



## *Calamoecia australis* Centropagid copepod

### Taxonomy

*Calamoecia australis* (Searle, 1911)

The taxon has various synonymised names, including *C. viridis*, *C. expansa*, *Brunella australis*, *B. expansa* and *B. viridis*.

### Current conservation status

Categorised as Vulnerable in the 2009 Advisory list of threatened invertebrate fauna in Victoria (DSE 2009).

### Proposed conservation status

Vulnerable in Victoria

Criterion D2

Most *Calamoecia* species have restricted distributions and are often rare. It is likely this species does occur in other systems, but further surveys are required to confirm this.

### Species Information

#### Description and Life History

There are three subclasses in the Hexanauplia: the Copepoda, the Tantulocarida and the Thecostraca, with only the Copepoda and Thecostraca having freshwater representatives. As a group, copepods originated from marine forms, but they have colonized all aquatic habitats, including hypersaline, brackish, and freshwater ecosystems, as well as terrestrial and semi-terrestrial habitats. Copepods have been considered to be the most abundant metazoans of the world and include a large diversity of forms and habitats (Boxshall and Halsey, 2004 cited in Suárez-Morales, 2015). Of the approximately 2,300 species of *Calanoida*, about 550 are freshwater forms. Centropagidae contains 14 genera, mostly marine, but also contains some important freshwater groups. (Suárez-Morales, 2015).

*Calamoecia* is confined to the Australasia region (Bayly, 1998) with 22 accepted taxa (Walter and Boxshall, 2009), 14 of which occur in Australian freshwater systems and three in Australian athalassic saline waters (Bayly and Boxhall, 2009). *C. australis* is a free living, planktonic calanoid centropagid copepod endemic to Australia. Most free-living copepods are small in size typically ranging from 0.5-2.0mm, however a few taxa can reach lengths over 3mm (Suárez-Morales 2015). Copepods are ecologically important and play significant roles in trophic dynamics both as primary and secondary consumers, and as a major source of food for many larger invertebrates and vertebrates (Reid and Williamson, 2010 cited in Suárez-Morales 2015).

Centropagids are typically planktonic or benthic suspension feeders that predominantly feed on phytoplankton or smaller zooplankton such as nauplii, rotifers and cladocerans. There is currently no data available on the diet of *C. australis*, however another species of *Calamoecia* (namely *C. lucasi*) has been found to feed on up to 18 different phytoplankton taxa (Kobayashi, 1995). This suggests that *C. australis* may have a diverse diet, depending on the availability of food sources in its environment.

Most of the calanoid copepods occurring in Australian inland waters belong to the genera *Calamoecia* or *Boeckella* (Bayly, 1998) and form a major component of the planktonic microfauna, which is an important food source for fish (Bayly, 1992 cited in Kobayashi, 1995; Maly and Maly, 1997). The ecological relationship between the two genera



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is highly significant in terms of their relative abundance, where *Calamoecia* spp. may be released from predation pressure in the presence of *Boeckella* due to fish typically tending to target larger calanoids (Maly et al. 1997).

Centropagids are highly adaptable in terms of their salinity tolerance, with some taxa found to occur in low saline lakes with as low as 10 mg l<sup>-1</sup> salinity, and up to athalassic brines with as high as 200g l<sup>-1</sup> salinity (Bayly and Boxshall, 2009). In Tasmania, *C. australis* has a habitat preference for highly coloured coastal lagoons; waters with high sodium/magnesium and low calcium content (Walsh, 1997; Bayly, 1962), as well as acidic inland waters (Bayly, 1962; 1964). As such, the taxon most likely has a reproductive strategy adapted to such environments, although this has not been confirmed.

Some taxa of *Calamoecia* may produce eggs that are dormant but ready to hatch at any time, as well as true diapausing eggs that require some external stimulus to develop. It is possible that this life history strategy may be a means of overcoming unpredictable environments, wherein staggering hatching times would increase chance of survival (Maly, 1984). Information available for other species within the genus suggest that the females may possess the ability to store sperm, which allows males to copulate with any female encountered (instead of just gravid ones). This ultimately promotes quick completion of a generation as it enhances the speed at which a population may move through its life cycle (Maly, 1984). The clutch size in other *Calamoecia* spp. is small, and as such they remain rare relative to other centropagids (i.e. *Boeckella* spp.) and have a low probability of establishment (Maly, 1984). Maly (1984) argues that due to reduced weight of the small *Calamoecia* clutch, they may be able to disperse great distances, however this has not been confirmed.

The actual size of the clutch for *C. australis* is not known and is highly variable even within the genus (Maly, 1984). Similarly, predicting the timing of development for *C. australis* is problematic, as studies on closely related taxa (namely *C. lucasi*) range from three weeks in summer up to 12 weeks in winter. As such, further research is required into the reproductive biology and life cycle of *C. australis* to inform future conservation efforts.

## Generation Length

The generation length of *C. australis* is inferred to be 20 to 60 days. This is inferred from a better studied congener, *C. lucasi* (Maly, 1984).

## Distribution

This taxon is known to occur in Nyora, south eastern Victoria, Heidelberg, southern Victoria (Searle, 1911; cited in Bayly, 1960), Wartook Reservoir, and western Victoria. Spatial data are limited for the taxon and it is uncommon, recorded from about ten localities, most of which were of acid-humic character. Nagambie is a previously unpublished locality (R. Shiel, pers. comm. 2019), and it is likely that it occurs in more localities than is currently known. This reflects the lack of survey effort into macroinvertebrates in Victoria - several experts in zooplankton studies have been consulted and none have any additional records in Victoria.

The taxon has also been found in south-west and north-east of the Tasmanian mainland (Walsh, 1997), Bruny Island (Walsh 1991; cited in Walsh, 1997. P31), and Kangaroo Island, South Australia (Seaman, 2002).

## Habitat

The habitat preference for this taxon in Victoria is not well known. The only record in Victoria that can be linked to a habitat type is at Wartook Reservoir, which is a permanent water storage in the Grampians.

In south western Tasmania, *C. australis* is found mostly in shallow, highly coloured coastal lagoons, in both acidic and alkaline conditions. It has been said to have a habitat preference for waters with high sodium/magnesium and low calcium content (Walsh, 1997; Bayly, 1962), and has also been found to inhabit acidic inland waters in the Lake Pedder-Maria complex, South-Western Tasmania (Bayly, 1962; 1964).

Maly et al. (1997) found *Calamoecia* taxa in both temporary and permanent environments in Western Australia, however this was not definitively determined for *C. australis*.

*C. australis* has been recorded in Grassdale Lagoon, Kangaroo island, which is a freshwater wetland considered nationally important under the Australia and New Zealand Environment and Conservation Council (ANZECC) criteria. The wetland is under conservation management land and was recorded as being in 'pristine' condition with no major disturbances at the time of the survey (Seaman, 2002).

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### Threats

No specific threats have been identified for the taxon, however land use, water resource management, human recreational activities which impact on water quality, and introduced predator species (i.e. trout, redbfin, gambusia) are all considered potential threats to the calanoid copepods. Altered water regimes brought on by climate change, including changes in temperature, could also impact the taxon via reduced habitat quality and altered reproductive cues/rates.

### IUCN Criteria

Criterion A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%
<p>A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.</p> <p>A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p>A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3]</p> <p>A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.</p>			
<p>based on any of the following:</p> <ul style="list-style-type: none"> <li>(a) direct observation [except A3]</li> <li>(b) an index of abundance appropriate to the taxon</li> <li>(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat</li> <li>(d) actual or potential levels of exploitation</li> <li>(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites</li> </ul>			

### Evidence:

#### Ineligible under Criterion A

There is insufficient evidence to determine whether there has been or will be a reduction in population sufficient to meet any threshold for Criterion A.

The bushfires of 2019/2020 are believed to have impacted on a few sites where the species has been recorded. Therefore the taxon may have been impacted by water quality issues.

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Criterion B. Geographic range in the form of either B1 (extent of occurrence) and/or B2 (area of occupancy)			
	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1. Extent of occurrence (EOO)	< 100 km <sup>2</sup>	< 5,000 km <sup>2</sup>	< 20,000 km <sup>2</sup>
B2. Area of occupancy (AOO)	< 10 km <sup>2</sup>	< 500 km <sup>2</sup>	< 2,000 km <sup>2</sup>
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

## Evidence:

### Ineligible under Criterion B

The Extent of Occurrence (EoO) across the taxon's range is estimated to be 4,900 km<sup>2</sup>, and the Area of Occupancy (AoO) is estimated to be 12 km<sup>2</sup>, but other thresholds under this criterion have not been met.

Criterion C. Small Population size and decline				
	Critically Endangered	Endangered	Vulnerable	
Number of mature individuals	< 250	< 2,500	< 10,000	
AND at least one of <u>C1</u> or <u>C2</u>				
<u>C1</u>	An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
<u>C2</u>	An observed, estimated, projected or inferred continuing decline AND least 1 of the following 3 conditions:			
(a)	(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
	(ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals				

## Evidence:

### Ineligible under Criterion C as Data Deficient

No surveys have specifically targeted this species so there is no reliable estimate of the total population size for the taxon.

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Criterion D - Very small or restricted population <sup>□</sup>			
	Critically Endangered <sup>□</sup>	Endangered <sup>□</sup>	Vulnerable <sup>□</sup>
Number of mature individuals (observed or estimated) <sup>□</sup>	<50 <sup>□</sup>	<250 <sup>□</sup>	<1,000 <sup>□</sup>
D2 - Only applies to the VU category <sup>¶</sup> Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time. <sup>□</sup>	- <sup>□</sup>	- <sup>□</sup>	D2 - Typically: <sup>¶</sup> AoO < 20 km <sup>2</sup> or number of locations ≤ 5 <sup>□</sup>

### Evidence:

#### Eligible under criterion D2 as Vulnerable

The data available are over 30 years old and there have been no recent surveys targeting this taxon. However, it is estimated to be very restricted, with an AoO of 12 km<sup>2</sup> and three locations. This restriction makes it possible that the taxon could become Critically Endangered or Extinct within a time frame of one or two generations in response to the identified threats, namely habitat damage due to altered water regimes brought on by climate change.

**Criterion E (Quantitative Analysis) was not addressed as the taxon does not have a detailed Population Viability Analysis.**

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