Australian Journal of Taxonomy
Open-access, online, rapid taxonomy
https://doi.org/10.54102/ajt

New species of the land snail genus *Bothriembryon* Pilsbry, 1894 (Mollusca: Gastropoda: Bothriembryontidae) from south-west Western Australia

Corey S. Whisson[1]*, Peter U. Middelfart[1] & Lisa A. Kirkendale[1]

[1] Collections & Research, Western Australian Museum, 49 Kew Street, Welshpool, Western Australia 6106, Australia.
*Corresponding author: corey.whisson@museum.wa.gov.au

Corey S. Whisson https://orcid.org/0000-0003-2119-0598; Peter U. Middelfart https://orcid.org/0000-0002-3191-8434; Lisa A. Kirkendale https://orcid.org/0000-0002-6682-6994

Abstract

The Australian land snail genus *Bothriembryon* Pilsbry, 1894 currently comprises 57 extant species, with all but five of these species found in Western Australia. We describe ten new species, *B. isabellae* n. sp., *B. connori* n. sp., *B. christineae* n. sp., *B. limone* n. sp., *B. spiralis* n. sp., *B. harveyi* n. sp., *B. transitus* n. sp, *B. moondynejoei*, *B. wandoo* n. sp. and *B. brunneus* n. sp. from the biodiversity hotspot of south-west Western Australia, based on molecular and morphological data.

Cite this paper as: Whisson CS et al. (2025). New species of the land snail genus *Bothriembryon* Pilsbry, 1894 (Mollusca: Gastropoda: Bothriembryontidae) from south-west Western Australia. *Australian Journal of Taxonomy* 107: 1–26. doi: https://doi.org/10.54102/ajt.a31d8

urn:lsid:zoobank.org:pub:92A48EFF-FC06-450E-9160-7B2B8CA46C31

Introduction

The genus *Bothriembryon* Pilsbry, 1894 is most speciose in the south-west Western Australia (SWWA) biodiversity hotspot, with only a handful of species found outside of this area. These include shared species ranging across Western Australia into South Australia as well as others endemic to South Australia. Endemic species are also known from the lower Northern Territory (1), south-east Tasmania (1) (Stanisic et al. 2018; Whisson & Ryan 2019) and the northern Pilbara region of Western Australia (1) (Whisson et al. 2024).

Iredale (1939) described many *Bothriembryon* species, although his review was based on a few dry shells, which is understandable given the lack of collecting effort at the time and vast area of occurrence. The next new species of *Bothriembryon* was not until 1983, when Hill et al. (1983) described *B. kendricki* from the Swan Coastal Plain, before taxonomic work on the group halted again, despite many undescribed species being acknowledged (Solem 1998; Whisson & Breure 2016). Recent reviews of *Bothriembryon* collections, primarily type material (Breure & Ablett 2012; Breure & Whisson 2012; Stanisic et al. 2018) have provided improved morphological and geographical data on described species. This has in turn led to an explosion of new species descriptions since 2016, primarily using shell morphology, totalling over a third (36.8%) of described *Bothriem-*

This paper was submitted on 15 July 2025 and published on 18 December 2025 (2025-12-17T19:59:15.057Z). It was reviewed by Isabel Hyman and John Stanisic, and edited by Mark Harvey. Lisa Kirkendale is an Editor of the Australian Journal of Taxonomy. She did not at any stage have access to the manuscript while in peer review, and had no influence on its acceptance or handling, as is standard practice for manuscripts submitted by editors. Australian Journal of Taxonomy. ISSN: 2653-4649 (Online).

bryon. This taxonomic work has concentrated on the far eastern edges of SWWA (15 species), the northern SWWA (3), the southern SWWA (2) (Morrison 2021; Morrison & Schneider 2019, 2021, 2022a-b, 2023a-b; Morrison et al. 2019, 2024; Schneider & Morrison 2018; Whisson & Breure 2016) and the Pilbara (1) (Whisson et al. 2024). A fossil species, dated as late Pliocene, was also described from the inland Nullarbor (Ryan et al. 2023).

Currently 57 extant and 8 fossil *Bothriembryon* species are recognised (WoRMS Editorial Board 2025). The taxonomy and conservation of the genus *Bothriembryon* is a major research project at the Western Australian Museum (WAM), with the first molecular phylogeny of the genus soon to be published (Koehler et al. 2025, in review). This phylogeny has revealed many lineages, the ten described within being the most genetically differentiated and morphologically distinct from existing species. Authorship reflects a single species description initially by Breure & Whisson, before the manuscript and remaining nine species were compiled by Whisson, Middelfart and Kirkendale.

Methods

Samples were collected through Environmental Impact Assessment (EIA) surveys in SWWA or by WAM staff during fieldwork (Figure 1). Specimens were sequenced through earlier projects (Net Conservation Benefits) or routine sequencing through the WAM Mollusc Section. Alignment of COI mtDNA sequence data was by Geneious using MAFFT software. Evolutionary distances were calculated in MEGA v. 11.0.13 using the P-distance method (Tamura et al. 2013).

Material from the WAM was compared with described species from the available literature and type specimens housed in WAM. Shell measurements i.e. maximum shell height (H) and maximum shell diameter (D) were taken from intact adult shells using digital callipers to 0.01 mm and followed the methods figured by Breure (1974: figure 2) or measured from imaged specimens using ImageJ measuring software (https://imagej.net/ij/). Finer measurements of aperture height (AH), aperture diameter (AD), last whorl height (LWH), total number of whorls (TW), protoconch whorls (PW), protoconch diameter (PD), convexity B suture distance (CB) and convexity A distance from outer edge to B (CA) were taken from calibrated shell images using ImageJ. Shell images were taken using two setups, 1, a Canon 6D full frame camera with a Canon 180mm macro lens, mounted on a WeMacro macro rail or 2, Canon 6D body mounted on a Leica MZ16 microscope with photo port adapters. Either setup was controlled with HeliconRemote and captured images were focus stacked in HeliconFocus (see https://www.heliconsoft.com/ for both software packages). All plates were built in Adobe Photoshop v26.2.

There are various methods for counting the number of protoconch whorls. Most studies require identification of the D-shell or the early protoconch I to define the beginning of the turns of the protoconch sutures (see e.g. Breure, 1974, figure 3). This is challenging because direct developing embryos exhibit substantial variation in the first developmental stages, or shell condition is poor due to shell collapse or erosion. For the purpose of stability, we decided to count the whorls from the outer lip of the protoconch, which is the most readily identifiable shell feature, backward towards the embryonic shell. The count will include the earliest suture line identifiable as the end count. If this is in fact the earliest shell stage then a number will be indicated, e.g. 2.5 whorls, if this is not possible then a + will be indicated, e.g. 2.2+ whorls.

Where differential diagnoses include size and shape references to closely similar species, those specific characters may be found in Breure & Whisson (2012) or Breure & Ablett (2012). For taxa described after 2012, subsequent literature with types measured and illustrated were consulted. Distributional maps were plotted using QGIS Version 3.40.4 Bratislava. Live snail images were generally taken using an Olympus Stylus Camera in the field. For type localities, information not present on the original label is enclosed by square brackets.

Abbreviations used for depositories: AM, Australian Museum, Sydney, Australia; MAGNT, Museum and Art Gallery of Northern Territory, Darwin City, Australia; MV, Museum of Victoria, Melbourne, Australia; QM, Queensland Museum, South Brisbane, Australia; SAM, South Australian Museum, Adelaide, Australia; TMAG Tasmanian Museum and Art Gallery, Hobart, Australia; WAM, Western Australian Museum, Perth, Australia.

Discussion

This paper is the first in a three-part series documenting new species of *Bothriembryon* in Western Australia. A robust molecular phylogeny by Koehler et al. (2025, in review) underpins these descriptions, denoted by WAM OTU (GAS) codes to better manage new or unidentified species.

Many of the species described within are known from only a few records, collected mainly by consultants during Environmental Impact Assessments. More detailed collecting and sequencing (including additional nuclear markers) is needed to further define species distributions, ecological requirements and evolutionary distances. Detailed anatomical work is also required to ascertain if any differences exist in the reproductive systems between species.

The high diversity of *Bothriembryon* and the short ranges of many species highlights the need for conservation management. For example, the species richness documented in this paper from the Goldfields region, specifically the Southern Cross belt, was surprising given only *Bothriembryon sedgwicki* Iredale, 1939 had been previously described from the wider area. Land clearing for

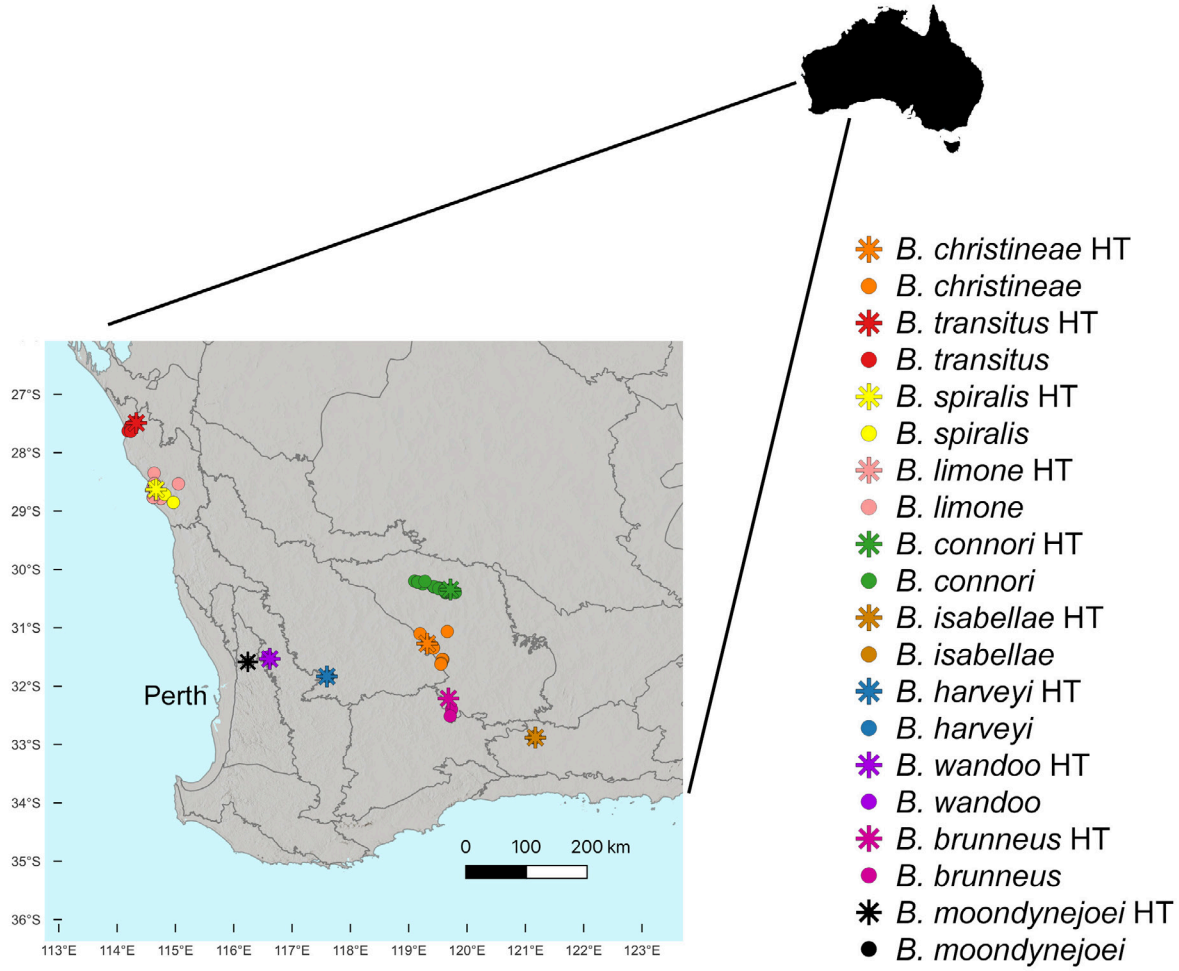

Figure 1. Distribution and type locality of ten new *Bothriembryon* species. HT, holotype.

agricultural, urban or mining developments, coupled with climate change resulting in increased temperatures and reduced rainfall continues to place significant pressure on this and other ancient groups with Gondwanan heritage.

Taxonomy

Family BOTHRIEMBRYONTIDAE Iredale, 1937
Subfamily BOTHRIEMBRYONTINAE Iredale, 1937

Bothriembryon Pilsbry, 1894

https://zoobank.org/NomenclaturalActs/c4754cd8-6fd5-4b61-bf1e-33fec4714012

Bothriembryon Pilsbry, 1894: 36

Liparus Albers, 1850: 172 (non Olivier, 1807)
Hartogembryon Iredale, 1933: 41
Larapintembryon Iredale, 1933: 41
Satagembryon Iredale, 1933: 41
Tasmanembryon Iredale, 1933: 41

Type species: *Helix melo* Quoy & Gaimard, 1832, by original designation

Bothriembryon isabellae n. sp.

Figure 3

https://zoobank.org/NomenclaturalActs/25C8103E-C734-4D81-A410-319946B2DAE0

Holotype: AUSTRALIA, Western Australia: Peak Charles National Park, Peak Charles, Kumarl, 32°52'55.0"S, 121°10'15.0"E, under large granite rock in bank of drainage line, 2 June 2014, A.F. Longbottom, wet (WAM S66623).

Paratypes: AUSTRALIA, Western Australia: From type locality, 1 wet (WAM S66621), 1 wet (WAM S66622); Peak Charles National Park, Peak Charles, along gully at foot of E. side, 32°52'55.83"S, 121°10'11.67"E, under stones, 27 May 1978, A.K. Lance, G.W. Kendrick, 1 wet (WAM S16781); Peak Charles National Park, Peak Charles, 32°53'S, 121°09'E, under rocks in damp areas, 8 May 1977, A.F. Longbottom, 3 dry (WAM S7935), 1 dry (WAM S29982), 1 dry (AM C.613493), 1 dry (SAMA D76719); same locality, 32°53'S, 121°10'E, above creek under stones, 16 April 1976, S.M. Slack-Smith, 6 wet (WAM S7639), 1 dry (WAM S60850); same locality, 32°53'S, 121°10'E, 16 May 1976, A.F. Longbottom, A. Merrifield, 10 wet (WAM S7642).

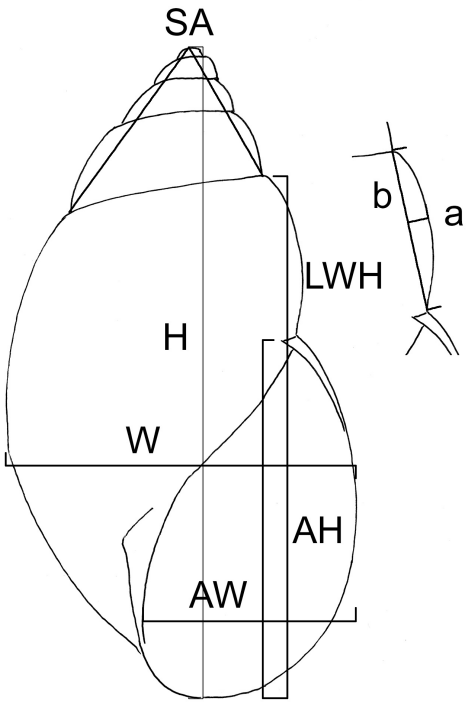

Figure 2. Some shell measurements used in this *Bothriembryon* study. H, maximum shell height; D, maximum shell diameter; AH, aperture height; AD, aperture diameter; LWH, last whorl height; CA, convexity A, distance from outer edge to B; CB, convexity B suture distance; SA, spire angle.

Table 1. Summary of P-distances between *Bothriembryon* species used in this study (COI). Max: maximum intraspecific variation. Min: minimum interspecific variation. Blank cells indicate that only one COI sequence was available.

Species	**Comparative Taxa**			
	max	min	min	min
	B. isabellae n.sp.	*B. connori n.sp.*	*B. sophiarum*	*B. balteolus*
B. isabellae n.sp.	-	16.49%	20.46%	21.53%
	B. connori n.sp.	*B. rocketi*	*B. sedgwicki*	
B. connori n.sp.	3.36%	14.20%	16.03%	
	B. christineae n.sp.	*B. kendricki*	*B. sedgwicki*	*B. connori n.sp.*
B. christineae n.sp.	-	17.40%	19.70%	17.71%
	B. limone n.sp.	*B. perobesus*	*B. onslowi*	*B. spiralis n.sp.*
B. limone n.sp.	0.76%	12.18%	12.82%	17.71%
	B. spiralis n.sp.	*B. kendricki*	*B. harveyi n.sp.*	*B. limone n.sp.*
B. spiralis n.sp.	5.50%	14.05%	17.40%%	17.71%
	B. harveyi n.sp.	*B. kendricki*	*B. spiralis n.sp.*	*B. cf. praecelsus*
B. harveyi n.sp.	1.83%	15.27%	17.40%	20.92%
	B. transitus n.sp.	*B. limone n.sp.*	*B. kalbarriensis*	
B. transitus n.sp.	0.30%	15.27%	17.71%	
	B. moondynejoei n.sp.	*B. kendricki*	*B. indutus*	*B. bulla*
B. moondynejoei n.sp.	-	18.02%	16.03%	14.29%
	B. wandoo n.sp.	*B. bulla*	*B. moondynejoei n.sp.*	*B. indutus*
B. wandoo n.sp.	-	14.81%	18.32%	16.79%
	B. brunneus n.sp.	*B. simoneae*	*B. cf. praecelsus*	*B. christineae n.sp.*
B. brunneus n.sp.	-	18.02%	19.08%	23.97%

Table 2. Summary of shell measurements and ratios for the type material of ten new species of *Bothriembryon.* H, maximum shell height; D, maximum shell diameter; H/D, height to diameter ratio; TW, total number of whorls; PW, number of protoconch whorls; PD, protoconch diameter; AH, aperture height; AD, aperture diameter; AH/AD, aperture height to aperture diameter ratio; AH/H, aperture height to height ratio; LWH, last whorl height; LWH/H, last whorl height to height ratio; CA, convexity A, distance from outer edge to B; CB, convexity B suture distance; C, convexity; SA, spire angle.

Taxa		H	D	H/D	TW	PW	PD	AH	AD	AH/AD	AH/H	LWH	LWH/H	CA	CB	C	SA
B. isabellae	Holotype	14.27	7.62	1.87	5.46	2.00	1.95	7.20	4.50	1.60	0.50	11.19	0.78	0.43	3.55	0.12	62.00
n = 8	Minimum	11.58	6.74	1.72	4.35	1.95	1.95	6.14	3.67	1.33	0.45	9.39	0.76	0.34	2.97	0.11	58.00
	Maximum	15.13	8.29	1.88	5.46	2.20	2.26	7.70	5.02	1.67	0.55	12.15	0.81	0.55	4.03	0.14	74.00
	Average	13.64	7.59	1.80	4.96	2.02	2.06	6.83	4.42	1.55	0.50	10.78	0.79	0.44	3.53	0.13	66.75
	SD	1.28	0.58	0.06	0.37	0.08	0.10	0.62	0.39	0.10	0.03	0.96	0.02	0.07	0.41	0.01	5.85
B. connori	Holotype	14.00	8.64	1.62	4.70	2.00	2.30	8.06	4.86	1.66	0.58	11.72	0.84	0.43	3.32	0.13	76.00
n = 29	Minimum	11.02	6.80	1.48	4.25	1.90	1.90	6.06	3.52	1.35	0.49	8.91	0.77	0.27	2.31	0.00	69.00
	Maximum	15.61	9.53	1.72	5.00	2.20	2.35	8.22	5.73	2.05	0.63	12.34	0.84	0.64	4.20	0.17	85.00
	Average	13.57	8.54	1.59	4.71	2.00	2.09	7.31	4.91	1.50	0.54	10.97	0.81	0.47	3.40	0.13	75.54
	SD	1.03	0.61	0.06	0.18	0.06	0.12	0.56	0.50	0.13	0.03	0.85	0.02	0.09	0.40	0.03	4.17
B. christineae	Holotype	13.55	8.41	1.61	4.55	2.00	2.33	8.94	5.43	1.65	0.66	11.35	0.84	0.60	3.49	0.17	84.60
n = 21	Minimum	11.87	7.93	1.39	4.30	1.95	1.95	6.75	4.69	1.39	0.54	10.15	0.79	0.39	2.88	0.13	70.60
	Maximum	15.62	9.88	1.58	4.90	2.10	2.30	8.49	5.60	1.60	0.62	12.41	0.86	0.55	3.88	0.17	92.64
	Average	13.33	8.96	1.50	4.69	2.02	2.18	7.75	5.20	1.49	0.58	11.16	0.84	0.48	3.31	0.15	84.45
	SD	0.85	0.50	0.05	0.15	0.04	0.10	0.50	0.26	0.06	0.02	0.61	0.02	0.05	0.22	0.01	5.14
B. limone	Holotype	20.01	14.93	1.34	4.65	1.80	3.05	11.82	8.83	1.34	0.59	17.21	0.86	0.86	5.41	0.16	97.00
n = 18	Minimum	13.78	11.00	1.23	4.05	1.80	2.85	9.33	6.33	1.34	0.58	12.33	0.84	0.36	2.97	0.12	90.00
	Maximum	20.01	15.02	1.42	4.90	2.15	3.26	12.01	8.83	1.58	0.70	17.21	0.91	0.86	5.41	0.16	112.00
	Average	17.07	13.02	1.31	4.48	2.02	3.03	10.79	7.34	1.47	0.63	14.91	0.87	0.61	4.19	0.14	101.39
	SD	1.86	1.27	0.05	0.22	0.09	0.13	0.82	0.68	0.06	0.04	1.52	0.02	0.14	0.71	0.01	5.91
B. spiralis	Holotype	10.52	7.28	1.45	4.40	2.00	2.25	5.58	4.06	1.37	0.53	8.52	0.81	0.46	2.65	0.17	81.00
n = 5	Minimum	10.10	7.28	1.36	4.20	1.90	2.08	5.58	4.06	1.37	0.52	8.36	0.80	0.34	2.26	0.14	73.00
	Maximum	13.55	8.74	1.55	4.85	2.00	2.35	7.70	4.75	1.75	0.64	10.78	0.84	0.48	3.22	0.17	90.00
	Average	11.55	7.86	1.46	4.43	1.98	2.24	6.65	4.31	1.54	0.58	9.44	0.82	0.43	2.78	0.15	82.00
	SD	1.55	0.63	0.08	0.27	0.04	0.11	0.87	0.28	0.17	0.05	1.14	0.02	0.06	0.42	0.01	6.00
B. harveyi	Holotype	11.36	8.28	1.37	4.50	2.00	2.34	6.95	5.00	1.39	0.61	9.60	0.85	0.47	3.04	0.15	80.00
n = 8	Minimum	10.79	7.43	1.36	4.35	2.00	2.19	6.17	4.20	1.30	0.53	9.06	0.80	0.34	2.52	0.13	75.00
	Maximum	13.10	8.61	1.52	4.70	2.15	2.40	7.02	5.00	1.51	0.61	10.62	0.85	0.56	3.32	0.19	90.00
	Average	11.73	8.04	1.46	4.48	2.03	2.32	6.59	4.63	1.43	0.56	9.66	0.82	0.46	2.98	0.15	79.63
	SD	0.72	0.34	0.07	0.11	0.06	0.06	0.31	0.28	0.07	0.03	0.52	0.01	0.08	0.26	0.02	4.60
B. transitus	Holotype	16.90	14.02	1.21	4.40	2.10	3.10	11.70	8.51	1.37	0.69	16.07	0.95	0.61	4.19	0.15	102.00
n = 13	Minimum	16.90	13.38	1.20	4.40	1.80	2.68	11.47	8.11	1.40	0.60	16.07	0.80	0.59	4.19	0.12	81.00
	Maximum	22.84	16.50	1.50	5.10	2.20	3.28	13.83	10.00	1.53	0.69	19.18	0.95	0.82	5.65	0.17	102.00
	Average	19.97	14.55	1.37	4.67	2.05	2.97	12.35	8.69	1.42	0.62	17.44	0.87	0.70	4.83	0.14	93.54
	SD	1.43	0.88	0.09	0.21	0.11	0.17	0.70	0.51	0.05	0.03	0.92	0.03	0.08	0.37	0.01	6.68
B. moondynejoei	Holotype	15.10	12.30	1.23	4.20	2.00	3.30	10.70	-	-	0.71	13.50	0.89	0.60	3.70	0.16	96.00
n = 10	Minimum	15.10	8.00	1.23	4.20	2.00	3.00	10.50	7.60	1.28	0.53	13.50	0.83	0.50	3.70	0.12	80.10
	Maximum	21.30	15.20	1.48	5.00	2.20	3.40	12.00	8.80	1.50	0.71	17.60	0.90	0.70	5.60	0.16	107.00
	Average	17.44	12.54	1.34	4.47	2.09	3.23	11.00	8.04	1.39	0.63	15.19	0.87	0.62	4.31	0.14	97.11

	SD	1.83	1.84	0.07	0.24	0.06	0.14	0.53	0.42	0.07	0.05	1.25	0.02	0.08	0.55	0.02	8.47
B. wandoo	Holotype	18.70	12.20	1.53	4.80	2.00	3.20	10.80	7.40	1.46	0.58	15.70	0.84	0.60	4.60	0.13	86.00
n = 7	Minimum	11.80	8.90	1.33	4.00	2.00	3.00	7.90	5.20	1.41	0.58	10.10	0.84	0.30	2.30	0.10	84.00
	Maximum	19.70	13.00	1.54	4.70	2.20	3.40	12.00	7.80	1.61	0.67	16.60	0.86	0.70	4.90	0.14	93.00
	Average	15.90	10.95	1.44	4.41	2.08	3.17	9.87	6.43	1.54	0.62	13.47	0.85	0.45	3.50	0.13	87.50
	SD	3.00	1.54	0.08	0.25	0.10	0.15	1.50	1.09	0.07	0.03	2.49	0.01	0.16	1.03	0.02	3.21
B. brunneus	Holotype	16.75	13.15	1.53	4.70	2.20	3.08	10.93	7.71	1.42	0.65	14.49	0.87	0.48	3.77	0.13	94.00
n = 2	Minimum	15.02	12.90	1.49	4.40	2.20	3.08	10.07	7.55	1.33	0.65	13.14	0.87	0.39	3.09	0.13	94.00
	Maximum	16.75	13.15	1.53	4.70	2.20	3.15	10.93	7.71	1.42	0.67	14.49	0.87	0.48	3.77	0.13	104.00
	Average	15.89	13.03	1.51	4.55	2.20	3.12	10.50	7.63	1.38	0.66	13.82	0.87	0.44	3.43	0.13	99.00
	SD	1.22	0.18	0.03	0.21	0.00	0.05	0.61	0.11	0.06	0.01	0.95	0.01	0.06	0.48	0.00	7.07

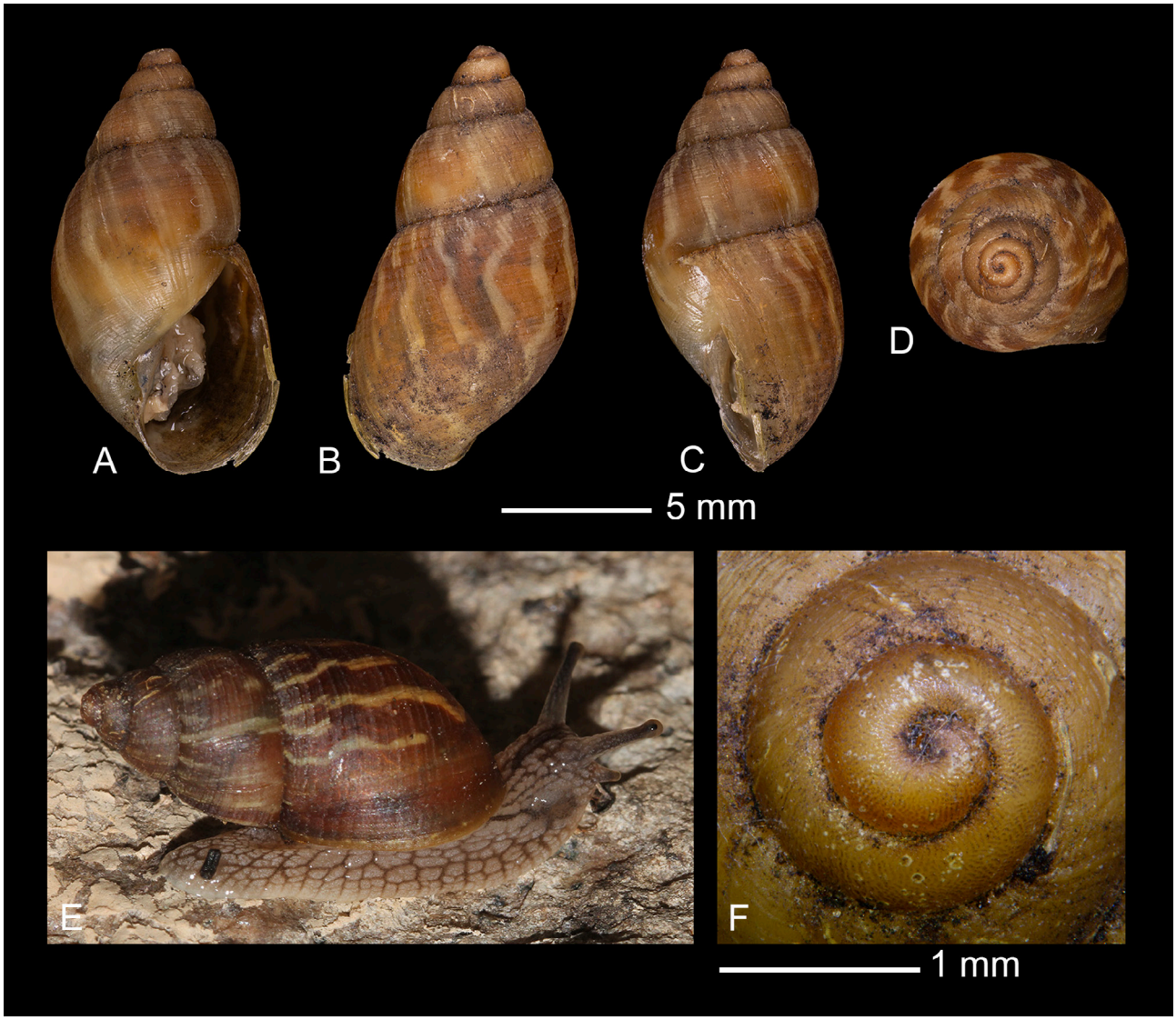

Figure 3. *Bothriembryon isabellae* n. sp. Holotype WAM S66623; A, apertural view; B, dorsal view; C, lateral view; D, apical view; E, crawling holotype; F, sculpture on teleoconch and protoconch whorls (photo E by A. Longbottom).

Diagnosis

Shell characterized by the elongate-conical shape with slightly flared outer lip, spiral teleoconch sculpture and brown-yellow colouration, often forming axial streaks. *Bothriembryon isabellae* shells differ from the morphologically similar species *B. kingii* by the smaller size, convex whorls, less acuminate spire, spiral sculpture and darker colour pattern. Compared to *B. whissoni* the shell

differs by the less turreted shape, slightly flared outer lip and coarse and fine spiral cords on the last whorl, and to *B*. *sophiarum* by a lack of axial sculpture, less turrited shape, and the larger aperture. The shell differs from the nearest geographical species *B*. *balteolus* by the smaller size, elongate-conical shape and lack of spiral banding.

Genetic diagnosis

Sequenced specimens of *B*. *isabellae* exhibited the smallest interspecific evolutionary distance from *B*. *connori* n. sp. *Bothriembryon isabellae* is most morphologically similar to *B*. *sophiarum*, and *B*. *balteolus* is the nearest species geographically to *B*. *isabellae* (P-distances listed in Table 1 for comparison).

Mitochondrial: Cytochrome c oxidase subunit I (CO1), WAM S66622; 16S ribosomal RNA (16S), WAM S66621-623. Nuclear: Adenine nucleotide translocases (ANT), WAM S66621-623. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell elongate-conical with slightly convex whorls, rather thin, sutures well impressed. Height 11.58–15.13 mm (mean 13.64 mm, SD 1.28), diameter 6.74–8.29 mm (mean 7.59 mm, SD 0.58) with 4.35–5.46 whorls (mean 4.96, SD 0.37) and a H/D ratio of 1.72–1.88 (mean 1.80, SD 0.06) (Table 2). Protoconch of 1.95–2.20 whorls (mean 2.02, SD 0.08) with axial wrinkles extending ca. one quarter of whorl depth from suture, before coalescing into a honeycomb matrix. Teleoconch sculpture consists of uniformly spaced coarse spiral cords often broken into dashes which are separated by 3-4 finer, less prominent spirals cords. On the penultimate whorl, approximately 8 coarse spiral cords are present. On the body whorl, 10-12 coarse spiral cords are present, most prominent below the suture. Body whorl prominent with short, acuminate spire (mean LWH/H 0.79, SD 0.02). Aperture elongate-ovate, about half of shell height (mean AH/H 0.50, SD 0.03) with a thin, simple lip that is slightly flared outward near base. Parietal wall is smooth, indiscernible from the body whorl. Columellar wall thin, transparent, triangular, dilated toward the parietal wall with a keeled inner edge bordering the narrow and deep umbilicus. Shell colour light brown, upper spire mottled with irregular brown-yellow blotches, these usually forming regularly spaced wavy yellow axial streaks on body whorl, less prominent on penultimate whorl.

Animal (holotype): Foot, head and tentacles overall grey to pale brown with dark brown reticulate pattern. Side and base of the foot paler in colour. Broad, dark brown nape stripe measuring ca. one-quarter of foot length. Cephalic tentacles with dark brown line terminating with black eye spot at distal end. Posterior foot acuminate.

Other material examined: AUSTRALIA, Western Australia: Peak Charles National Park, Peak Charles, near Kumarl, 32°53'S, 121°09'E, 16 April 1976, WAM Survey Party, 22 dry (WAM S7926); Peak Charles, Kumarl, 32°52'55.0"S 121°10'15.0"E, under large granite rock in bank of drainage line, 2 June 2014, A.F. Longbottom, 1 dry (WAM S66620); same locality, in litter under large rock, 2 June 2014, A.F. Longbottom, 9 dry (WAM S66624); in litter under large rock, 2 June 2014, A.F. Longbottom, 1 wet (WAM S66625); In litter under *Carpobrotus*, 2 June 2014, A.F. Longbottom, 1 dry (WAM S66626); Peak Charles, N. of camp, 32°53'S, 121°09'E, creek, 8 May 1977, A.F. Longbottom, 5 dry (WAM S7930); Peak Charles, 32°53'S, 121°09'E, 24 May 1955, A.R. Main, 2 dry (WAM S7947); same locality, 17 February 1956, A.R. Main, 2 dry (WAM S7931); 18 May 1967, A.R. Main, 3 dry (WAM S7936); 28 October 1969, L.A. Smith, 5 dry (WAM S7939); bottom of breakaway, 6 April 1967, A.F. Longbottom, 2 dry (WAM S7932); bottom of breakaway, 16 April 1976, A.F. Longbottom, H. Merrifield, 15 dry (WAM S7938); under stones in leaf litter, 16 April 1976, H. Merrifield, 2 dry (WAM S7942), 7 dry (WAM S7945); under rocks on granite slope, 16 April 1976, S.M. Slack-Smith, 4 dry (WAM S7941); 16 April 1976, A.F. Longbottom, H. Merrifield, 1 wet (WAM S7644); *Casuarina* litter, 16 April 1976, S.M. Slack-Smith, 23 dry (WAM S7927); above creek under stones, 16 April 1976, S.M. Slack-Smith, 8 dry (WAM S7933); above creek bed, *Casuarina* and other litter on steep slope, 16 April 1976, 12 dry (WAM S7934); 16 April 1976, S.M. Slack-Smith, 1 dry (WAM S7946); 16 April 1976, S.M. Slack-Smith, 7 dry (WAM S7949); above creek under stone, 16 April 1976, S.M. Slack-Smith, 1 dry (WAM S60850); 17 April 1976, S.M. Slack-Smith, 5 dry (WAM S7928); under rocks, 8 May 1977, A.F. Longbottom, 1 dry (WAM S7937); under stones along gully, 27 May 1978, K.A. Lance, G.W. Kendrick, 9 dry (WAM S7940); 21 July 1979, K. Newby, 1 dry (WAM S3603); April 1976, S. Slack-Smith, 4 wet (WAM S7944); Peak Charles, 32°53'S, 121°10'E, 16 April 1976, A.F. Longbottom, H. Merrifield, 4 wet (WAM S7640); same locality, on steep slope above creek bed in *Casuarina* litter, 16 April 1976, S.M. Slack-Smith, 3 wet (WAM S7635); 16 April 1976, H. Merrifield, 5 wet (WAM S7637); under rocks among ferns on granite slope, 16 April 1976, S. Slack-Smith, 4 wet (WAM S7638); under stones in leaf litter and soil, 16 April 1976, H. Merrifield, 4 wet (WAM S7643); 28 October 1969, L.A. Smith, 5 wet (WAM S7641); Peak Charles, along gully at foot of E. side, 32°52'50.83"S, 121°10'11.67"E, under stones attached to rock surface, 27 May 1978, K.A. Lance, G.W. Kendrick, 8 wet (WAM S7636); Peak Charles, 0.4 km SW. of carpark, one third up W. slope, 32°53'06.0"S, 121°10'12.0"E, under rock slabs, 2 June 2013, A.F. Longbottom, 2 dry (WAM S29885).

Etymology

The specific epithet honours the first author's youngest daughter, Isabella Joy Whisson.

Distribution, habitat and cultural significance

Bothriembryon isabellae is only known from Peak Charles and its immediate surroundings in the Eastern Mallee (MAL-01) IBRA subregion (Figure 1). It is found on or under granitic rocks usually in proximity to creeks or drainage lines. Occasionally found in *Casuarina* leaf litter. The Tjarltjraak aboriginal name for Peak Charles is "Kardutjaanup".

Remarks

Previously assigned the OTU code GAS016 in Koehler et al. (2025, in review).

Bothriembryon connori n. sp.

Figure 4

https://zoobank.org/NomenclaturalActs/58028597-d35e-4300-bf4d-5625a0595242

Holotype: AUSTRALIA, Western Australia: Bungalbin Hill, 48 km NNE. of Koolyanobbing, 30°20'44.45"S, 119°42'52.35"E, rocky hillslope, mallee woodland, clay-loam soil, 17 October 2013, F. Bokhari, wet (WAM S88182).

Paratypes: AUSTRALIA, Western Australia: From type locality, 1 wet (WAM S88174); Bungalbin Hill, 48 km NNE. of Koolyanobbing, 30°21'28.54"S, 119°42'05.83"E, rocky ridge/gorge, mallee/proteaceous woodland, clay-loam soil, 17 October 2013, F. Bokhari, 1 wet (WAM S88183); same locality, 30°22'38.38"S, 119°40'48.54"E, rocky hill, mallee woodland, clay-loam soil, 17 October 2013, F. Bokhari, 1 wet (WAM S88184); 30°21'01.83"S, 119°36'52.26"E, rocky hill, mallee woodland, clay-loam soil, 17 October 2013, C. Knuckey, 11 dry (WAM S88164); Mount Jackson, 30°12'S, 119°06'E, leaf and bark litter around tree base, 14 April 1980, J. Henry, 28 dry (WAM S3488); same locality, 2 dry (AM C.613494), 2 dry (SAMA D76720); 30°12'58.619"S, 119°09'17.368"E, station MJ18, *Acacia* shrubland on slope, 18 August 2006, M. Johnson, 3 dry (WAM S61204); same locality, station MJ20, 19 August 2006, M. Johnson, 3 dry (WAM S61205); Bungalbin area, Helena and Aurora Ranges, 30°21'33.0"S, 119°41'46.6"E, in litter beside rocks, emergent *Dryandra* and shrubs, laterite gravels brown loam, station BG-9-1, 23 October 2008, Ninox Wildlife Consulting, 1 dry (WAM S59180); Bungalbin Hill, 48.2 km NNE. of Koolyanobbing, 30°21'40.57"S, 119°37'10.28"E, steep rocky slope, 3 April 2013, S. White et al., 1 dry (WAM S81711); same locality, 30°18'57.65"S, 119°31'03.35"E, plain with some shrubland, 3 April 2013, S. White et al., 5 dry (WAM S81717).

Diagnosis

Shell characterized by the slender size, elongate-conical to bulimoid shape with moderately convex whorls, pillared teleoconch sculpture and light brown to yellow colouration that rarely has axial streaks. *Bothriembryon connori* shells differ from the morphologically similar and geographically closest *B. sedgwicki* by the more elongate-conical shape, narrower size, more convex whorls and more frequent and prominent spiral lines. Compared to the similar *B. isabellae* and *B. whissoni* the shell is less turreted with more convex whorls, has pillared teleoconch sculpture and rarely has axial streaks.

Genetic diagnosis

Sequenced specimens of *B. connori* exhibited the smallest interspecific evolutionary distance from *B. rocketi*. *Bothriembryon connori* is morphologically and geographically closest to *B. sedgwicki* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S83193, S88002, S88006, S88026, S88028, S88173, S88174, S88179, S88182, S88183, S88184, S81715; 16S, WAM S88002, S88173, S88174, S88182, S88183; Nuclear: ANT, WAM S88173. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell elongate-conical to bulimoid with moderately convex whorls, rather thin, sutures strongly impressed. Height 11.02–15.61 mm (mean 13.57 mm, SD 1.03), diameter 6.80–9.53 mm (mean 8.54 mm, SD 0.61) with 4.25–5.00 whorls (mean 4.71, SD 0.18) and a H/D ratio of 1.48–1.72 (mean 1.59, SD 0.06) (Table 2). Protoconch of 1.90–2.20 whorls (mean 2.00, SD 0.06) with crowded axial wrinkles extending ca. one third of whorl depth from suture, before coalescing irregularly, more separate on the second whorl. Teleoconch sculpture consists of low axial ribs crossed by evenly spaced spiral cords or incised spiral lines, creating a pillared sculpture that becomes less obvious toward the anterior end of the body whorl. On the penultimate whorl, approximately 8 spiral rows or cords are present. Body whorl prominent with short, acuminate spire (mean LWH/H 0.81, SD 0.02). Aperture roundly-ovate, half of shell height (mean AH/H 0.54, SD 0.03) with a thin, simple lip. Parietal wall has smooth, translucent callus, discernible by a faint line which on the body whorl extends from the junction of the outer lip to the junction of the inner columellar wall. Columellar wall transparent, relatively long and triangular, dilated toward the parietal wall with a keeled, slightly reflected inner edge bordering the narrow umbilicus. Shell colour light brown, often becoming pale yellowish toward the anterior end of the body whorl with occasional yellow axial streaks.

Other material examined: AUSTRALIA, Western Australia: From type locality, 6 dry (WAM S88166), 1 wet (WAM S88173); Bungalbin Hill, 30°24'S, 119°38'E, in leaf litter and loam, Ribbon Gums, 22 April 1980, M.C. Ellis, 11 dry (WAM S3489); 60 km NE. of Koolyanobbing, 30°17'31.94"S, 19°25'20.98"E, *Eucalyptus* woodland plain, sand-clay, 12 December 2012, S. White & J. Vos 1 dry (WAM S33185); same locality, 30°18'07.77"S, 119°26'16.88"E, *Eucalyptus* woodland plain, clay, 12 December 2012, S. White, J. Vos, 3 dry (WAM S33191); 30°22'53.83"S, 119°40'42.11"E, *Eucalyptus* woodland plain, clay, 22 November 2012, S. White et al., 1 dry (WAM S33193); same locality, 2012, S. White et al., 1 dry (WAM S33195); *Eucalyptus* woodland, 3-11 April 2013, S. White et al., 2 dry (WAM S81710); same locality, 30°20'55.95"S, 119°42'44.14"E, *Eucalyptus* woodland,

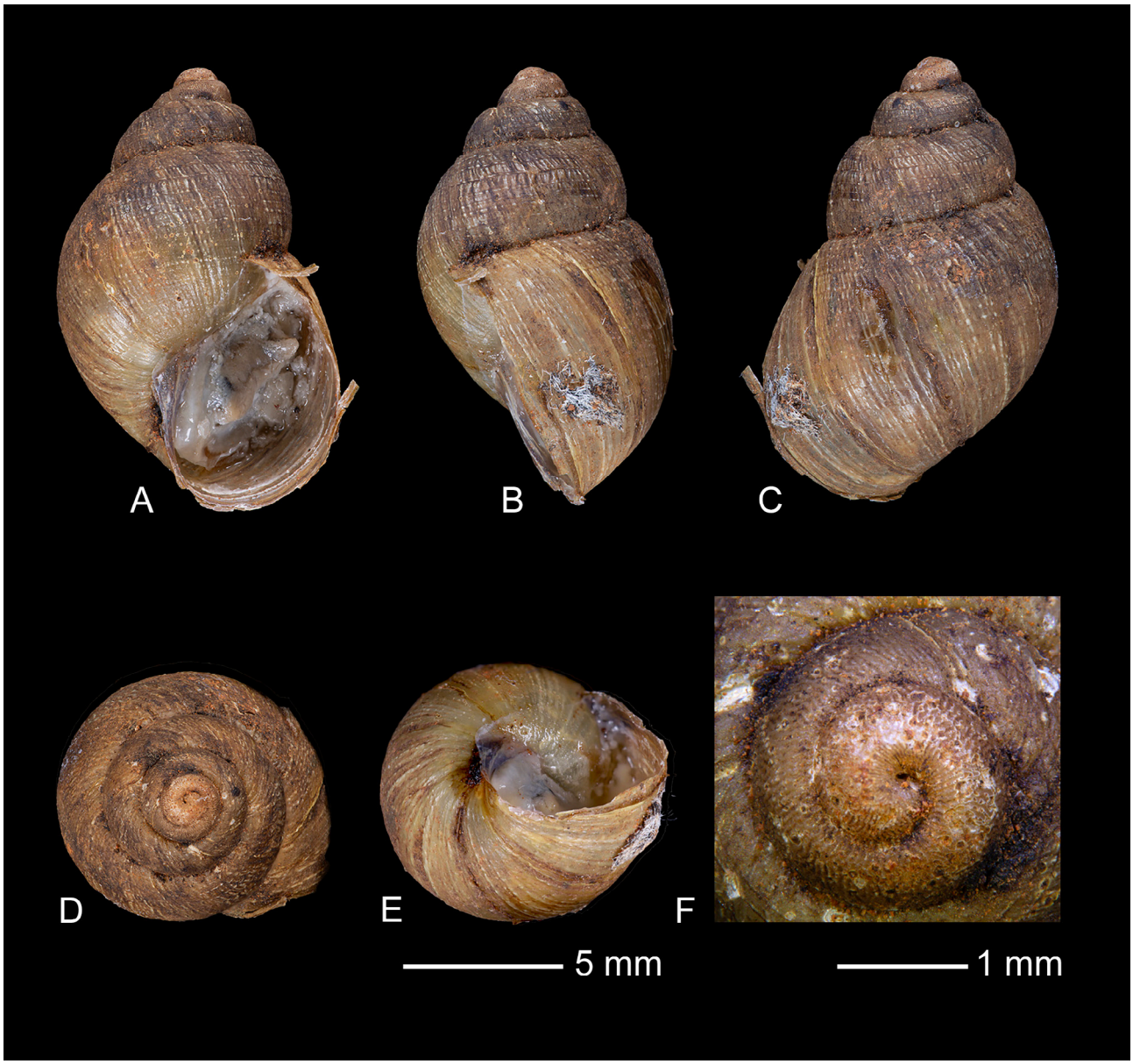

Figure 4. *Bothriembryon connori* n. sp. Holotype WAM S88182; A, apertural view; B, lateral view; C, dorsal view; D, apical view; E, basal view; F, sculpture on teleoconch and protoconch whorls.

3-11 April 2013, S. White et al., 2 dry (WAM S81712); 30°19'45.30"S, 119°34'12.35"E, *Eucalyptus* and *Acacia* woodland in drainage on plain, sand, 12 December 2012, S. White & J. Vos, 1 dry (WAM S33194); Bungalbin area, 30°21'34.3"S, 119°41'48.1"E, station BG-36, emergent *Eucalyptus* & *Dryandra* shrubs, laterite gravels red loam, 23 October 2008, Ninox Wildlife Consulting, 2 dry (WAM S59178); same locality, 30°21'29.3"S, 119°42'00.3"E, station BG-16, under shrubs in litter, 23 October 2008, Ninox Wildlife Consulting, 1 dry (WAM S59179); 30°21'33.0"S, 119°41'46.6"E, station BG-9, emergent *Dryandra* and shrubs, in leaf litter beside rocks, 23 October 2008, Ninox Wildlife Consulting, 2 dry (WAM S59181); 30°18'57.64"S, 119°31'03.34"E, *Eucalyptus* woodland, 3-11 April 2013, S. White et al., 9 dry (WAM S81713); 30°18'07.78"S, 119°26'16.85"E, drainage, 3-11 April 2013, S. White, et al. 1 wet, 1 dry (WAM S81715), 30°22'42.62"S, 119°41'56.69"E, *Eucalyptus* woodland, 3-11 April 2013, S. White et al., 2 dry (WAM S81718); 30°17'44.21"S, 119°26'03.13"E, rocky plain and foot slopes, 3-11 April 2013, S. White et al., 1 dry (WAM S81725); Bungalbin Hill, 48 km NNE. of Koolyanobbing, 30°22'38.38"S, 119°40'48.54"E, rocky hill, mallee woodland, clay-loam, 17 October 2013, F. Bokhari, 1 wet (WAM S88002); same locality, 1 wet (WAM S88006), 1 wet (WAM S88026), 1 wet (WAM S88028), 1 wet (WAM S88042), 1 wet (WAM S88179), 3 dry (WAM S88169); 30°22'56.08"S, 119°40'44.41"E, gimlet woodland, 17 October 2013, F. Bokhari, 4 dry (WAM S88167); 30°19'43.10"S, 119°30'54.71"E, *Acacia* shrubland, sandy plain, 17 October 2013, A. Heidrich,3 dry (WAM S88178); 30°21'01.83"S, 119°36'52.26"E, mallee woodland, rocky hill, clay-loam, 17 October 2013, F. Bokhari, 1 dry (WAM S88181); Bungalbin Hill, 60 km N. of Koolyanobbing,

30°23'25.3"S, 119°37'58.1"E, mallee woodland, under leaf litter, 23 April 1980, R. How, 1 wet (WAM S11934); Mount Jackson area, Western South, 30°12'58.619"S, 119°09'17.368"E, station MJ19, *Acacia* shrubland on slope, 19 August 2006, M. Johnson, 13 dry (WAM S61203); same locality, station MJ17, 19 August 2006, M. Johnson, 7 dry (WAM S61206); Approx. 80 km NE. of Bullfinch, 30°23'49.55"S, 119°47'51.32"E, station Woodland.S03, tall open woodland, floodplain, aestivating, 17 November 2015, M.K. Curran, D. Harms, 2 wet (WAM S88403); same locality, 30°21'41.75"S, 119°41'45.56"E, station Bungalbin.S21, mixed woodland, iron-scree with gully, 21 November 2015, M.K. Curran, D. Harms, 1 dry (WAM S88405); 30°21'34.01"S, 119°36'53.60"E, 18 November 2015, station Ironhill.S05, M.K. Curran, D. Harms, 1 dry (WAM S88406); Marda, 114 km N. of Southern Cross, 30°12'10.918"S, 119°16'40.241"E, creekline, 14-23 September 2011, M. Peterson, 1 wet (WAM S83193); Bungalbin Hill, 48 km NNE. Koolyanobbing, 30°21'28.54"S, 119°42'05.83"E, rocky ridge/gorge, mallee/proteaceous woodland, clay-loam soil, 17 October 2013, A. Heidrich, 1 dry (WAM S88177). Koolyanobbing area, Mt Jackson, 30°14'59.0"S, 119°14'19.0"E, Site 03, Salmon gum woodland, under rotten log, 27 November 2000, Ecologia Environmental, 1 dry (WAM S12911).

Etymology

The specific epithet honours the first author's youngest child and only son, Connor McEwan Whisson.

Distribution, habitat and cultural significance

Bothriembryon connori is only known from the narrow Mount Jackson Range and Bungalbin Hill and its drainages in the Southern Cross (COO-02) IBRA subregion, a linear distance of 70 km (Figure 1). It has been found in *Eucalyptus* mallee woodland on rocky banded-iron formation hillslopes and gullies. Among bark and leaf litter.

Remarks

Previously assigned the OTU code GAS015 in Koehler et al. (2025, in review). Some type material had a calcareous (WAM S59180) or mucoid (WAM S61205) epiphragm.

Bothriembryon christineae n. sp. Breure and Whisson

Figure 5

https://zoobank.org/NomenclaturalActs/0483ba57-1375-498d-b657-82a913a2a16d

Holotype: AUSTRALIA, Western Australia: Southern Cross area, St Barbara Gold Mine, 31°16'16.9160"S, 119°18'58.59"E, Transvaal site 08, 29 July 2008, Western Wildlife Consulting, wet (WAM S41473).

Paratypes: AUSTRALIA, Western Australia: Southern Cross area; St Barbara Gold Mine; 31°16'16.9182"S, 119°19'05.51"E, 29 July 2008, Transvaal site 08, Western Wildlife Consulting, 1 wet (WAM S41472); same locality, 31°15'15.1338"S, 119°18'54.02"E, Transvaal site 06, 29 July 2008, Western Wildlife Consulting, 6 dry (WAM S41474); 31°20'20.7610"S, 119°25'16.05"E, Transvaal site 02, 31 July 2008, Western Wildlife Consulting, 1 dry (WAM S41475); Marvel Loch, S. of Southern Cross, St Barbara operations, Transvaal area, 31°17'32"S, 119°19'38"E, site 07, November 2007, J. Wilcox, 1 dry (WAM S61275); Marvel Loch, S. of Southern Cross, St Barbara operations, Cornishman area, 31°18'18"S, 119°23'35"E, station 04, 7 November 2007, K. Edward, P. Langlands, 1 dry (WAM S29986); same locality, 8 dry (WAM S61278), 1 dry (AM C.613495), 1 dry (SAMA D76721); same locality, 31°20'43"S, 119°25'18"E, station 03, 9 November 2007, J. Wilcox et al., 4 dry (WAM S61277); 31°20'43"S, 119°25'18"E, station 02, 9 November 2007, J. Wilcox et al., 1 dry (WAM S61279); Southern Cross area, 31°06'06.8108"S, 119°11'37.38"E, station Corenthia-020, leaf litter, 3 August 2008, Western Wildlife Consulting, 1 dry (WAM S59076).

Diagnosis

Shell characterized by the elongate-conical to bulimoid shape with slightly convex whorls, coarse teleoconch pillared sculpture that fades away on the anterior half of the body whorl and white axial streaks, most prominent on body whorl. *Bothriembryon christineae* shells differ from the morphologically similar and geographically closest species *B. connori* by the larger size, less convex whorls, flared outer lip and prominent pillared sculpture. The shell differs from *B. sedgwicki* by having coarser and more prominent pillared sculpture.

Genetic diagnosis

Sequenced specimens of *B. christineae* exhibited the smallest interspecific evolutionary distance from *B. kendricki*. *Bothriembryon christineae* is morphologically and geographically closest to *B. sedgwicki* and *B. connori* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S41473; 16S, WAM S41472-73; Nuclear: ANT, WAM S41473. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell elongate-conical to bulimoid with slightly convex whorls, rather thin, sutures well impressed. Height 11.87–15.62 mm (mean 13.33 mm, SD 0.85), diameter 7.93–9.88 mm (mean 8.96 mm, SD 0.50), with 4.30–4.90 whorls (mean 4.69, SD 0.15) and a H/D ratio of 1.39–1.61 (mean 1.49, SD 0.05) (Table 2). Protoconch of 1.95–2.10 whorls (mean 2.02, SD 0.04) with crowded axial wrinkles that coalesce irregularly, more separate on the second whorl. Teleoconch sculpture consists of crowded, coarse axial ribs crossed by well-spaced incised spiral lines creating a coarse pillared sculpture, which on the body whorl is seen only on the dorsal half. On the penultimate whorl, approximately 12-13 spiral lines or cords are present. Body whorl prominent with short, acuminate spire (mean LWH/H 0.84, SD 0.02). Aperture large, roundly-ovate, over half

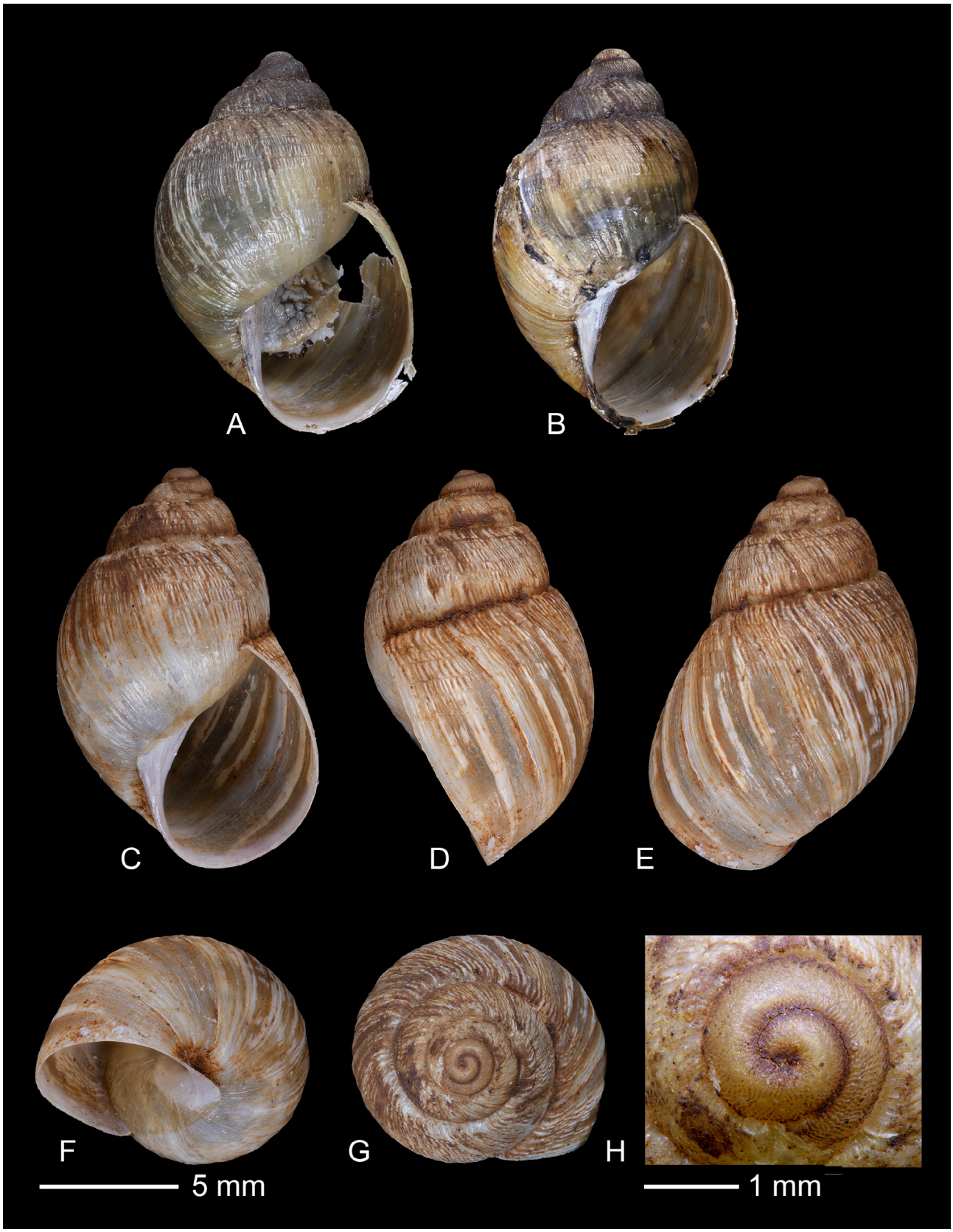

Figure 5. *Bothriembryon christineae* n. sp. Breure & Whisson. Holotype WAM S41473; A, apertural view; paratype WAM S41472; B, apertural view; paratype WAM S29986; C, apertural view; D, lateral view; E, dorsal view; F, basal view; G, apical view; H, sculpture on teleoconch and protoconch whorls.

of shell height (mean AH/H 0.58, SD 0.02) with a thin, simple lip that is slightly flared outward near base. Parietal wall has smooth, thin, translucent callus, discernible by a faint line which on the body whorl extends from the

junction of the outer lip to the junction of the inner columellar wall. Columellar wall transparent, relatively long and triangular, dilated toward the parietal wall with a keeled, slightly reflected inner edge bordering the narrow, deep umbilicus. Shell colour light brown to light cream, on the last whorl frequently with narrow white axial streaks, sometimes broken up into blotches.

Other material examined: AUSTRALIA, Western Australia: SW. of Southern Cross, 31°16'15.6"S, 119°19'07.9"E, open *Eucalyptus* woodland, bluebush understory, 22 October 2021, C.S. Whisson, H. Ryan, 3 dry (WAM S58183); Southern Cross area, 31°32'32.424"S, 119°35'5.86"E, station Burbridge-010, *Allocasuarina* shrubland, under log, 30 July 2008, Western Wildlife Consulting, 1 dry (WAM S59073); same locality, 31°32'32.913"S, 119°34'25.66"E, station Burbridge-016, under bark, 30 July 2008, Western Wildlife Consulting, 2 dry (WAM S59075); Parker Range area, Mt Caudan, 31°36'37"S, 119°33'24"E, station KLA-005, *Eucalyptus* woodland, 11 May 2009, Keith Lindbeck and Associates Consulting, 1 dry (WAM S59103); same locality, 2 dry (WAM S59104); S. of Marvel Loch, Parker Range, 31°37'24"S, 119°33'01"E, station 25, *Eucalyptus* woodland, *Melaleuca* thicket, 21 April 2010, V. Saffer, 1 dry (WAM S64546); 6 km S. of Lake Seabrook, 31°03'49.0”S, 119°39'37.0”E, 5 August 1979, K. Newbey, 1 dry (WAM S8121).

Etymology

The specific epithet is named after Christine Moldrickx, a German artist.

Distribution, habitat and cultural significance

Bothriembryon christineae is known from Corinthia, north of Southern Cross, then in a south-east direction to Mt Caudan, at the south end of the Parker Ranges in the Southern Cross (COO-02) IBRA subregion, a linear distance of 67 km (Figure 1). There is also a tentative identification from south of Lake Seabrook (WAM S8121). Found in tall *Eucalyptus* woodland dominated by *E. salubris* over blue bush. Among bark and leaf litter over clay-loam soils.

Remarks

Previously assigned the OTU code GAS009 in Koehler et al. (2025, in review). Dead specimens have been observed with clear mucoid (WAM S59076) and white, calcareous (WAM S61277) epiphragm.

Bothriembryon limone n. sp.

Figure 6

https://zoobank.org/NomenclaturalActs/50062ef3-50b7-4900-9108-a24f5e60ce32

Holotype: AUSTRALIA, Western Australia: NE of Geraldton, Wokatherra Hill, 28°38'48.51"S, 114°39'42.37"E, station WOK C10, August 2009, Ecologia Staff, wet (WAM S59464).

Paratypes: AUSTRALIA, Western Australia: From type locality, 1 wet (WAM S112536); approx. 18 km NE of Geraldton, Conservation Park, 28°37'45.386"S, 114°40'04.595"E, site 06, litter sieve, 10 July 2009, L. Roque-Albelo, S. White, S., 1 wet (WAM S60332); 13 miles N of Geraldton on Northampton Road, 28°36'27.61"S, 114°37'58.49"E, station ARM 197, March 1954, J.A. Calaby, 1 dry (WAM S9474); same locality, 5 dry (WAM S112537), 3 dry (WAM S112538); N of Geraldton (21 km N of Geraldton and 21 km S of Bowes River), on side of road, 28°35'56.89"S, 114°38'2.38"E, under sandstone rock, red loam, 15 November 1976, C.W. Bryce, R. Johnstone, 20 dry (WAM S9465); same locality, 2 dry (WAM S112539), 2 dry (WAM S112540) 1 dry (AM C.613496), 1 dry (SAMA D76722).

Diagnosis

Shell characterized by the globose shape with inflated body whorl, coarse nodulose teleoconch sculpture arranged in spiral rows and the light yellow to light brown colour, usually with darker axial streaks. *Bothriembryon limone* shells differ from the morphologically similar and geographically closest species *B. whitleyi* by the wider inflated body whorl, thinner shell, narrow umbilicus and finer and more prolific nodulose sculpture. The shell differs from the morphologically similar species *B. perobesus* by the smaller size, narrow umbilicus, nodulose sculpture and less prominent axial flames. The shell differs from the morphologically similar species *B. wagooensis* by the thinner shell, inflated body whorl, lighter colour, lack of axial flames and more rounded aperture.

Genetic Diagnosis

Sequenced specimens of *B. limone* exhibited the smallest interspecific evolutionary distance from *B. perobesus*. *Bothriembryon limone* is most morphologically similar to *B. onslowi*, and *B. spiralis* n. sp. is the nearest species geographically to *B. limone* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S59464_1, WAM S112536 (ex. WAM S59464_2), WAM S59466_1, WAM S112541 (ex. WAM S59466_2), WAM S60332; 16S, WAM S59464_1, WAM S112536, WAM S59466_1, WAM S112541, WAM S60332; Nuclear: ANT, WAM S59464_1, WAM S112535, WAM S112541, WAM S60332. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell globose with moderately convex whorls, thin, fragile, sutures well impressed. Height 13.78–20.01 mm (mean 17.07 mm, SD 1.86), diameter 11.00–15.02 mm (mean 13.02 mm, SD 1.27), with 4.05–4.90 whorls (mean 4.48, SD 0.22) and a H/D ratio of 1.23–1.42 (mean 1.31, SD 0.05) (Table 2). Protoconch of 1.80–2.15 whorls (mean 2.02, SD 0.09) with crowded axial wrinkles that coalesce irregularly, on the second whorl forming a honeycomb matrix on the lower part, colour often bleached white. Teleoconch sculpture consists of narrow, raised axial ribs broken into coarse nod-

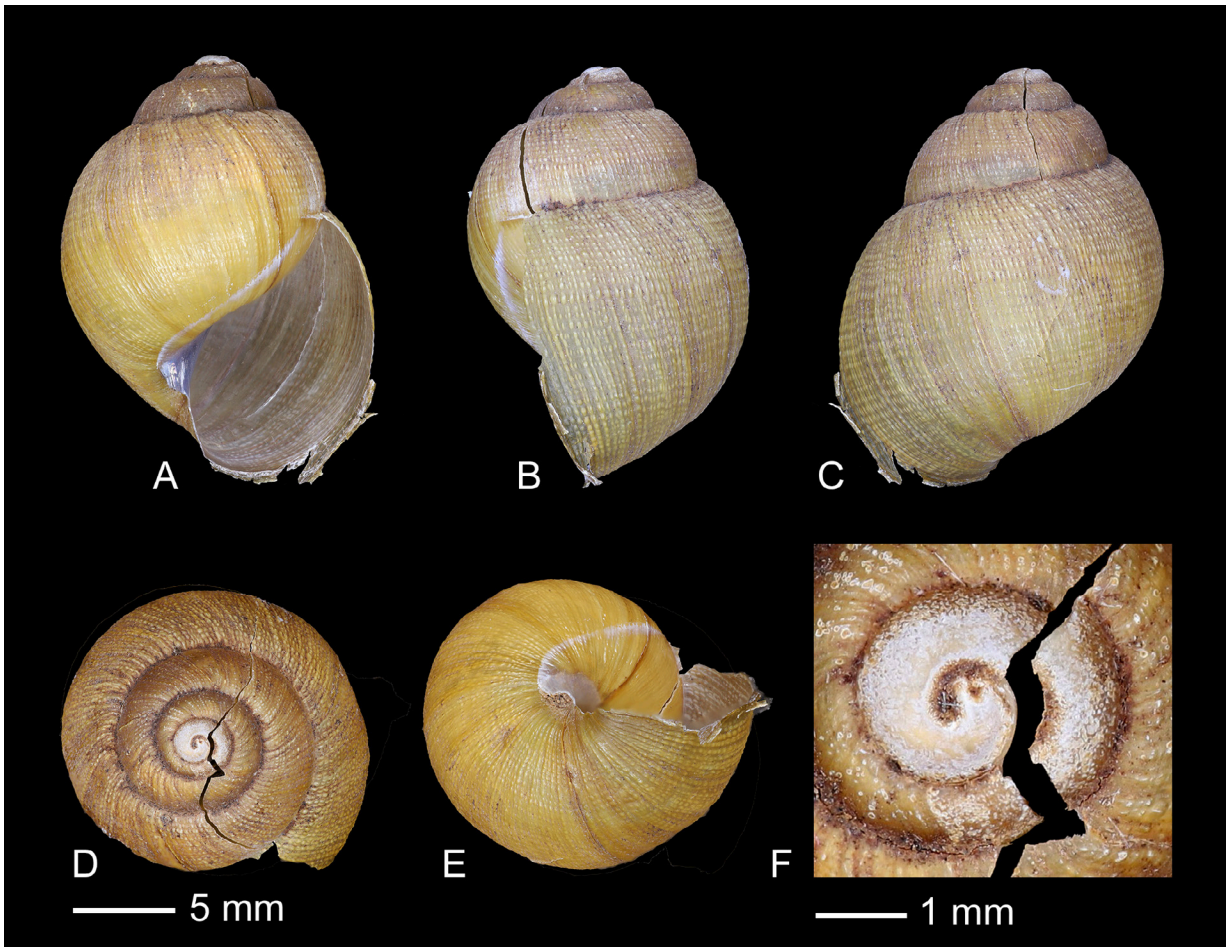

Figure 6. *Bothriembryon limone* n. sp. Holotype WAM S59464; A, apertural view; B, lateral view; C, dorsal view; D, apical view; E, basal view; F, sculpture on teleoconch and protoconch whorls.

ules (sometimes rectangular) by incised spiral lines, arranged into evenly spaced spiral rows. On the penultimate whorl, approximately 16 spiral rows are present. Body whorl inflated, prominent with very short spire (mean LWH/H 0.87, SD 0.02). Aperture large, roundly-ovate, over half of shell height (mean AH/H 0.63, SD 0.04) with a thin, simple lip. Parietal wall has smooth, thin, white callus, sometimes only represented by a broad white line, which on the body whorl extends from the junction of the outer lip to the junction of the inner columellar wall. Columellar wall is transparent to silver in colour, short and broadly triangular, dilated toward the parietal wall with a slightly reflected inner edge bordering the narrow umbilicus. Shell colour light yellow to light brown, on body whorl usually with axial streaks of darker brown, sometimes partly broken.

Other material examined: AUSTRALIA, Western Australia: N of Geraldton, 28°46'S, 114°37'E, under sandstone rock, red loam, 15 November 1976, C.W. Bryce, 1 dry (WAM S9481); NE of Geraldton, Oakajee Nature Reserve, 28°34'14.87"S, 114°39'12.52"E, Station OKA A, 10 August 2009, Ecologia Staff, 1 wet (WAM 59466); same locality, 1 wet (WAM S112541); Oakajee area, 28°35'41.12"S, 114°36'46.45"E, station FG45-2, August-September 2006, Ecologia Staff, 2 dry (WAM S71050); Geraldton area, 28°46'S, 114°37'E, September 1982, R. Parsons, 2 dry (WAM S3311); N of Geraldton, 28°46'S, 114°37'E, under sandstone rock, red loam, 11 July 1986, C.W. Bryce, 1 dry (WAM S9471); Northampton area, 28°21'S, 114°38'E (approximate locality), 15 November 1976, A.P. James, 2 dry (WAM S9469); N of Geraldton, 10 km N of White Peak Rd, W edge of Moresby Range, 28°31'41.86"S, 114°38'21.62"E, *Melaleuca megacephala*, low shrubland, under rock, 2 October 2007, A. Desmond, 1 dry (WAM S112542); 23 km NE of Geraldton, Oakajee Nature Reserve (Regional Geraldton), 28°34'30.71"S, 114°39'17.19"E, station OKA B, 10-17 August 2009, Ecologia Staff, 1 dry (WAM S59470); Waggrakine (via Geraldton), W face of Moresby Range, 28°42'29.73"S, 114°40'32.57"E, 22 May 1985, G.W. Kendrick, 1 dry (WAM S9468); Moonyoonooka, 0.5 mile east of the farm driveway, 28°47'S, 114°45'E, limestone spur, 29 June 1973, G.W. Kendrick, 1 dry (WAM S3658); Moonyoonooka, N side of fossil hill, 28°47'S, 114°45'E, outcrop of Newmarracarra limestone, 27 July 1973, G.W. Kendrick, 1 dry, (WAM S3659); Oakajee, along Olsen Road, edge of road, 28°34'10.5"S, 114°39'15.4"E, dense grassy thickets, low shrubs, buried in humus, 1 August 2024, B. Schneider, 1 wet (WAM S118731); 45 km ESE of

Northampton, 28°32'S, 115°03'E, April 1980, J.C. Barnett, 2 dry (WAM S3561).

Etymology

The species epithet is a noun based on the French word limon, referring to the colour of the shell (*limon*, Spanish, lemon) (Brown 1954).

Distribution, habitat and cultural significance

Bothriembryon limone is known from an area north-east of Geraldton in the Geraldton Hills (GES-01) IBRA subregion (Figure 1). It is found as far north as Northampton, then in a south direction to Moonyoonooka, a linear distance of 50 km. There is also a tentative record from 45 km east south-east of Northampton. Often found under sandstone rocks in low shrubland, sometimes associated with limestone.

Remarks

Previously assigned the OTU code Coded as GAS014 in Koehler et al. (2025, in review). Occasionally sympatric with *B. spiralis* n. sp. The frequency of eroded protoconchs may be a result of shell rasping from juveniles in a calcium-poor environment.

Bothriembryon spiralis n. sp.

Figure 7

https://zoobank.org/NomenclaturalActs/fc643595-80ce-4bc4-b2d7-f5aa66d279a1

Holotype: AUSTRALIA, Western Australia: NE of Geraldton, near Yetna, 28°37'45.386"S, 114°40'04.595"E, site 06, litter sieve, 10-14 July 2009, L. Roque-Albelo, S. White, wet (WAM S61038).

Paratypes: AUSTRALIA, Western Australia: ca. 16.5 km NNE of Geraldton, 28°38'26.28"S, 114°39'45.27"E, station WOK B, 10-17 August 2009, Ecologia Staff, 1 dry (WAM S59471); NE of Geraldton, Oakajee Nature Reserve, 28°34'14.87"S, 114°39'12.52"E, station OKA A, 10-17 August 2009, Ecologia Staff, 1 wet (WAM S66707); Newmarracarra (near Geraldton), 28°43'S, 114°49'E, September 1926, L. Glauert, 1 dry (WAM S9464); Greenough River crossing at Ellendale; breakaway 0.25 mile north of river crossing, 28°51'05.8"S, 114°57'48.2"E, *Acacia*, under rocks, in crevices and litter, 19 April 1965, G.W. Kendrick, 1 wet (WAM S11914); same locality, 1 dry (AM C.613497).

Diagnosis

Shell characterized by the bulimoid shape with moderately convex whorls and spiral teleoconch sculpture and brown to brown-yellow colouration that lacks axial streaks. *Bothriembryon spiralis* shells differ from the geographically closest species *B. limone* by the shorter and narrower size, extended spire, more convex whorls and generally unbroken teleoconch spiral cords. The shell differs from the morphologically similar species *B. kendricki* by the shorter and narrower size, prominent spiral cords and lack of axial flames.

Genetic diagnosis

Sequenced specimens of *B. spiralis* exhibited the smallest interspecific evolutionary distance from *B. kendricki*. *Bothriembryon spiralis* is most morphologically similar to *B. harveyi* n. sp., and *B. limone* is the nearest species geographically to *B. spiralis* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S59467, WAM S61038, WAM S66707, WAM S66708; 16S, WAM S59467, WAM S61038, WAM S66707, WAM S66708; Nuclear: ANT, WAM S59467, WAM S61038, WAM S66707, WAM S66708. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell bulimoid to elongate-conical with moderately convex whorls, rather thin, sutures impressed. Height 10.10–13.55 mm (mean 11.55 mm, SD 1.55), diameter 7.28–8.74 mm (mean 7.86 mm, SD 0.63) with 4.20–4.85 whorls (mean 4.43, SD 0.27) and a H/D ratio of 1.36–1.55 (mean 1.46, SD 0.08) (Table 2). Protoconch of 1.90–2.00 whorls (mean 1.98, SD 0.04) with crowded axial wrinkles extending ca. one third of whorl depth from suture before coalescing irregularly, on the second whorl becoming more separate and deflected. Teleoconch sculpture consists of very low axial ribs crossed by uniformly spaced coarse spiral cords or dashes, occasionally separated by 1-2 finer, less prominent spiral cords. On the penultimate whorl, approximately 8 coarse spiral cords are present. Body whorl prominent with short, acuminate spire (mean LWH/H 0.82, SD 0.02). Aperture roundly-ovate, over half of shell height (mean AH/H 0.58, SD 0.05) with a thin, simple lip. Parietal wall has smooth, thin, white callus, sometimes only represented by a white line which on the body whorl extends from the junction of the outer lip to the junction of the inner columellar wall. Columellar wall is transparent to white in colour, relatively long and triangular, dilated toward the parietal wall with a slightly reflected inner edge bordering the narrow, deep umbilicus. Shell colour brown to brown-yellow.

Other material examined: AUSTRALIA, Western Australia: NE of Geraldton, Oakajee Nature Reserve, 28°34'14.87"S, 114°39'12.52"E, station OKA A, 10-17 August 2009, Ecologia Staff, 1 wet (WAM S66708); same locality, 1 wet (WAM S59467); Greenough River crossing at Ellendale; breakaway 0.25 mile north of river crossing, 28°51'05.8"S, 114°57'48.2"E, *Acacia*, under rocks, in crevices and litter, 19 April 1965, G.W. Kendrick, 3 dry (WAM S112620).

Etymology

The species epithet is an adjective that refers to the teleoconch spiral sculpture of this species (*spiralis*, Latin, spiral) (Brown 1954).

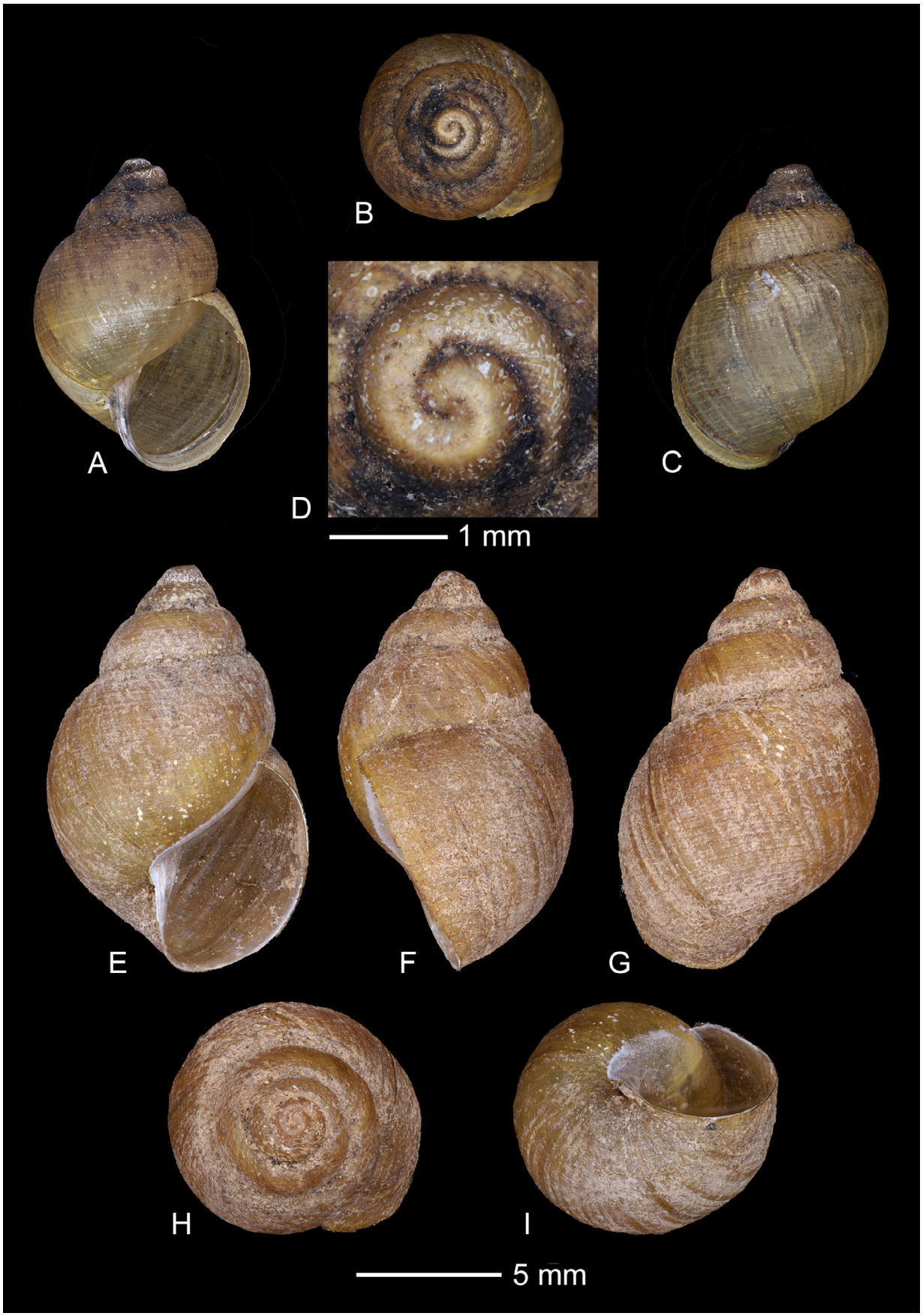

Figure 7. *Bothriembryon spiralis* n. sp. Holotype WAM S61038; A, apertural view; B, apical view; C, dorsal view; D, sculpture on teleoconch and protoconch whorls; paratype WAM S59471; E, apertural view; F, lateral view; G, dorsal view; H, apical view; I, basal view.

Distribution, habitat and cultural significance

Bothriembryon spiralis is known from, and thus far restricted to, an area north-east of Geraldton in the Geraldton Hills (GES-01) IBRA subregion (Figure 1). It is found as far north as Oakajee Nature Reserve, then in a south direction to near Ellendale Pool, a linear distance of 44 km. Habitat data is sparse, has been found under rocks and in litter associated with *Acacia*.

Remarks

Previously assigned the OTU code GAS012 in Koehler et al. (2025, in review). Occasionally sympatric with *B. limone*.

Bothriembryon harveyi n. sp.

Figure 8

https://zoobank.org/NomenclaturalActs/65f5f45e-6d1b-478f-a14a-6eaf25e742d5

Holotype: AUSTRALIA, Western Australia: S side of Mt Stirling, on W face of gully near base, 31°50'03.0"S, 117°35'46.4"E, site PRAE04, under or at base of granite rocks and boulders, deep litter, 3 August 2015, C.S. Whisson, L. Kirkendale, wet (WAM S66258).

Paratypes: AUSTRALIA, Western Australia: From type locality, 1 wet (WAM S66256), 1 wet (WAM S66257), 1 wet (WAM S66259), 1 wet (WAM S66260), 4 dry (WAM S66261), 14 dry (WAM S66262), 1 dry (AM C.613498), 1 dry (SAMA D76723); Mount Stirling, Shire of Quairading, 31°50'S, 117°37'E, 29 June 2001, M. Harvey, J. Waldock, 2 wet (WAM S11911); same locality, 1 wet (WAM S11921), 1 wet (WAM S27652), 1 wet (WAM S27653); Mt Stirling Nature Reserve, 31°50'06.0"S, 117°35'42.0"E, 12 August 2006, K. Edward, 1 dry (WAM S117263).

Diagnosis

Shell characterized by the bulimoid to elongate-conical shape with moderately convex whorls, spiral teleoconch sculpture and brown to brown-yellow colouration. *Bothriembryon harveyi* shells differ from the geographically closest species *B. praecelsus* by the considerably shorter and narrower size, more convex whorls and teleconch spiral sculpture. The shell differs from the morphologically similar and geographically close species *B. sedgwicki* by the slightly shorter and narrower size, teleoconch spirals that lack pillared sculpture and less prominent axial flames. The shells can be difficult to distinguish from the morphologically similar and geographically distant species *B. spiralis*, but has a much busier and coarser teleoconch spiral sculpture that can be irregularly nodulose, and occasional axial flames on the body whorl.

Genetic Diagnosis

Sequenced specimens of *B. harveyi* exhibited the smallest interspecific evolutionary distance from *B. kendricki*. *Bothriembryon harveyi* is most morphologically similar to *B. spiralis*, and *B.* cf. *praecelsus* is the nearest species geographically to *B. harveyi* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S11921_1, WAM S27652 (ex. WAM S11921_2), WAM S27653 (ex. WAM S11921_3), WAM S66258, WAM S66259; 16S, WAM S11921_1, WAM S27652, WAM S27653, WAM S66258, WAM S66259; Nuclear ANT, WAM S11921_1, WAM S66259. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell bulimoid to elongate-conical with moderately convex whorls, rather thin, sutures deeply impressed. Height 10.79–13.10 mm (mean 11.73 mm, SD 0.72), diameter 7.43–8.61 mm (mean 8.04 mm, SD 0.34) with 4.20–5.00 whorls (mean 4.63, SD 0.28) and a H/D ratio of 1.36–1.52 (mean 1.46, SD 0.07) (Table 2). Protoconch of 2.00–2.15 whorls (mean 2.03, SD 0.06) with crowded axial wrinkles that coalesce irregularly, on the second whorl forming a honeycomb matrix. Teleoconch sculpture consists of irregular low axial ribs crossed by uniformly spaced spiral cords, occasionally forming small nodules and usually separated by 1-2 finer, less prominent spirals cords. On the penultimate whorl, approximately 10 coarse spiral cords are present. Body whorl prominent with acuminate spire (mean LWH/H 0.82, SD 0.01). Aperture ovate, over half of shell height (mean AH/H 0.56, SD 0.03) with a thin, simple lip. Parietal wall has smooth, thin, shiny brown callus. Columellar wall is transparent to silver in colour, relatively long and triangular, dilated toward the parietal wall with a slightly reflected inner edge bordering the narrow, umbilicus. Shell colour brown to brown-yellow, occasionally with darker axial flames on the body whorl.

Animal (type locality): Foot and head overall grey with a black reticulate coarse pattern. Side and base of the foot cream. Cephalic tentacles paler grey colour with a black eye spot at distal end. Posterior foot acuminate.

Other material examined: AUSTRALIA, Western Australia: From type locality, 10 dry (WAM S27654); 25 km SW of Kellerberrin, 31°50'S, 117°37'E, under stones, 19 August 1957, A.R. Main, 3 dry (WAM S3607); same locality, under rocks and shrubs, 24 February 1952, A.R. Main, 7 dry (WAM S3608).

Etymology

The specific epithet honours Dr. Mark Harvey, previous Arachnology Curator at WAM, who retired in 2024 after an illustrious career documenting WA's terrestrial biodiversity. Through his incidental collections, he assisted greatly in improving our understanding of the distribution of *Bothriembryon*, especially in the SWWA. Much of the paratype material for this new species was collected by Mark and a team from WAM, including the first live-taken specimens found in 2001.

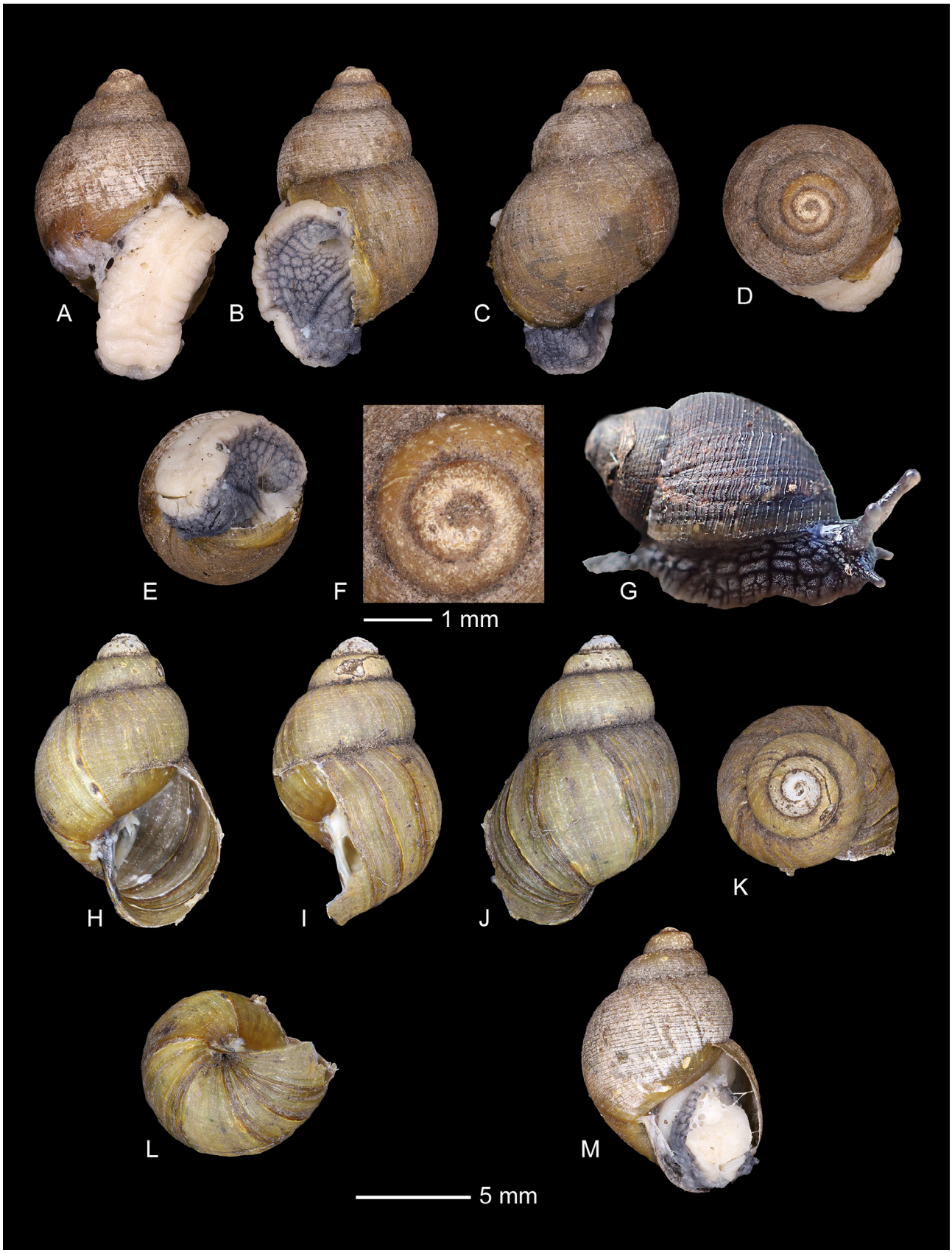

Figure 8. *Bothriembryon harveyi* n. sp. Holotype WAM S66258; A, apertural view; B, lateral view; C, dorsal view; D, apical view; E, basal view; F, sculpture on teleoconch and protoconch whorls; paratype WAM S66261; G, animal from type locality not to scale; H, apertural view; I, lateral view; J, dorsal view; K, apical view; L, basal view; paratype WAM S66259 M; apertural view.

Distribution, habitat and cultural significance

Bothriembryon harveyi is only known from Mount Stirling in the wheatbelt region of WA, in the Avon Wheatbelt (AVW-01) IBRA subregion (Figure 1). There is an unverified record from the nearby Mount Caroline. It is found in loamy soil or deep litter, under or near the base of granitic boulders.

Remarks

Previously assigned the OTU code GAS017 in Koehler et al. (2025, in review). A few dead specimens have been observed with a white, calcareous epiphragm (WAM S27654).

Bothriembryon transitus n. sp.

Figure 9

https://zoobank.org/NomenclaturalActs/abcadbe4-5224-4da5-a5cd-3906f2763506

Holotype: AUSTRALIA, Western Australia: ca. 29 km NE of Kalbarri, about 800m NE of Betties Crossing, above Murchison River flood height, 27°29'27.0"S, 114°19'41.0"E, upper slopes and vegetated areas, mating in sparse litter, 19 July 2014, J. Hynes, wet (WAM S66821).

Paratypes: AUSTRALIA, Western Australia: From type locality, 1 wet (WAM S66822); Murchison River National Park, 1 mile N of Bettie Crossing, on old telegraph line, 27°28'50.40"S, 114°19'16.41"E, under *Eremophila*, *Acacia* and *Curara* bush, pink-yellow sand, 19 May 1968, J.L. Bannister, R. Gliddon, 32 dry (WAM S3627), 1 dry (WAM S27358), 1 dry (AM C.613499), 1 dry (SAMA D76724).

Diagnosis

Shell characterized by the globose shape with inflated body whorl, nodulose teleoconch sculpture arranged in spiral rows, crenulated subsutural pattern on penultimate whorl and the light brown colour with axial streaks and speckles. *Bothriembryon transitus* shells can be hard to distinguish from the morphologically similar and geographically close species *B. kalbarriensis*, but the shell is slightly wider, teleoconch subsutural area more crenulate, outer lip often more flared and the nape and body stripes are paler. The shell differs from the geographically close species *B. wagooensis* by the more globose shape, flared outer lip and lighter colour, and from the species *B. grohi* by the larger size, flared outer lip, smaller umbilicus, lighter colour and lack of colour inside aperture.

Genetic Diagnosis

Sequenced specimens of *B. transitus* exhibited the smallest interspecific evolutionary distance from *B. limone*. *Bothriembryon transitus* is morphologically and geographically closest to *B. kalbarriensis* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S66821, WAM S66822; 16S, WAM S66821, WAM S66822; Nuclear: ANT, WAM S66821, WAM S66822. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell globose with slightly convex whorls, relatively thick, sutures well impressed. Height 16.90–22.84 mm (mean 19.97 mm, SD 1.43), diameter 13.38–16.50 mm (mean 14.55 mm, SD 0.88), with 4.40–5.10 whorls (mean 4.67, SD 0.21) and a H/D ratio of 1.20–1.50 (mean 1.37, SD 0.09) (Table 2). Protoconch of 1.80–2.20 whorls (mean 2.05, SD 0.11) with crowded, deflected axial wrinkles that coalesce irregularly, towards the end of the second whorl forming a honeycomb matrix. Teleoconch sculpture consists of regular, raised axial ribs broken into coarse nodules (sometimes rectangular) by incised spiral lines, arranged into evenly spaced spiral rows. On the penultimate whorl, approximately 12-13 spiral rows are present. The nodulose sculpture is only present on the dorsal third of the body whorl. Body whorl inflated, prominent with very short spire (mean LWH/H 0.87, SD 0.03), subsutural area crenulate, particularly on body whorl, formed from terminating axial ribs. Aperture large, roundly-ovate, well over half of shell height (mean AH/H 0.62, SD 0.03) with a simple lip that is slightly flared outward near base. Parietal wall has smooth, thin, transparent callus, discernible by a narrow white line which on the body whorl extends from the junction of the outer lip to the junction of the inner columellar wall. Columellar wall cream to white in colour, short and broadly triangular, dilated toward the parietal wall with a slightly reflected inner edge bordering the narrow umbilicus. Shell colour light brown on body whorl with spire often a darker brown. Teleoconch with white to cream axial flames with white speckles from the nodulose sculpture.

Animal (type series): Foot, head and tentacles overall cream to pale brown with faint brown reticulate pattern. Side and base of the foot paler in colour. Relatively broad, brown to dark brown nape stripe measuring ca. one-half of foot length, terminating within shell cover. Accompanied by two narrow brown to dark brown lateral body stripes of similar length. Cephalic tentacles with brown to dark brown lines terminating with black eye spot at distal end. Posterior foot is strongly acuminate.

Other material examined: AUSTRALIA, Western Australia: Murchison House Station, North side of river opposite homestead, 27°38'S, 114°14'E, atop limestone plateau, grazed grass and stones, on wet ground, 11 June 1999, B.R. Wilson, 20 wet (WAM S30178); same locality, 1 dry (WAM S117474); Murchison Station, between Bookah Spring and Weerinogudda Dam, 27°28'22.4"S, 114°19'07.3"E, September 1977, R. Simmons, 6 dry (WAM S3650); Murchison Station, Murchison House, Murchison River Valley, N side near Stonewell, 27°34'43.26"S, 114°15'41.89"E, on chalk surface, 17 July 1992, G.W. Kendrick, 6 dry (WAM S3649); Murchison House Station, on slopes 1 km NW of

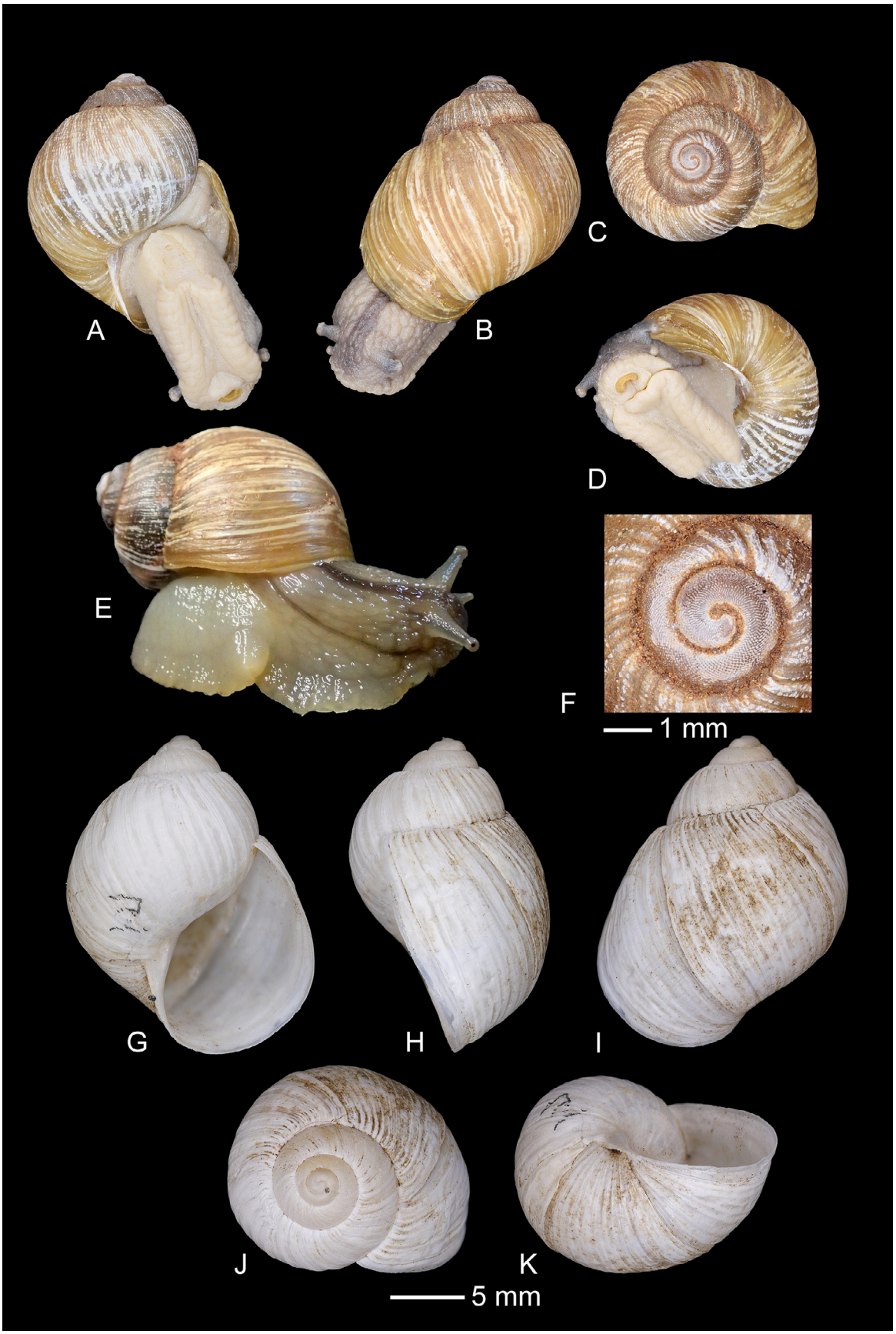

Figure 9. *Bothriembryon transitus* n. sp. Holotype WAM S66821 A, apertural view; B, dorsal view; C, apical view; D, basal view; E, lateral view, live animal; F, sculpture on teleoconch and protoconch whorls; paratype WAM S27358; G, apertural view; H, lateral view; I, dorsal view; J, apical view; K, basal view (photo E by A. Longbottom).

Thirindine Point, 27°36'17.0"S, 114°14'16"E, on Toolonga Calcilutite chalk, low grass and forbs, 8 August 1994, A. Baynes, 1 wet (WAM S12073); Murchison House Station, Tutula camp, 27°36'37.76"S, 114°11'09.45"E, washaway, 20 June 1994, K. Brimmell, A. Baynes, 1 wet (WAM S4294); Murchison House Station, 27°32'46.59"S, 114°13'43.68"E, washaway, 20 June 1994, K. Brimmell, A. Baynes, 5 wet (WAM S4296).

Etymology

The species epithet is a noun that refers to Bettie Crossing, located near to the type locality. Historically this crossing was used by early settlers to traverse the large and wide Murchison River (*transitus*, Latin, crossing, passage).

Distribution, habitat and cultural significance

Bothriembryon transitus is known from an area north-east of Kalbarri on the north side of the Murchison River, in the Geraldton Hills (GES-01) IBRA subregion (Figure 1). It is found as far north-east as Bookah Spring, then in a south-west direction to near the Tutula Camp, a linear distance of 21 km. Habitat data is sparse, it has been found in vegetated areas, often associated with limestone and chalk surfaces.

Remarks

Previously assigned the OTU code GAS010 in Koehler et al. (2025, in review). A few of the paratypes were observed with a white, calcareous epiphragm (WAM S3627).

Bothriembryon moondynejoei n. sp.

Figure 10

https://zoobank.org/NomenclaturalActs/e40b900c-1e06-463f-ac12-6cb61cd71611

Holotype: AUSTRALIA, Western Australia, Avon Valley National Park, at north end of Forty One Mile Road, 31°35'12.7"S, 116°14'28.5"E, under rocks and leaf litter, 9 July 2001, F.K. Turnbull, wet (WAM S11955).

Paratypes: AUSTRALIA, Western Australia: From type locality, 1 wet (WAM S117479), 2 dry (WAM S11977), 1 dry (AM C.613500), 1 dry (SAMA D76725); Avon Valley National Park, end of Quarry Road, N of valley campground, E side Avon River, 31°35'12.5"S, 116°14'29.2"E, Jam tree thicket, wandoo, under dolerite rock, 6 August 2021, C.S. Whisson, L. Kirkendale, 1 wet (WAM S91401); same locality, 1 wet (WAM S91402), 3 wet (WAM S91403), 1 wet (WAM S91404), 1 wet (WAM S91405), 1 wet (WAM S91406), 5 dry (WAM S91407), 1 wet (WAM S117371); Avon Valley National Park, uphill from the end of Forty One Mile Road, 31°35'27"S, 116°14'38"E, 1 July 2001, F.K. Turnbull, 1 wet (WAM S11923).

Diagnosis

Shell characterized by the bulimoid to globose shape with inflated body whorl, coarsely nodulose teleoconch sculpture that is arranged in spiral rows and most prominent below the suture, crenulated subsutural pattern and the light to dark brown colour with long yellow axial streaks. *Bothriembryon moondynejoei* shells can be hard to distinguish from the morphologically similar and geographically close species *B. kendricki*, but the shell is generally taller and lighter brown with more frequent axial flames. The shell differs from the geographically close species *B. indutus* by the globose shape, shorter height and prominent axial flames.

Genetic Diagnosis

Sequenced specimens of *B. moondynejoei* exhibited the smallest interspecific evolutionary distance from *B. kendricki*, which is most morphologically similar to *B. moondynejoei*. The nearest species geographically to *B. moondynejoei* are *B. indutus and B. bulla* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S11955; 16S, WAM S11955, WAM S117479 (ex. WAM S11955B); Nuclear: ANT, WAM S117479. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell bulimoid to globose with slightly convex whorls, sutures deeply impressed. Height 15.10–21.30 mm (mean 17.44 mm, SD 1.83), diameter 8.00–15.20 mm (mean 12.54 mm, SD 1.84), with 4.20–5.00 whorls (mean 4.47, SD 0.24) and a H/D ratio of 1.23–1.48 (mean 1.34, SD 0.07) (Table 2). Protoconch of 2.00–2.20 whorls (mean 2.09, SD 0.06) with short, axial wrinkles extending ca. one fifth of whorl depth from suture before coalescing to form a honeycomb matrix, subsutural wrinkles usually absent on second whorl, colour often bleached white, partly eroded. Teleoconch sculpture consists of regular, raised axial ribs broken into coarse nodules (sometimes rectangular) by coarse and faint incised spiral lines, arranged into evenly spaced spiral rows. On the penultimate whorl, approximately 12 spiral rows are present. The nodulose sculpture is most prominent on the dorsal quarter of the body whorl. Body whorl inflated, prominent with short, acuminate spire (mean LWH/H 0.87, SD 0.02), subsutural area moderately crenulate, formed from terminating axial ribs. Aperture large, roundly-ovate, well over half of shell height (mean AH/H 0.63, SD 0.05) with a simple lip that is very slightly flared outward near base. Parietal wall has smooth, thin, white to transparent callus, represented by a broad white line, which on the body whorl extends from the junction of the outer lip to the junction of the inner columellar wall. Columellar wall is transparent to white in colour, long and broadly triangular, dilated toward the parietal wall with a slightly reflected inner edge bordering the relatively wide and deep umbilicus. Shell colour light to dark brown, usually with regular axial streaks of yellow that extend the depth of the whorls.

Animal (type series): Foot, head and tentacles overall dark grey to black with coarse reticulated pattern. Side

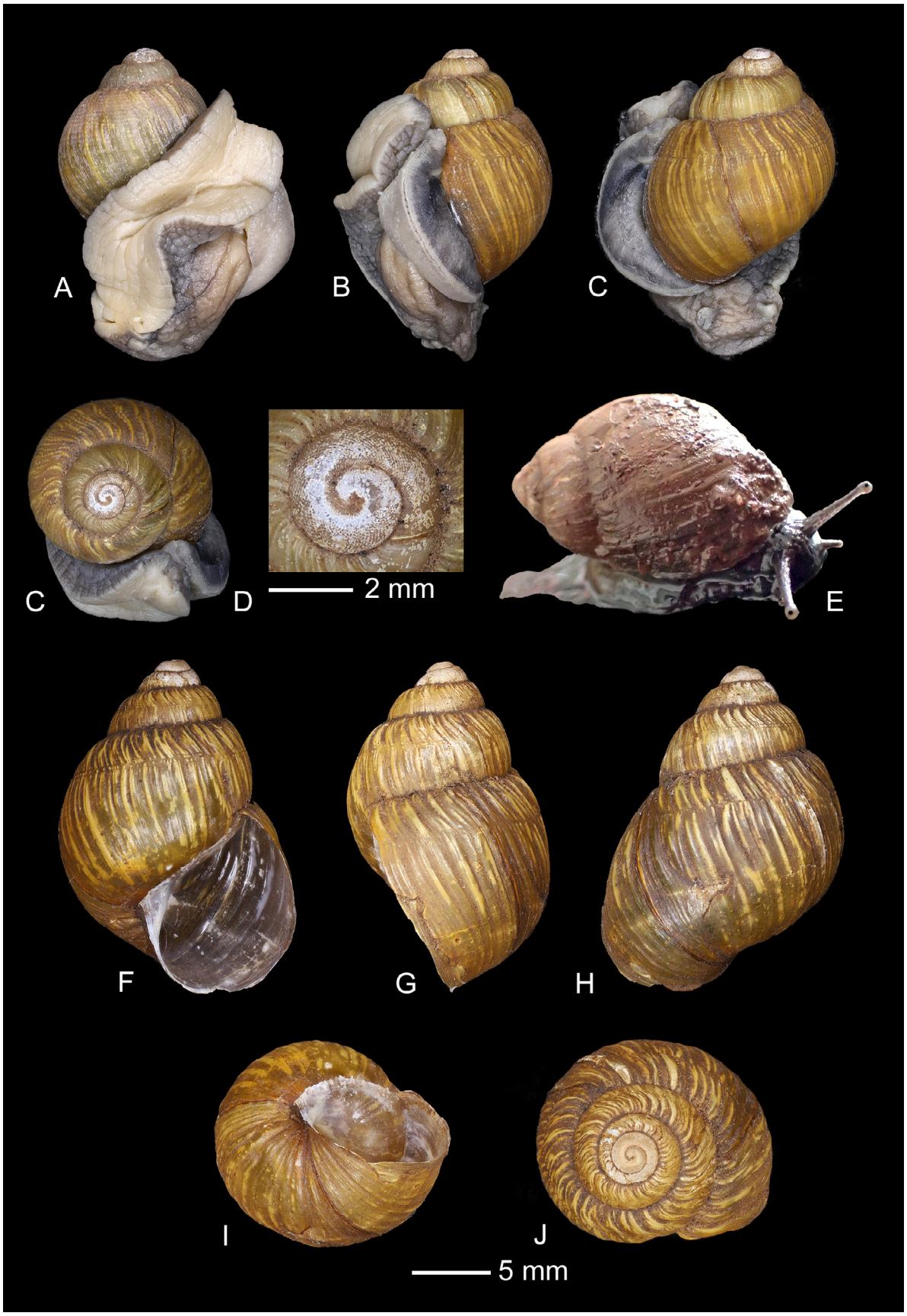

Figure 10. *Bothriembryon moondynejoei* n. sp. Holotype WAM S11955; A, apertural view; B, lateral view; C, dorsal view; D, apical view; E, sculpture on teleoconch and protoconch whorls; paratype WAM S91401; F, live specimen; paratype WAM S11977; G, apertural view; H, lateral view; I, dorsal view; J, basal view; K, apical view.

and base of the foot pale cream. Nape and lateral body stripes absent. Cephalic tentacles usually pale cream toward distal end with black eye spot. Posterior foot acuminate.

Etymology

The specific epithet honours the infamous bushranger Moondyne Joe who frequently used the Avon Valley as a hideout.

Distribution, habitat and cultural significance

Bothriembryon moondynejoei is only known from the type locality, in the Northern Jarrah Forest (JF-01) IBRA subregion (Figure 1). Found under rocks or leaf litter on a scree slope, often associated with Jam trees, *E. wandoo*, grasses and ferns.

Remarks

Previously assigned the OTU code GAS029 in Koehler et al. (2025, in review).

Bothriembryon wandoo n. sp.

Figure 11

https://zoobank.org/NomenclaturalActs/9782b0fa-3da2-48ff-a5ea-779b2dc1917c

Holotype: AUSTRALIA, Western Australia: Shire of Toodyay, Wongamine Nature Reserve, Eastern Section, [31°32'S, 116°37'E], 22 August 1997, F.A. Turnbull, wet (WAM S12697).

Paratypes: AUSTRALIA, Western Australia: From type locality, 1 wet (WAM S73612), 2 dry (WAM S73613); Shire of Toodyay, Wongamine Nature Reserve, Southern Section, 31°32'S, 116°37'E, 16 July 1999, F.A. Turnbull, 1 wet (WAM S12696); same locality, 5 dry (WAM S29810), 1 wet (WAM S73601); Wongamine, 30°30'01.5"S, 116°34'59.3"E, 26 September 1990, A.R. Main, B.Y. Main, 2 dry (WAM S69534), 1 dry (AM C.613501).

Diagnosis

Shell characterized by the bulimoid shape, coarsely nodulose teleoconch sculpture that is arranged in spiral rows and extending the full depth of whorls, rounded spire and the dark brown colour with golden yellow speckles and axial streaks. *Bothriembryon wandoo* shells can be hard to distinguish from the morphologically similar and geographically close species *B. moondynejoei* and *B. bulla* but the shell lacks spiral banding, has less prominent axial flames and has a more rounded spire. The shells differ from the geographically close species *B. indutus* by the shorter and slender size, spiral teleoconch sculpture and shorter, less acuminate spire.

Genetic Diagnosis

Sequenced specimens of *B. wandoo* exhibited the smallest interspecific evolutionary distance from *B. bulla*. *Bothriembryon wandoo* is most morphologically similar to *B. moondynejoei*, and *B. bulla* and *B. indutus* are the nearest species geographically to *B. wandoo* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S12696, WAM S12697, WAM S73601; 16S, WAM S12696, WAM S73601; Nuclear: ANT, WAM S12696, WAM S73601. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell bulimoid with convex whorls, sutures impressed. Height 11.80–19.70 mm (mean 15.90 mm, SD 3.00), diameter 8.90–13.00 mm (mean 10.95 mm, SD 1.54), with 4.00–4.70 whorls (mean 4.41, SD 0.25) and a H/D ratio of 1.33–1.54 (mean 1.44, SD 0.08) (Table 2). Protoconch of 2.00–2.20 whorls (mean 2.08, SD 0.10) with short, axial wrinkles extending ca. one fifth of whorl depth from suture before coalescing to form a honeycomb matrix, subsutural wrinkles usually absent on second whorl, colour often bleached white, partly eroded. Teleoconch sculpture consists of regular, low axial ribs broken into coarse nodules by incised spiral lines, arranged into evenly spaced spiral rows. On the penultimate whorl, approximately 11-12 spiral rows. The nodulose sculpture extends the full depth of the body whorl. Body whorl inflated with short, rounded spire (mean LWH/H 0.85, SD 0.01). Aperture large, ovate, well over half of shell height (mean AH/H 0.62, SD 0.03) with a simple lip. Parietal wall has smooth, thin, white to brown callus, represented by a thin line, which on the body whorl extends from the junction of the outer lip to the junction of the inner columellar wall. Columellar wall is transparent white to brown in colour, long and narrow triangular, dilated toward the parietal wall with a slightly reflected inner edge bordering the very narrow umbilicus. Shell colour dark brown with golden yellow speckles from the nodulose sculpture and irregular golden yellow axial streaks.

Other material examined: AUSTRALIA, Western Australia: End of Toodyay-Bindoon Road, Bolgart end, 31°16'50.35"S, 116°30'28.33"E, 18 June 1952, A.R. Main, 2 dry (WAM S74996).

Etymology

The species epithet is a noun that refers to *Eucalyptus wandoo*, which characterises the vegetation of Wongamine Nature Reserve. The bark colouration of *E. wandoo* with its two-tone brown and yellow colouration is similar to the external shell colouration of this species.

Distribution, habitat and cultural significance

Bothriembryon wandoo is known only from the southern and eastern sections of Wongamine Nature Reserve in the Avon Wheatbelt P2 (AW-02) IBRA subregion (Figure 1). No habitat information is available. There is a tentative record from 25 km north of Wongamine, near Bolgart (WAM S74996).

Remarks

Previously assigned the OTU code GAS020 in Koehler et al. (2025, in review). This species has not been sighted

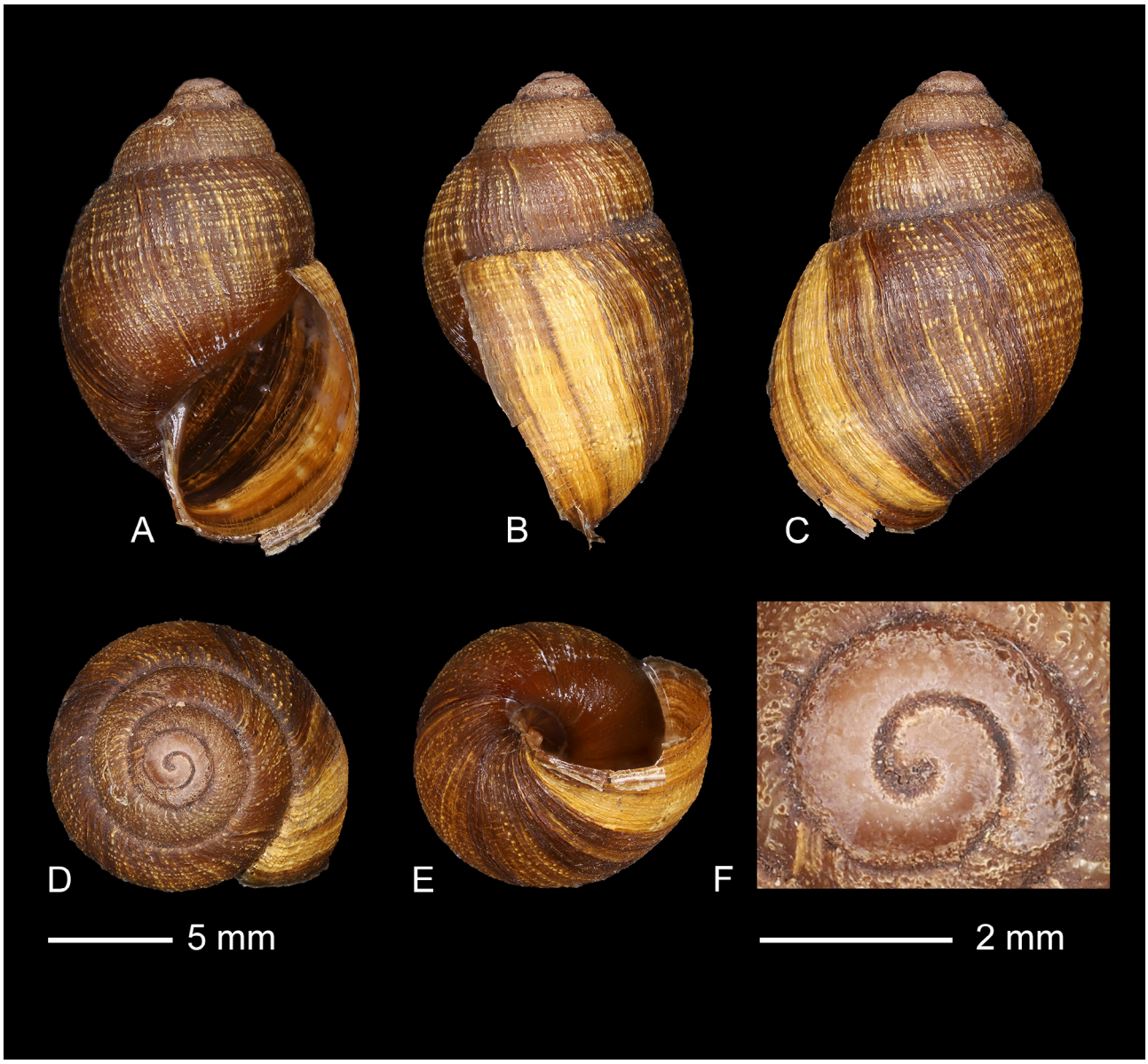

Figure 11. *Bothriembryon wandoo* n. sp. Holotype WAM S12697; A, apertural view; B, lateral view; C, dorsal view; D, apical view; E, basal view; F, sculpture on teleoconch and protoconch whorls.

since 1997 and the exact location where it was originally found within the 330 hectare Wongamine Nature Reserve is not known.

Bothriembryon brunneus n. sp.

Figure 12

https://zoobank.org/NomenclaturalActs/c896f016-b774-4780-906e-2c901304358c

Holotype: AUSTRALIA, Western Australia: ca. 20 km N of Forrestania, 32°12'36"S, 119°40'48"E, open *Eucalyptus* woodland, red loamy sand, on side of fallen log, 12 July 2017, R. Browne-Cooper, wet (WAM S71072).

Paratypes: AUSTRALIA, Western Australia: Lake Cronin Nature Reserve, 32°24'S, 119°44'E, 21 May 1997, L.J.S. Silvester, 2 dry (WAM S28560).

Diagnosis

Shell characterized by the strongly globose shape, coarsely nodulose teleoconch sculpture that is arranged in spiral rows and extending the full depth of whorls and the medium brown to cinnamon brown colour with chestnut protoconch. *Bothriembryon brunneus* shells can be hard to distinguish from the morphologically similar species *B. praecelsus* but are smaller and more globose, have more prominent spiral teleoconch sculpture and a smaller umbilicus. The shells differ from the nearest geographical species *B. isabellae* by the wider size, globose shape and lack of axial flames, and from *B. christineae* by the wider size, more globose shape, lack of pillared sculpture on the teleoconch and the non-flared outer lip.

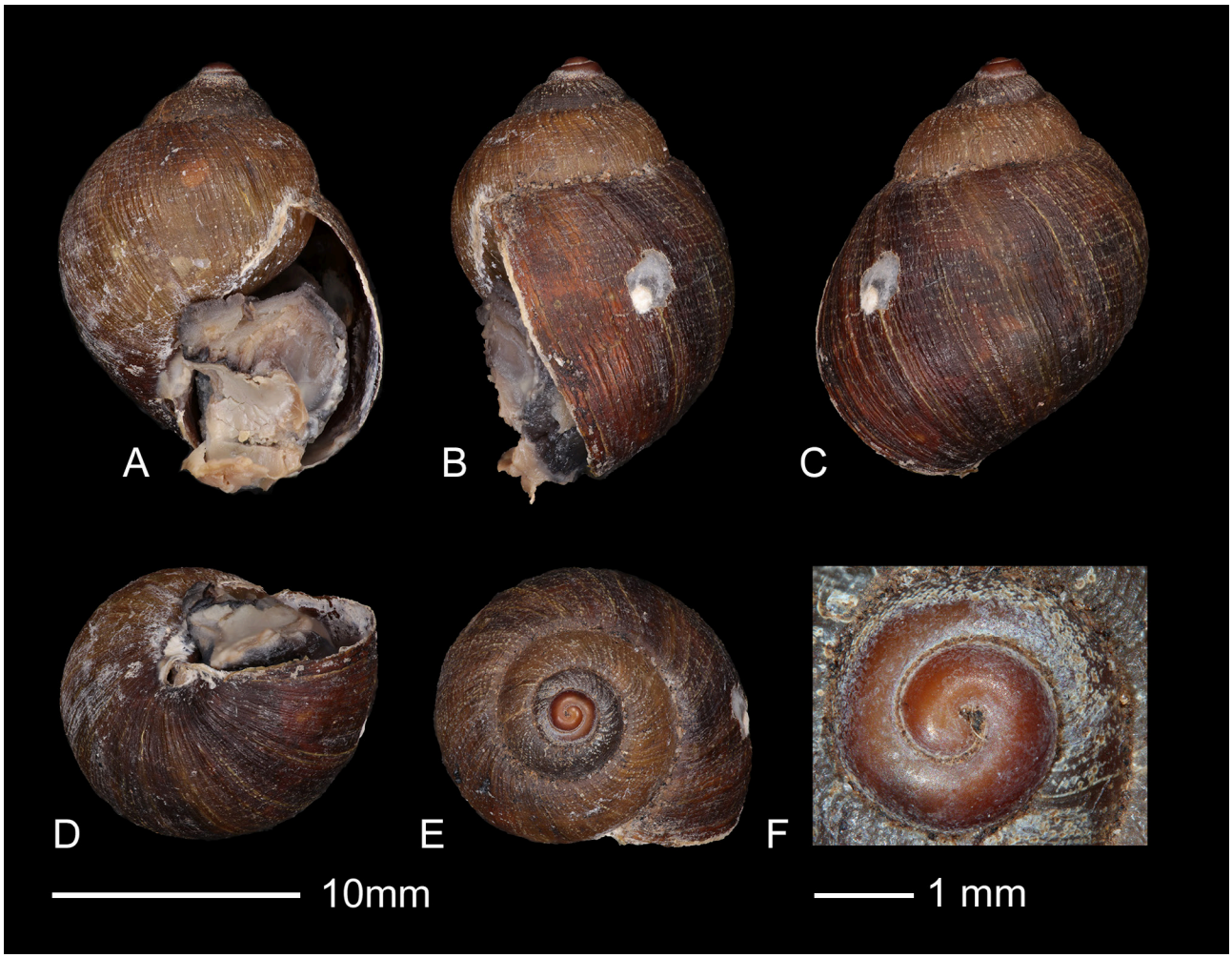

Figure 12. *Bothriembryon brunneus* n. sp. Holotype WAM S71072; A, apertural view; B, lateral view; C, dorsal view; D, basal view; E, apical view; F, sculpture on teleoconch and protoconch whorls.

Genetic Diagnosis

Sequenced specimens of *B. brunneus* exhibited the smallest interspecific evolutionary distance from *B. simoneae*. *Bothriembryon brunneus* is most morphologically similar to *B.* cf. *praecelsus*, and *B. christineae* is the nearest species geographically to *B. brunneus* (P-distances listed in Table 1 for comparison).

Mitochondrial: CO1, WAM S71072; 16S, WAM S71072; Nuclear: ANT, WAM S71072. GenBank numbers provided in Supplementary Table 1, see also Koehler et al. (2025, in review).

Description

Shell (type series): Shell strongly globose with slightly convex whorls, sutures impressed. Height 15.02–16.75 mm (mean 15.89 mm, SD 1.22), diameter 12.90–13.15 mm (mean 13.03 mm, SD 0.18), with 4.40–4.70 whorls (mean 4.55, SD 0.21) and a H/D ratio of 1.49–1.53 (mean 1.51, SD 0.03) (Table 2). Protoconch of 2.20 whorls (mean 2.20, SD 0.00) with short, axial wrinkles extending ca. one fifth of whorl depth from suture before coalescing to form a honeycomb matrix, subsutural wrinkles absent on second whorl, colour chestnut, shiny. Teleoconch sculpture consists of regular, low axial ribs broken into coarse nodules by incised spiral lines, arranged into evenly spaced spiral rows. On the penultimate whorl, approximately 12-14 spiral rows. The nodulose sculpture extends the full depth of the body whorl. Body whorl strongly inflated with short, very acuminate spire (mean LWH/H 0.87, SD 0.01). Aperture large, ovate, about two-thirds of shell height (mean AH/H 0.66, SD 0.01) with a simple lip. The parietal wall is only discernible from the body whorl by a thin white line that extends from the junction of the outer lip to the junction of the inner columellar wall. Deep and narrow umbilicus. Shell colour medium brown to cinnamon brown with chestnut protoconch.

Other material examined: AUSTRALIA, Western Australia: Forrestania, ca. 80 km E of Hyden, 32°30'51.09"S, 119°42'37.04"E, site POI 034, soil sample, 30 June 2010, V. Saffer, 2 dry (WAM S64847).

Etymology

The species epithet is an adjective that refers to the deep chestnut brown to rich mahogany external shell

colouration of this species (*brunneus*, Latin, dark, dusky, brown) (Brown 1954).

Distribution, habitat and cultural significance

Bothriembryon brunneus is only known from three localities north of Forrestania (including Lake Cronin Nature Reserve) in the Southern Cross (COO-02) IBRA subregion, a linear distance of 35 km (Figure 1). It is found in *Eucalyptus* woodland on red loamy sands.

Remarks

Previously assigned the OTU code GAS022 in Koehler et al. (2025, in review). The strongly globose shell shape may suggest the species is sand dwelling.

Disclosures

There are no conflicts of interest.

Acknowledgments

We thank previous malacological workers at the Western Australian Museum who helped build and curate the large *Bothriembryon* collection, namely Shirley Slack-Smith, George Kendrick and Hillary Merrifield. We would also like to thank Bram Breure, Frank Koehler, Alan Longbottom, Hugh Morrison and Ben Schneider for ongoing discussions about *Bothriembryon* taxonomy and ecology. Numerous Environmental Consultants made this study possible by depositing specimens with the WA Museum. Molecular data was generated by staff at the WAM Molecular Systematic (now Genomic Resources) Unit, namely Dr. Kim Lema, Michelle Condy, Kiah Grogan and Dr. Nerida Wilson. This sequencing work was funded by the Gorgon Project's Barrow Island Net Conservation Benefits Fund. Taxonomic work was supported by the BHP Social Investment Fund.

Supplementary Data

Supplementary Table 1. GenBank Numbers for the mitochondrial and nuclear sequences used in this study. DOI: 10.5061/dryad.7m0cfxq7d

Supplementary Table 2. Shell measurements and ratios for the type material of ten new species of *Bothriembryon.* H, maximum shell height; D, maximum shell diameter; H/D, height to diameter ratio; TW, total number of whorls; PW, number of protoconch whorls; PD, protoconch diameter; AH, aperture height; AD, aperture diameter; AH/AD, aperture height to aperture diameter ratio; AH/H, aperture height to height ratio; LWH, last whorl height; LWH/H, last whorl height to height ratio; CA, convexity A, distance from outer edge to B; CB, convexity B suture distance; C, convexity; SA, spire angle (SA). DOI: 10.5061/dryad.7m0cfxq7d

References

Breure, ASH (1974) Caribbean land molluscs: Bulimulidae, I. Bulimulus. *Studies on the Fauna of Curaçao and Caribbean Islands* 45: 1–80.

Breure ASH & Ablett JD (2012) Annotated type catalogue of the Bothriembryontidae and Odontostomidae (Mollusca, Gastropoda, Orthalicoidea) in the Natural History Museum, London. *ZooKeys* 182: 1–70.

Breure ASH & Whisson CS (2012) Annotated type catalogue of *Bothriembryon* (Mollusca, Gastropoda, Orthalicoidea) in Australian museums, with a compilation of types in other museums. *ZooKeys* 194: 41–80.

Brown RW (1954) Composition of scientific words. Revised edition. Smithsonian Institution Press, Washington, D.C.

Hill A, Johnson, MS & Merrifield H (1983) An electrophoretic and morphological examination of *Bothriembyron kendricki* (Pulmonata: Bulimulidae), a new species previously considered conspecific with *B*. *bulla* (Menke). *Australian Journal of Zoology* 31(2): 227–242. https://doi.org/10.1071/zo9830227

Iredale T (1939) A review of the land Mollusca of Western Australia. *Records of the Western Australian Museum and Art Gallery* 2 Part 1: 1–88.

Koehler F, Whisson CS, Wilson NG, Hosie AM, Breure ASH & Kirkendale LA (In Review) High lineage diversity of a neglected Australian land snail in a global biodiversity hotspot. *Journal of Biogeography*.

Morrison HM (2021) Description of two new species of *Bothriembryon* (Gastropoda: Stylommatophora: Brothriembryontidae) from the semi-arid zone of the southeast corner of Western Australia. *Conchylia* 52(1–2): 3–18.

Morrison HM & Schneider B (2019) Description of two new species of the genus *Bothriembryon* (Gastropoda, Pulmonata: Bothriembryontidae) from the Fitzgerald River National Park on the south coast of Western Australia. *Conchylia* 50(1–4): 129–142.

Morrison HM & Schneider B (2021) Description of a new species of *Bothriembryon* (Gastropoda: Stylommatophora: Bothriembryontidae) from the western side of the Nullarbor Plain, Western Australia. *Conchylia* 51(3–4): 23–33.

Morrison HM & Schneider B (2022a) Description of a new species of *Bothriembryon* (Gastropoda, Stylommatophora: Bothriembryontidae) from the eastern tip of Two Peoples Bay, near Albany, Western Australia. *Conchylia* 52(3–4): 3–14.

Morrison HM & Schneider B (2022b) Description of two New Species of *Bothriembryon* (Gastropoda, Stylommatophora: Bothriembryontidae) from near Kalbarri in the Mid West Region of Western Australia. *Conchylia* 52(3–4): 15–30.

Morrison HM & Schneider B (2023a) The description of three new species of *Bothriembryon* (Gastropoda, Stylommatophora: Bothriembryontidae) from the South West of Western Australia. *Conchylia* 53(3–4): 53–69.

Morrison HM & Schneider B (2023b) Description of three new species of *Bothriembryon* (Gastropoda, Stylommatophora: Bothriembryontidae) from Dundas Shire in the south-east of Western Australia. *Conchylia* 54(1–2): 71–84.

Morrison HM, Schneider B & Whisson CS (2019) A new species of the genus *Bothriembryon* (Gastropoda: Bothriembryontidae) from the shire of Esperance, Western Australia. *Conchylia* 50(1–4): 15–24.

Morrison HM, Schneider B & Whisson CS (2024) Description of three new species of *Bothriembryon* (Gastropoda, Stylommatophora: Bothriembryontidae) from the Great Southern Region of Western Australia. *Conchylia* 55(1-2): 59–75.

Ryan HE, Travouillon, KJ, Milne LA, Martin SK, Thorn KM & Whisson CS (2024) A new *Bothriembryon* from the Nullarbor Plain, Western Australia, with insights on the age of *Bothriembryon praecursor* from Kangaroo Well, Northern Territory. *Alcheringa* 1–16. https://doi.org/10.1080/03115518.2024.2323472

Schneider B & Morrison H (2018) A new species of the genus *Bothriembryon* (Gastropoda, Stylommatophora: Bothriembryontidae) from South Eastern Western Australia. *Conchylia* 49(3–4): 1–11.

Solem A (1998) Family Bulimulidae. In: Mollusca: The Southern Synthesis: Fauna of Australia. Part A. Beesley, P.L., Ross, G.J.B., Wells, A. (Eds.). CSIRO Publishing. 1094–1096.

Stanisic J, Shea M, Potter D & Griffiths O (2018) Australian Land Snails Volume 2. A field guide to southern, central and western species. Mauritius: Bioculture Press, pp. 1–594.

Tamura K, Stecher G, Peterson D, Filipski A & Kumar S (2013) MEGA6: Molecular evolutionary genetics analysis version 6.0. *Molecular Biology and Evolution* 30(12): 2725–2729.

Whisson CS & Breure ASH (2016) A new species of *Bothriembryon* (Mollusca, Gastropoda, Bothriembryontidae) from south-eastern Western Australia. *ZooKeys* 581: 127–140.

Whisson CS & Ryan HE (2019) Review of the fossil record of the Australian land snail genus *Bothriembryon* Pilsbry, 1894 (Mollusca: Gastropoda: Bothriembryontidae): new distributional and geological data. *Records of the Western Australian Museum* 34: 38–50.

Whisson CS, Breure ASH & Kirkendale LA (2024) *Bothriembryon rocketi* n. sp. (Mollusca, Gastropoda, Bothriembryontidae) from the semi-arid Pilbara region of Western Australia. *Australian Journal of Taxonomy* 60: 1–10. https://doi.org/10.54102/ajt.1y4jy

WoRMS Editorial Board (2025). World Register of Marine Species. Available from http://www.marinespecies.org at VLIZ. Accessed [2025-01-10]. doi:10.14284/170