Morphology of the resting eggs of the Australian endemic Fairy Shrimp *Australobranchipus* (Branchiopoda: Anostraca, Branchiopodidae): similarities and differences from other anostracans.

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ABSTRACT

Eggs in large Branchiopoda are often diagnostic of species and may show some phyletic relationships. Those of the two species of *Australobranchipus* are described and are easily separable from each other and are particularly distinctive among Australian anostracans, all unrelated. Within its family, the Branchiopodidae however, there is some similarity to two African genera, but not Eurasian species, indicative perhaps of a gondwanan connection. ❐ *Australobranchipus, Branchiopoda, morphology, Fairy Shrimp.*

Australia has just three genera of fairy shrimps in freshwater, *Branchinella* Sayce, 1903, *Streptocephalus* Baird, 1852 and *Australobranchipus* and two genera of brine shrimps in saline inland waters, *Artemia* and *Parartemia* (Timms 2012). There are 40 described species of *Branchinella*, many of widespread distribution, just one of *Streptocephalus* found in the northern half of Australia and *Australobranchipus* Rogers, Timms, Jocqué and Brendonck, 2007 with two species, both in southern inland Queensland and one in the adjacent northwest New South Wales (Timms 2012). *Parartemia* Sayce, 1903 is represented by 18 species across Australia and *Artemia* Leach, 1819 by two, mainly in salt works, but with one spreading in southwest Western Australia (Timms *et al.* 2009). Each of these genera belong to different families (Artemiidae Grochowski, 1896 and Parartemiidae Daday, 1910), with *Australobranchipus* the genus of focus here, with related genera in Africa and Eurasia (Brendonck 1997).

Australobranchipus is distinct from *Branchinella*, the common genus of fairy shrimp in Australia. While the detailed structure of the gonopods is used to characterise the anostracan genera, in *Australobranhipus* easily observed almost separate frontal appendages on the male (Fig. 1) and in females the subcylindrical brood pouch are distinctive compared with fused or absent frontal appendages in male *Branchinella* and elongated brood pouch in female *Branchinella* (Rogers *et al.* 2007). Perhaps noteworthy is its small size; adult length of both species is < 10 mm (Rogers *et al.* 2007) with *A. gilgaiphila* generally near 8 mm for males and 7 mm for females (author unpublished data). Such small size is coincident with fast maturation and as far as is known *A. gilgaiphila* has the shortest time from hatching to maturity of any Australian fairy shrimp (3-4 days) and a short life cycle (ca 10 days)(author unpublished data). This gives it an advantage of not being in

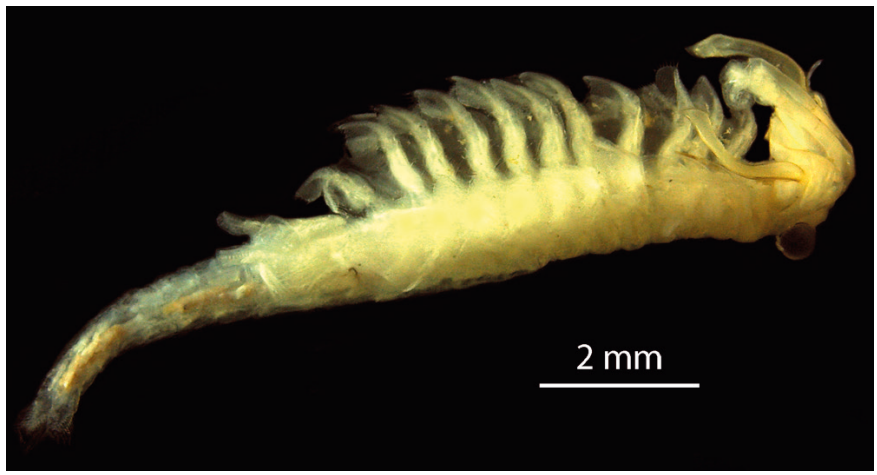

FIG. 1. Image of male *Australobranchipus gilgaiphila* Rogers *et al.* 2007.

competition with larger *Branchinella* which take much longer to mature.

Differences in egg morphology are useful in distinguishing between species and species groups in many anostracans. The eggs of *Australobranchipus* have only been cursorily described but seem to be different from those of *Branchinella* and *Streptocephalus* but with affinities to some African branchiopodids. I report in detail on the eggs of both known species, and to compare their morphology with those of other branchiopodids and with eggs of other Australian genera.

MATERIALS AND METHODS

Mature resting eggs were removed from the brood pouches of preserved females, air-dried and the mounted on carbon tabs on aluminium stubs and gold splutter coated. Ten per collection were photographed on a Zeiss Evo LS15 SEM using a Robinson Backscatter Detector. An average egg diameter was determined for each egg and the characteristic ridges and depressions noted. These were counted on the visible side (whole ridges/ depressions plus some only partly visible and scored as ½) then doubled to obtain the total number per egg.

RESULTS

Australobranchipus parooensis Rogers *et al*., 2007 (Fig. 2A, B, C)

Eggs were studied from the paratypes (AM P67198) which came from the type locality (Marsilea Pond (29° 32′ 13.4″S, 144°52′ 26.0″E), Bloodwood Station, 130 km nw of Bourke, New South Wales, 5 August 1998, B.V. Timms).

Egg irregularly cylindrical, length 225-238 µm, diameter 196-210 µm, n=10. Cylinder with 9-12 vertical ridges and 8-11 intervening rectangular depressions. Depression floors sloping laterally but flatish centrally with enclosing ridges narrow (5-15 µm) and rounded marginally. End ridges extended so that cylinder ends flanged; ends with 1-4 irregularly shaped cells, each U-shaped and marginal ridges flanged. Egg surface everywhere with innumerable microdepressions, extremely small (<2 µm) on depression floors morphing gradually into larger depressions (ca. 6 µm) ridge margins. The depressions with thick rounded walls and flat floors. Ridge margins thus an uneven mix of depressions and their margins. A few small spherical lumps (ca. 6 µm) superficially on and around the depressions. Eggs often seen grouped together (see Fig 11 in Timms *et al.* 2003), with the flanges interlocked.

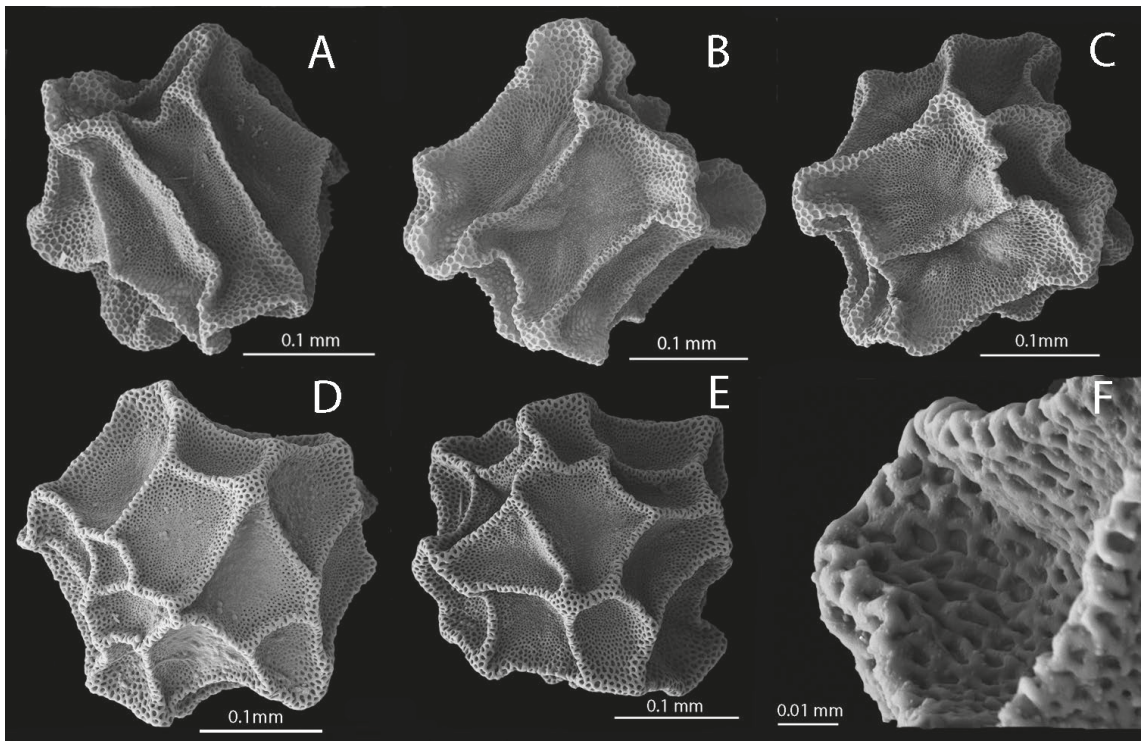

FIG. 2. Scanning Electron Micrographs of the eggs of *Australobranchipus parooensis* Rogers *et al.* 2007 (A, B, C) and *A. gilgaiphila* Rogers *et al.*2007 (D, E, F).

Australobranchipus gilgaiphila
Rogers *et al.*, 2007
(Fig. 2D, E, F)

Eggs were studied from females collected from a pool 25 km west of Bollon besides the Bolonne Highway (28° 01'S, 147° 03'E), Queensland, 26 June 2005, B.V. Timms, QM W27983.

Egg irregularly spherical, diameter 248-265 µm, n = 10. Egg surface divided into 24-32 polygonal depressions of various sizes with length and width subequal, each flatish floored with narrow dividing ridges (5-15 µm) with rounded margins. Egg surface covered with innumerable microdepressions, extremely small (< 2 µm) on depression floors morphing gradually into larger depressions (ca. 6 µm) ridge margins.Microdepressions with thick rounded walls and flat floors (Fig 2F). Numerous small (ca. 1-2 µm) spherical protrusions on the walls and floors of the depressions. Eggs also often grouped in the brood chamber but not to the same extent as in *A. parooensis*.

DISCUSSION

There are six genera in the Branchiopodidae (Rogers 2013), and although there is some overlap in egg morphology between some genera, the morphology of the eggs of *Australobranchipus* is distinctive. The normal morphology in *Branchipus* (Mura 1986) and *Branchipodopsis* (Hamer & Appleton 1996; Van Damme *et al.* 2004; Thiéry & Jean 2004) is spherical eggs with surficial polygonal depressions. These depressions differ between species somewhat in numbers, depth and intervening ridge structure so that the eggs of many species are distinctive within each genus. One of the greatest departures from this model, is seen in *Branchipus cortesi* Alonso & Jaume where the eggs are irregularly spherical and some ridges between depressions are flared

(Alonso & Jaume 1991), reminiscent of the structure in *Australobranchipus* eggs. However *B. cortesi* eggs lack the mircodepressions of *Australobranchipus* eggs. Another genus with spherical eggs is *Pumilibranchipus* from Namibia in Africa (Hamer & Brendonck 1995). Its eggs lack polygonal depressions but are completely covered with surface depressions superficially like those in *Australobranchipus*. However *Pumilibranchipus* depressions are larger (ca. 10-17 µm) and appear to be curved in cross section as opposed to flat in *Australobranchipus* (Hamer & Brendonck 1995 Figs 12 & 13).The remaining two genera, *Metabranchipus* and *Rhinobranchipus*, both African, have irregularly shaped eggs with just a few deep polygonal depressions (Brendonck 1995; Rogers & Hamer 2012). In this they resemble eggs of *A. gilgaiphila*, but again the microdepressions on the ridges in *Australobranchipus* are distinctive. It is of interest that the eggs of *Australobranchipus* are most similar to African genera rather than the European based *Branchipus* and African/Asian *Branchipodopsis* which may suggest a gondwanan relationship.

Egg structure is only weakly phyletic (cf eggs of Artemiina vs Anostracina; Limnadiidae vs Cyzicidae vs Laevicaudata vs Notostraca), partly because of specific adaptations to environmental needs. This may be to counter predation (Dumont *et al.*, 2002); in the case of *Australobranchipus* the prominent ridges and flanges may deter predation just as in *Branchinella longirostris* the numerous spines and hooks counter attack by flatworms (Timms & Lindsay 2011). On the other hand the ridges and flanges tend to lock eggs together in multiunit masses. This feature intuitively could lessen dispersal opportunities, though Pinceel *et al.* 2015 suggest this may not be so, and experimentation using egg masses and individual eggs are needed. Each species has a narrow distribution of a few hundred km^2, suggesting dispersal limitations, but equally this may be due to the limited geographical spread of the specific habitat in which each lives. Egg morphology is not random, but finding the meaning is difficult.

The eggs of *Australobranchipus* are also distinctive among eggs of other Australian anostracans. Eggs of introduced *Artemia* (2 forms) and most native *Parartemia* (12 of the 18 species so far examined) are spherical and without surface adornment (Timms *et al.* 2003; Timms & Hudson 2009; author, unpublished data); the remainder have yet to be studied, but are not expected to be too different. Eggs of the single species of *Streptocephalus* (*S. archeri* Sars) are distinctive, being tetrahedral in shape with four triangular faces (Timms, *et al.* 2003) as it typical for the subgenus *Parastreptocephalus* (Brendonck & Coomans 1994a, 1994b). The 40 species of *Branchinella* known at present all have spherical eggs with polygonal depressions (Timms 2015; Timms & Lindsay 2011; author, unpub. data). These vary in size, complexity, compartment numbers and adornment, but none are like the eggs of *Australobranchipus*. Three features of *Australobranchipus* eggs are distinctive: (a) the non-spherical shape, (b) the numerous microdepressions particularly on the ridge margins which give it a praetextate appearance (= a Roman garment weaved with a fringe of hollows and ridges), and (c) the interlocking of the ridges/flanks so that individual eggs tend to mass together.

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LITERATURE CITED

Alonso, M. & Jaume, D. 1991. *Branchipus cotesi* n. sp.: a new anostracan from western Spain (Crustacea, Branchiopoda). *Hydrobiologia* **212**: 22-230 https://doi.org/10.1007/BF00026004.

Brendonck, L. 1995. A new branchipodid genus and species (Crustacea: Branchipoda: Anostraca) from South Africa. *Zoological Journal of the Linnean Society* **115**: 359-372 https://doi.org/10.1111/j.1096-3642.1995.tb01429.x.

Brendonck, L. 1997. An updated diagnosis of the branchipodid genera (Branchipoda: Anostraca: Branchipodidae) with reflections on the genus concept of DUBOIS (1988) and the importance

of genital morphology in anostracan taxonomy. *Archiv für Hydrobiologie Supplement* **107**(2): 149-186.

Brendonck, L. & Coomans, A. 1994a. Egg morphology in African Streptocephalidae (Crustacea: Branchipoda: Anostraca) Part 1: South of Zambesi and Kunene rivers. *Archiv für Hydrobiologia Supplement* **99**(3): 313-334.

1994b. Egg morphology in African Streptocephalidae (Crustacea: Branchipoda: Anostraca) Part 2: North of Zambesi and Kunene rivers, and Madagascar. *Archiv für Hydrobiologia Supplement* **99(3):**335-356.

Dumont, H.J., Nandini, S. & Sarma, S.S.S. 2002. Cyst ornamentation in aquatic invertebrates: a defence against egg predation. *Hydrobiologia* **486:** 161-167 https://doi.org/10.1023/A:1021346601235.

Hamer, M.L. & Appleton, C.C. 1996. The genus *Branchipodopsis* (Crustacea, Branchiopodidae, Anostraca) on Southern Africa. Morphology, distribution, relationships and the description of five new species. *Annals of the South African Museum* **104 (10):** 311-377.

Hamer, M. & Brendonck, L. 1995. *Pumilibranchipus deserti*, a new genus and species of branchipodid (Crustacea: Branchipodida: Anostraca) from Namibia. *Annuals of the Natal Museum* **36**: 1-7.

Mura, G., 1986. SEM morphological survey on the egg shell in the Italian anostracans (Crustacea. Branchiopoda). *Hydrobiologia* **134**: 273-286 https://doi.org/10.1007/BF00008496.

Pinceel, T., Brendonck, L. & Vanschoenwinkel, B. 2015. Propagule size and shape may promote local wind dispersal in freshwater zooplankton — a wind tunnel experiment. *Limnology and Oceanography* **61**(1): 122-131 https://doi.org/10.1002/lno.10201.

Rogers, D.C. 2013. Anostraca Catalogus (Crustacea: Branchiopoda). *The Raffles Bulletin of Zoology*. **61**: 525-546.

Rogers, D.C. & Hamer, M. 2012. Two new species of *Metabranchipus* Mai, 1925 (Anostraca: Branchipodidae). *Journal of Crustacean Biology* **32**(6): 972-980 https://doi.org/10.1163/1937240X-00002101.

Rogers, D.C., Timms, B.V. Jocqué, M. & Brendonck, L. 2007. A new genus and species of branchiopod fairy shrimp (Crustacea: Branchipoda: Anostraca) from Australia. *Zootaxa* **1551**: 49-59.

Thiéry, A. & Jean, S. 2004. *Branchipodopsis buettiberi*, new species (Anostraca: Branchiopodidae) the first Arabian (Sultanate of Oman) representative of the genus of freshwater fairy shrimps, with biogeographical remarks. *Journal of Crustacean Biology* **24(3)**: 398-408 https://doi.org/10.1651/C-2469.

Timms, B.V. 2012. An appraisal of the diversity and distribution of large branchiopods (Branchipoda: Anostraca, Laevicaudata, Spinicaudata, Cyclestherida, Notostraca) in Australia. *Journal of Crustacean Biology* **32**(4): 615-623.

2015 A new species of the fairy shrimp *Branchinella* (Crustacea, Anostraca, Thamnocephalidae) from western New South Wales, Australia. *Proceedings of the Linnean Society of New South Wales* **137**: 37-43.

Timms, B.V. & Hudson, P. 2009. The brine shrimps (*Artemia* and *Parartemia* of South Australia, including descriptions of four new species of *Parartemia* (Crustacea: Anostraca: Artemiina). *Zootaxa* **2248**:47-68.

Timms, B.V. & Lindsay, S. 2011. Morphometrics of the resting eggs of the fairy shrimp *Branchinella* in Australia (Anostraca: Thamnocephalidae). *Proceedings of the Linnean Society of New South Wales* **133**: 51-68.

Timms, B.V., Pinder, A. & Campagna V. 2009. The biogeography and conservation status of the Australian endemic brine shrimp *Parartemia* (Crustacea, Anostraca, Parartemidae). *Conservation Science* **7**(2): 413-427.

Timms, B.V., Shepard, W.D. & Hill, R.E. 2005. Cyst shell morphology of the fairy shrimps (Crustacea: Anostraca) of Australia. *Proceedings of the Linnean Society of New South Wales* **125**: 73-95.

Van Damme, K., Dumont, H.J. & Weekers, P.H.H. 2004. Anostraca (Crustacea: Branchiopoda) from Socotra Island: A new *Branchiopodopsis* and its relationship with its African and Asian congeners. *Fauna of Arabia* **20**: 193-209.