A new volute, *Ericusa ngayawang* sp. nov. (Gastropoda: Volutidae), from the Miocene of South Australia

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**ABSTRACT**

*Ericusa ngayawang* sp. nov. is described from shells preserved in the Middle Miocene Cadell Formation in the western Murray Basin of South Australia. At the time the Murray Basin was part of the Southeastern Australian Marine Biogeographic Province. *Ericusa ngayawang* is a small heavily costate species of *Ericusa* with clear affinities to the Early Miocene *E. atkinsoni* of Victoria and Tasmania but can be distinguished from it by its smaller size, more slender proportions and its heavily costate body whorl. *Ericusa atkinsoni* and its relative, *E. macroptera*, inhabited the basins to the east of the Murray Basin during the Late Oligocene and Early Miocene but were extinct there before the end of the Burdigalian Stage of the Early Miocene. The persistence of *E. ngayawang* into the Langhian Stage of the Middle Miocene is another piece of evidence for partial biogeographic isolation of the western Murray Basin from the rest of the Southeastern Australian Province during the Miocene.

**Subjects**  Biogeography, Evolutionary Studies, Paleontology, Taxonomy, Zoology

**Keywords**  Volutidae, Murray basin, Miocene, Cadell formation, South Australia, Southeast Australian Province, Langhian, Biogeography, Gastropoda

**INTRODUCTION**

*Ericusa Adams & Adams* (1858), is an endemic Australian genus of volutid that is characterized by a fusiform shell and a moderately large to large, paucispiral protoconch that has its axis of coiling offset from that of the teleoconch by about 45° or less (*Darragh*, 1989). The oldest named species of the genus come from the Chattian Stage, Late Oligocene of the Jan Juc Formation in the Otway Basin of Victoria. Two distinct species are present in this formation, indicating that the genus has an older origin and that some diversification had occurred prior to the deposition of the Jan Juc Formation. Indeed, *Darragh* (1989) reported fragments of an undescribed volutid from the Priabonian Stage (Late Eocene), Narrawaturk Marl (as Browns Creek Clay) that bear similarity to *Ericusa atkinsoni*. These fragments have not been figured so it is not possible to assess whether or not they truly belong to *Ericusa*. There is a distinct possibility that they may belong to a stem-member of the tribe Livoniini to which *Ericusa* belongs (*Bail & Poppe*, 2001). Among the early occurring species of *Ericusa*, *E. atkinsoni* (*Pritchard*, 1896) and its relative *E. macroptera* (*McCay*, 1866) stand out from extant species in possessing a strongly exsert tip of the first protoconch whorl and axial sculpture in form of costae, often with shoulder nodules, on at least the early teoloconch whorls. These two species bear

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some resemblance to early members of Livonia, particularly *L. stephensi* (Johnston, 1880). *Livonia* is the presumed sister genus of *Ericusa* (*Darragh, 1989*) and the resemblance between *L. stephensi* and especially *E. atkinsoni* is probably an indication that neither is particularly distant from the common ancestor of the two genera. Thus it is plausible that *E. macroptera* and *E. atkinsoni* are an early branch of the genus and may well be the sister group to all other species in the genus. The *E. macroptera*–*E. atkinsoni* lineage was short lived in south eastern Australia and makes its last appearance before the end of the Burdigalian Stage (Early Miocene) in the Fishing Point Marl of the Otway Basin (*Darragh, 1989*).

Here a new species of the *E. macroptera*–*E. atkinsoni* lineage is described from the Langhian Stage (middle Miocene) of the more westerly Murray Basin of South Australia. It indicates that the lineage survived into the Middle Miocene after going extinct in the more easterly Otway and Bass Basins of Victoria and Tasmania. It is further evidence of the biogeographic distinctiveness of the molluscan fauna of the Murray Basin in comparison to more easterly basins during the Miocene.

**GEOLOGICAL SETTING**

All of the specimens of the new species described here were collected from the Murbko Marl Member of the Cadell Formation of the Morgan Subgroup (*Lukasik & James, 1998; Cowley & Barnett, 2007*), at its type section on the east bank of the Murray River, 6 km south of Morgan, South Australia (*Fig. 1*). The Morgan Subgroup is a part of the Oligo-Miocene Murray Group, a marine sequence filling the western Murray Basin (*Ludbrook, 1961; Lukasik & James, 1998; Gallagher & Gourley, 2007*). The Murbko Marl Member is a soft grey marl containing an abundant and diverse mollusc assemblage (*Lukasik & James, 1998*). Much of the Murray Group is composed of porous calcarenites where ground water has stripped away original aragonite, leaving only moulds of aragonitic shells. The Murbko Marl Member is one of very few beds where this has not occurred, making it a favourite destination for amateur collectors and professional palaeontologists alike.

Outcrops of the Cadell Formation are restricted to the western part of the Murray Basin, in the vicinity of the town of Morgan. Nevertheless subsurface argillaceous beds that can be correlated with the Cadell Formation extend eastwards into far western Victoria (*Gallagher & Gourley, 2007*).

The age of the Cadell Formation is early middle Miocene (Langhian Stage) based on biostratigraphy using planktonic foraminifera (*Li & McGowran, 1999*).

**MATERIALS AND METHODS**

The specimens described herein were all collected from the Cadell Formation at its type section. Collection of fossil shells in South Australia is considered “fossicking” and can be conducted on non-reserved public lands without a permit provided no mechanical devices or explosives are used and the specimens are not sold. Most specimens were found in the loose slips of eroded material that cover much of the slope of the Cadell Formation at its type locality but the holotype was excavated from the cliff section, at
approximately two thirds of the height of the formation from its base. These specimens have been deposited in the palaeontological collection of the Museum and Art Gallery of the Northern Territory, held at Megafauna Central, in Alice Springs, Northern Territory.

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SYSTEMATIC PALAEONTOLOGY

GASTROPODA Cuvier (1795)
CAENOGASTROPODA Cox (1960)
NEOGASTROPODA Wenz (1938)
VOLUTIDAE Rafinesque (1815)
CYMBIINAE Adams & Adams (1858)
LIVONIINI Bail & Poppe (2001)
ERICUSA Adams & Adams (1858)

Type species—Voluta fulgetrum Sowerby (1825)
ERICUSA NGAYAWANG SP. NOV.
urn:lsid:zoobank.org:act:E133FA7E-2327-4AA3-8D55-B7B9DA5CF950

Etymology—Named after the now extinct language spoken in the area that the fossils were found prior to European colonisation (Horgen, 2004). There are few words of this language recorded, so it seems appropriate that the people that spoke this language are at least commemorated here.

Holotype—NTM P11217, an adult shell missing the anterior end of the body whorl (Fig. 2).

Paratypes—NTM P8464, juvenile; NTM P9019, three spire fragments.

Type locality and horizon—Cliffs immediately south of small gully, 4.8 km South of Morgan Ferry–Cadell Road on the east bank of the Murray River, opposite Brenda Park (The type section of the Murbko Marl Member of the Cadell Formation). Langhian Stage, Miocene.

Specific diagnosis—Adult size approximately 70 mm. Shell slender with gradually tapering spire. First whorl of protoconch with exsert tip and deviated 40° to 15° from axis. Axial costae persistent from first teleoconch whorl to body whorl. Reflected outer lip narrow, not winglike.

Description—The shell is small for an Ericusa (Fig. 3; Table 1). With an estimated adult length of approximately 70 mm, the holotype lies within the known size range of Ericusa subtilis, and exceeds only E. naniforma (Bail & Limpus, 2013). The protoconch consists of 2 to 2.5 smooth whorls. The first of these is rounded and deviated from the axis of coiling of the rest of the shell. The angle of deviation is less than that observed in other species of Ericusa and varies from 40° to 15°. The initial portion of the first protoconch whorl forms a low rounded posterior projection that resembles a more subdued version of the more strongly exsert tip seen in E. atkinsoni and E. macroptera. The adult spire consists of about four whorls with convex profiles. Each spire whorl bears 11 to 12 rounded axial costae that become weakly nodulose on the last half of the last whorl. The spire whorls are crossed with fine spiral threads that attenuate on the last spire whorl although a few weak threads below the shoulders do persist onto the early part.
of the adult body whorl. There is a narrow and weakly concave posterior whorl slope between the shoulder nodules and the posterior suture. The middle section of the body whorl is mildly ventricose and expands slightly lateral to the level of the shoulder nodules. The anterior end is abruptly contracted and lacks a siphonal fasciole. The axial costae continue to be expressed on the body whorl with only the last example before the outer lip being weakly developed. The costae are weak to obsolete on the posterior whorl slope and bear moderately developed shoulder nodules. Each costa extends anteriorly to about the level of the anterior contraction, whereafter they become obsolete. The adult outer lip is weakly laterally everted and bears a small posterior expansion that is deflected dorsally. The columella is covered with a thin callus and bears three strong columellar plaits. No residual colour pattern could be observed under UV light.

Figure 2 Type specimens of *Ericusa ngayawang* sp. nov. (A–C) Holotype (NTM P11217) in (A) ventral, (B) labial and (C) dorsal views. (D, E) Juvenile paratype (NTM P8464) in (D) dorsal and (E) ventral views. (F) Close-up view of the protoconch of the holotype (NTM P11217). Scale bar for A–E = 20 mm. Scale bar for F = 5 mm. Specimens have been whitened with ammonium chloride. Photographs by the author.
Figure 3  Shells of various Livoniini compared. (A) Silhouettes from left to right of Livonia stephensi, Ericusa macroptera, Ericusa atkinsoni, Ericusa ngayawang sp. nov. and Ericusa fulgetrum drawn to scale. (B–F) Reconstructions of adult shells from each species showing diagnostic features (not to scale). (B) Livonia stephensi. (C) Ericusa macroptera. (D) Ericusa atkinsoni. (E) Ericusa ngayawang sp. nov. (F) Ericusa fulgetrum.
Specific comparisons—Differs from all species of *Ericusa* except *E. atkinsoni* and *E. macroptera* in its possession of both axial sculpture and an exsert tip of the protoconch. It differs from *E. macroptera* in the absence of a large, wing-like posterolateral expansion of the outer lip and its far stronger axial sculpture that persists onto the body whorl. It differs from *E. atkinsoni* by its smaller size (adult length approximately 70 mm vs. 132–140 mm: *Darragh, 1989*), the persistence of elongate axial costae onto the body whorl (vs. restriction of axial sculpture to short shoulder nodules on the body whorl), and its overall more slender shell with a less tumid body whorl and a relatively longer, more gradually tapering spire. It differs from *Livonia stephensi* in its smaller size, more slender form and absence of an exsert tip on the first protoconch whorl (Fig. 3).

**DISCUSSION**

*Ericusa ngayawang* is clearly related to *E. atkinsoni*. The latter species is known from the Freestone Cove Sandstone of the Bass Basin, Tasmania and from the Puebla Formation of the Torquay Sub-Basin of the Otway Basin in Victoria (*Darragh, 1989*; Fig. 4). These two formations considered to be age equivalent (*Ludbrook, 1967*) and both contain *Darragh (1985)* molluscan assemblage VIII. *Darragh’s numbered molluscan assemblages are a chronological series of assemblage zones that divide the Cenozoic marine sequence of southeastern Australia. The age of the Puebla Formation is well-constrained to the earliest Miocene (Aquitanian Stage) both with microfossil biostratigraphy (*Li, Davies & McGowran, 1999*) and strontium isotope stratigraphy (*Dickinson, 2002* reported in *McLaren et al., 2009*).

### Table 1 Dimensions of *Ericusa ngayawang* sp. nov. and other selected species of *Ericusa*. Length measured from the protoconch to the end of the anterior canal along the axis of the shell. Spire height measured from the level of the protoconch to the level of the apertural suture, parallel with the axis of the shell. For those measurements taken from the literature spire height is equal to length minus aperture height. Width measured perpendicular to the axis of the shell at its widest point, between axial costae. Where two measurements appear the specimen is incomplete and the number in parentheses refers to the measurement as preserved, whereas the number not in parentheses is the estimated measurement if complete.

| Species/Specimen | Length (mm) | Spire height (mm) | Width (mm) |
|------------------|-------------|------------------|------------|
| *Ericusa macroptera* NMV P12379<br> | 125<br> | –<br> | 62<br> |
| *Ericusa macroptera* NMV P12378<br> | 141<br> | 36<br> | 64<br> |
| *Ericusa macroptera* NMV P48588<br> | 134<br> | 47<br> | 52<br> |
| *Ericusa atkinsoni* NMV P9985<br> | 132<br> | 47<br> | 66<br> |
| *Ericusa atkinsoni* NMV P41723<br> | 140<br> | 48<br> | 61<br> |
| *Ericusa ngayawang* NTM P11217<br> | ~70 (59)<br> | 30<br> | 27<br> |
| *Ericusa ngayawang* NTM P8464<br> | 30<br> | 9<br> | 16<br> |
| *Ericusa subtilis* WAM 69.515<br> | 67<br> | 29<br> | 24<br> |
| *Ericusa subtilis* WAM 79.391<br> | 71<br> | 30<br> | 25<br> |
| *Ericusa naniforma* WAM S11656<br> | 62<br> | 18<br> | 34<br> |

Notes:

* Measurements taken from *Darragh (1989).*
* Measurements taken from *Bail & Limpus (2013).*
Younger specimens of *E. atkinsoni* are also known from the Fishing Point Marl (*Darragh, 1989; Fig. 4*). This unit, which occurs in the main Otway Basin, contains *Darragh (1985)* molluscan assemblage IX, and includes a number of first occurrences of younger taxa not found in the Freestone Cove Sandstone, Puebla Formation, or older beds, indicating that it is younger than these. *Carter (1958)* placed the lower part of the Fishing Point Marl in his foraminifera zone G which correlates with the mid part of the Burdigalian Stage of the Early Miocene (*Gallagher & Stanislaus, 2019*).

*Darragh (1989)* did not figure the Fishing Point Marl specimens but did mention that they are both smaller and more slender with elongate spires than topotype specimens. In these respects they show similarity to *E. ngayawang* and it is possible that the Fishing Point Marl specimens represent an intermediate population or even an early
population of *E. ngayawang*. However *Darragh (1985)* indicated that the Fishing Point Marl specimens were few in number and of poor preservation, hindering a definitive systematic assessment.

Following the deposition of the Fishing Point Marl in the mid Burdigalian Stage, the Miocene climatic optimum (*Böhme, 2003*) was reaching its zenith and transgressions covered the onshore basins of south eastern Australia for much of the remaining Early and Middle Miocene (*McGowran et al., 2004*). As a consequence there are many marine mollusc fossil sites dating to the late Early Miocene and Middle Miocene that were traditionally assigned the local stage names Batesfordian, Balcombian and Bairnsdalian, including the famously rich sites of Muddy Creek and Fossil Beach, Balcombe Bay. None of these have yielded an *Ericusa* that can be referred to the *E. macroptera–* *E. atkinsoni* lineage and it is reasonable to infer that the lineage was extinct east of the Murray Basin before the end of the Burdigalian Stage.

Mention should be made of a specimen retrieved from a depth of 73 m in Mundys Well in the Murray Basin on Canegrass Station 70 km NNE of the type section for the Murbko Marl Member of the Cadell Formation (*Fig. 1*). This specimen was referred to *E. atkinsoni* by *Darragh (1989)* but an examination of the specimen, well over a decade ago, by myself indicated that it was the same species as the one present in the Cadell Formation. Unfortunately the specimen could not be re-located in the collections at the South Australian Museum for measurement and figuring in this article. The stratigraphic position of the fossils from Mundys Well has never been discussed. Other molluscs from the same level in the well include *Corbula ephemilla* (*Tate, 1885*) and the nominate subspecies of *Athleta (Ternivoluta) antiscalaris* (*McCoy, 1866*) which are common members of the Cadell Formation assemblage at the type section for the Murbko Marl Member. *Gallagher & Gourley (2007)* found that the Cadell Formation was extensive in subsurface sections and could be recognised in several boreholes in western Victoria. Given the proximity of Mundys Well to the type section of the Murbko Marl Member of the Cadell Formation, the presence of other mollusc species that are typical of the Cadell Formation and the broad subsurface extent of the Cadell Formation, there is little doubt that the mollusc fossils from Mundys Well were taken from the Cadell Formation, nor is there much doubt that the specimen in question can be referred to *E. ngayawang*.

The majority of mollusc species in the Cadell Formation are shared with middle Miocene mollusk assemblages from the Otway and Port Phillip Basins. In particular many species are shared with *Darragh (1985)* molluscan assemblage XI which is typified by the famously rich deposit at Fossil Beach, Mornington Peninsula in the Port Phillip Basin. Darragh’s molluscan assemblage zones were proposed to provide a zonation within the Southeastern Australian Province. This marine province was initially established by *Crespin (1950)* after she noticed that there was a distinct biogeographic discontinuity between the foraminifera of basins west of the Mount Lofty Ranges and those to the east during the Mio-Pliocene. Initially the eastern province, including the Murray, Otway, Bass, Port Phillip and Gippsland Basins was named the Bass Strait Province (*Crespin, 1950*) but *Darragh (1985)* renamed it the Southeast Australian Province.
The persistence of the *E. macroptera–E. atkinsoni* lineage in the Murray Basin beyond its extinction further east is evidence that the Southeast Australian Province was not biogeographically uniform in the Middle Miocene. There are other examples of persistent mollusc taxa in the Cadell Formation that are only found in older Victorian strata. The possible columbariid *Hispidofusus piscatorius* and the nominate subspecies of the volutid *Athleta* (*Ternivoluta*) *antiscalaris* are present in the Langhian aged Cadell Formation but are only found in Victorian sites that are correlated with the Burdigalian Stage (*Darragh, 1969, 1971*, as Batesfordian). In addition to these persistent taxa there are several endemic species in the Cadell Formation with related congeners in the Otway or Port Phillip Basins, including cypraeids (*Schilder, 1935; Yates, 2008*), volutids (*Darragh, 1989*) and a venerid (*Darragh, 1965*). These all suggest some form of isolation of the western Murray Basin allowing it to evolve some distinctive taxonomic differences from more easterly basins in the Province. It is interesting to note that this difference is not due to the influence of the Austral-Indo-Pacific Province to the immediate west of the Murray Basin. This province, so-named because it is an extension of the Indo-Pacific Province, shares many warm-water foraminifera and molluscs with the Indo-Pacific Province and none with the Cadell Formation that cannot be found further east. This situation was temporary and the overlying Bryant Creek Formation of later Langhian age does contain molluscs with affinities to the Indo-Pacific Province including a species each of *Nemocardium*, *Globularia*, *Sphaerocypraea* and a strombid with some resemblance to *Thersistrombus* (A. Yates, 2009–2021, personal observations).

**CONCLUSIONS**

*Ericusa ngayawang* is a species of *Ericusa*, belonging to the *E. macroptera–E. atkinsoni* lineage. It lived in the western Murray Basin during the Langhian Stage of the Middle Miocene, when other members of the lineage had gone extinct elsewhere in the Southeastern Australian Province. The persistence of the lineage in the Western Murray Basin is matched with a few other molluscan taxa. In addition to the persistent lineages there are also some endemic mollusk species in the Cadell Formation. Together these indicate that there was some degree of biogeographic isolation of the western Murray Basin from the rest of the Southeastern Australian Province during the deposition of the Cadell Formation.

**INSTITUTIONAL ABBREVIATIONS**

| Abbreviation | Institution                              |
|--------------|------------------------------------------|
| NMV          | Museum Victoria, Melbourne, Australia.   |
| NTM          | Museum and Art Gallery of the Northern Territory, Darwin and Alice Springs, Australia. |
| WAM          | Western Australian Museum, Perth, Australia. |

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**Competing Interests**
The author declares that they have no competing interests.

**Author Contributions**
- Adam M. Yates conceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the article, and approved the final draft.

**Field Study Permissions**
The following information was supplied relating to field study approvals (i.e., approving body and any reference numbers):

The specimens were fossils collected from non-reserved public lands in South Australia. Fossils are covered by the Mining Act in South Australia which allows non-commercial fossicking without a permit provided there is no use of any mechanical equipment. Therefore there is no permit required for the collection of these specimens, neither could one be obtained.

**Data Availability**
The following information was supplied regarding data availability:

The specimens described in this article are lodged in the Palaeontological Collection of the Museum and Art Gallery of the Northern Territory. They are physically held at Megafauna Central, 21 Todd Street, Alice Springs, 0870 Northern Territory, Australia, which is a facility run by the Museum and Art Gallery of the NT, under accession numbers: NTM P8464, P9019 and P11217.

**New Species Registration**
The following information was supplied regarding the registration of a newly described species:

- Publication LSID: urn:lsid:zoobank.org:pub:0CFA9C77-D089-49D5-A6FA-EA51099D57E6
  - *Ericusa ngayawang* sp. nov. Species LSID: urn:lsid:zoobank.org:act:E133FA7E-2327-4AA3-8D55-B7B9DA5CF950.
REFERENCES

Adams H, Adams A. 1858. *The genera of recent mollusca*. Vol. 2. London: VanVoorst, 55.

Bail P, Limpus A. 2013. A new species of *Ericusa* H. & A. Adams, 1858 (Gastropoda: Volutidae) from the bathyal Western Australian waters. *Novapex* 14(1):1–4.

Bail P, Poppe GT. 2001. *A conchological iconography: a taxonomic introduction of the recent Volutidae*. Vol. 30. Hackenheim: ConchBooks, 5.

Böhme M. 2003. The Miocene Climatic Optimum: evidence from ecothermic vertebrates of Central Europe. *Palaeogeography, Palaeoclimatology, Paleoecology* 195:389–401 DOI 10.1016/S0031-0182(03)00367-5.

Carter AN. 1958. Tertiary foraminifera from the Aire District, Victoria. *Bulletin of the Geological Survey of Victoria* 55:1–76.

Cohen KM, Finney SC, Gibbard PL, Fan J-X. 2013. The ICS International Chronostratigraphic Chart. *Episodes* 36:199–204 DOI 10.18814/epiiugs/2013/v36i3/002.

Cowley WM, Barnett SR. 2007. Revision of Oligocene-Miocene Murray Group stratigraphy for geological and groundwater studies in South Australia. *MESA Journal* 47:17–20.

Cox LR. 1960. Thoughts on the classification of the Gastropoda. *Proceedings of the Malacological Society of London* 33(6):239–261 DOI 10.1093/oxfordjournals.mollus.a064829.

Crespin I. 1950. Australian Tertiary microfaunas and their relationships to assemblages elsewhere in the Pacific region. *Journal of Paleontology* 24:421–429.

Cuvier G. 1795. Second Mémoire sur l’organisation et les rapports des animaux à sang blanc, dans lequel on traite de la structure des Mollusques et de leur division en ordre, lu à la société d’Histoire Naturelle de Paris, le 11 prairial an troisième. *Magazin Encyclopédique, ou Journal des Sciences, des Lettres et des Arts* 2:433–449.

Darragh TA. 1965. *Proxichione* (Pelycopoda: Veneridae) from the Tertiary of South-Eastern Australia. *Proceedings of the Royal Society of Victoria* 79:165–173 pls 21–24.

Darragh TA. 1969. A revision of the Columbariidae (Mollusca: Gastropoda). *Proceedings of the Royal Society of Victoria* 83:63–119 pls 2–6, Figs. 1–24.

Darragh TA. 1971. Revision of the Australian Tertiary Volutidae (Mollusca: Gastropoda). The subfamily Athletinae. *Journal of the Malacological Society of Australia* 2(2):163–185 pls 14–16 DOI 10.1080/00852988.1971.10673850.

Darragh TA. 1985. Molluscan biogeography and biostratigraphy of the Tertiary of southeastern Australia. *Alcheringa: An Australasian Journal of Palaeontology* 9(2):83–116 DOI 10.1080/03115518508618960.

Darragh TA. 1989. A revision of the Tertiary Volutidae (Mollusca: Gastropoda) of South-Eastern Australia. *Memoirs of the Museum of Victoria* 49(2):195–307 DOI 10.24199/j.mmv.1988.49.12.

Dickinson JA. 2002. Neogene tectonics and phosphogenesis across the southeast Australian margin. Unpublished PhD thesis, University of Melbourne, Melbourne.

Gallagher SJ, Gourley TL. 2007. Revised Oligo-Miocene stratigraphy of the Murray Basin, southeast Australia. *Australian Journal of Earth Sciences* 54(6):837–849 DOI 10.1080/08120090701392705.

Gallagher S, Stanislaus F. 2019. New micropalaeontological results from legacy core, *Onshore Otway Basin, Victoria. Victorian Gas Program Technical Report 8*. Geological Survey of Victoria, Melbourne, 30.

Horgen M. 2004. The languages of the Lower Murray. Unpublished MA thesis, LaTrobe University, Melbourne.
Li Q, Davies PJ, McGowran B. 1999. Foraminiferal sequence biostratigraphy of the Oligo Miocene Janjukian strata from Torquay, southeastern Australia. *Australian Journal of Earth Sciences* 46:261–273 DOI 10.1046/j.1440-0952.1999.00696.x.

Li Q, McGowran B. 1999. Miocene foraminifera from the Finniss Clay and Cadell Marl, western Murray Basin: taxonomic and taphonomic contrasts and their environmental significance. *Alcheringa: An Australasian Journal of Palaeontology* 23(2):133–152 DOI 10.1080/03115519908619326.

Ludbrook NH. 1961. *Stratigraphy of the Murray Basin in South Australia*. Vol. 36. Bulletin: Geological Survey of South Australia, 1–96.

Ludbrook NH. 1967. Tertiary molluscan types from Table Cape in the Tasmanian Museum, Hobart. *Papers and Proceedings of the Royal Society of Tasmania* 101:65–69 pls 1–4.

Lukasik JJ, James NP. 1998. Lithostratigraphic revision and correlation of the Oligo-Miocene Murray Supergroup, Western Murray Basin, South Australia. *Australian Journal of Earth Sciences* 45(6):889–902 DOI 10.1080/08120099808728443.

McCoy F. 1866. On some new species of fossil volutes from the Tertiary beds near Melbourne. *Annals and Magazine of Natural History* 18(107):375–381 DOI 10.1080/00222936608679664.

McGowran B, Holdgate GR, Li Q, Gallagher SJ. 2004. Cenozoic stratigraphic succession in southeastern Australia. *Australian Journal of Earth Sciences* 51(4):459–496 DOI 10.1111/j.1400-0952.2004.01078.x.

McLaren S, Wallace MW, Gallagher SJ, Dickinson JA, McAllister A. 2009. Age constraints on Oligocene sedimentation in the Torquay Basin, southeastern Australia. *Australian Journal of Earth Sciences* 56(4):595–604 DOI 10.1080/08120090902806347.

Pritchard GB. 1896. A revision of the fossil fauna of the Table Cape Beds, Tasmania, with descriptions of new species. *Proceedings of the Royal Society of Victoria* 8:74–150 pls 2–4.

Rafinesque CS. 1815. *Analyse de la Nature ou Tableau de l'Univers et des Corps organisés*. Palermo. 224.

Schilder FA. 1935. Revision of the Tertiary Cypraeacea of Australia and Tasmania. *Proceedings of the Malacological Society of London* 21:325–355.

Sowerby GBI. 1825. A catalogue of the shells contained in the collection of the late Earl of Tankerville; arranged according to the Lamarckian conchological system; together with an appendix containing descriptions of many new species. London: Author. vii + 92 + xxxiv.

Tate R. 1885. Description of new species of Mollusca of the Upper Eocene beds at Table Cape. In: *Papers and Proceedings of the Royal Society of Tasmania*. Vol. 1884. 226–231.

Wenz W. 1938. *Gastropoda. Teil 1*. In: Schindewolf OH, ed. *Handbuch der Paläozoologie*. Vol. 6. Berlin: Gebrüer Bornträger, 85–231.

Yates AM. 2008. Two new cowries (Gastropoda: Cypraeidae) from the middle Miocene of South Australia. *Alcheringa: An Australasian Journal of Palaeontology* 32(4):353–364 DOI 10.1080/03115510802417927.