20Carter's%20Mussel.pdf)
- Zeritz, A., Sartori, A. F. & Klunzinger, M. W. (2013). Morphological evidence shows that not all Velesunioninae have smooth umbos. *Journal of Molluscan Studies* 79: 277-282.
-

To cite this resource: **Ponder, W. F., Hallan, A., Shea, M. E., Clark, S. A., Richards, K., Klunzinger, M. W., and Kessner, V. 2023. Australian Freshwater Molluscs. Revision 2.**

[https://keys.lucidcentral.org/keys/v3/freshwater\\_molluscs/](https://keys.lucidcentral.org/keys/v3/freshwater_molluscs/)

To contact the authors for comment or suggestions, please email: [fmollusc@gmail.com](mailto:fmollusc@gmail.com)

Copyright © 2023. All rights reserved. The Australian Museum.

