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Short Note
Current distribution of *Branchinecta gaini* on James Ross Island and Vega Island

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Introduction

The fairy shrimp *Branchinecta gaini* Daday is the largest freshwater invertebrate in Antarctica. Despite growing evidence of faunal endemism, it is believed to represent a mid- to late Holocene immigrant (Gibson & Bayly 2007, Hawes 2009, 2015). To complete its life cycle, a significant period with liquid water is needed and subzero temperatures represent a real physiological constraint on adult animals. Its success in the extreme environment of Antarctica is associated with a 'ruderal' strategy that consists of metabolic eurythermy and formation of highly resistant cysts suitable for passive dispersal (Hawes *et al.* 2008, Hawes 2009).

The distribution range of *B. gaini* includes Patagonia, South Georgia, the South Orkney and South Shetland islands, and half way along the western Antarctic Peninsula (Hawes 2009). Palaeolimnological data confirm the presence of *B. gaini* on James Ross Island for a significant period of the Holocene. However, it is currently considered to be extinct in this area (Björck *et al.* 1996).

James Ross Island is situated in the transitory zone between Maritime and Continental Antarctica. Only the northernmost part of the island, Ulu Peninsula, is significantly deglaciated, representing one of the largest ice-free areas in the north-eastern Antarctic Peninsula. Recently, six lake types were described on the Ulu Peninsula, classified according to their geomorphological position, physical and chemical characteristics, and biota (Nedbalová *et al.* 2013). We report the common occurrence of *B. gaini* on James Ross Island and the nearby Vega Island observed during limnological surveys in 2008–16.

Field surveys

Abundant populations of *B. gaini* were recorded in the Ulu Peninsula lakes in January/February 2008 and 2009. The fairy shrimp occupied shallow lakes located near the coast as well as inland lakes at higher altitudes (up to 230 m a.s.l.). Limnological characteristics of the lakes with *Branchinecta* (Black, Blue–green, Cyanobacterial, Dan, Green 1–2, Katia 1–2, Lachman 1–2, Monolith, Muddy, Phormidium, Red, Vondra 1–4 and White), as well as the sampling dates, can be found in Nedbalová *et al.* (2013). In the Lachman lakes, the continuous presence of *B. gaini* was documented from early January to late February. No *Branchinecta* were found in deep cirque and kettle lakes.

The Clearwater Mesa on the south-eastern side of Croft Bay, James Ross Island, is characterized by the presence of tens of shallow lakes and ponds at an altitude of 170–250 m a.s.l. In February 2009, *B. gaini* was observed in all of the lakes. Thick layers of dead animals accumulated by wind cover the shores of some lakes, indicating high population density at these sites. The occurrence of *B. gaini* in this area was confirmed in 2015 and 2016.

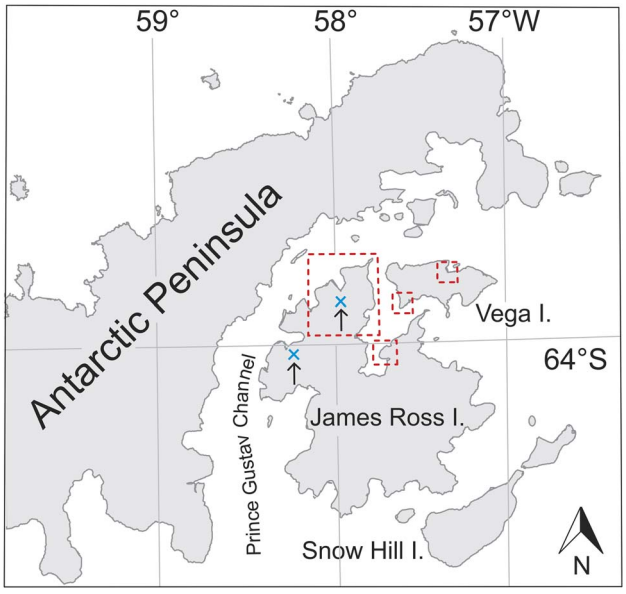

Fig. 1. Areas where *B. gaini* was observed in 2008–16. Blue crosses indicate sites where *B. gaini* cysts were recorded in sediment cores by Björck *et al.* (1996).

In January 2013, a field campaign in a small coastal area of Devil Bay (*c.* 8 km^2) provided the first record of *B. gaini* on Vega Island. It was found in low altitude shallow lakes but not in lakes situated on mesas at higher altitudes. In total, *B. gaini* was recorded in 14 of the 45 surveyed lakes. In 2014, the shrimp was observed at several sites on Cape Lamb, south-west Vega Island.

Figure 1 presents the areas where *B. gaini* has been observed. Lakes inhabited by *B. gaini* are characterized by rich photoautotrophic mats and by the presence of the calanoid copepod *Boeckella poppei* Mrázek. Birds (especially the Antarctic tern *Sterna vittata* Gmelin) were observed feeding on *B. gaini* in the coastal lakes on James Ross Island.

Discussion

In contrast to Björck *et al.* (1996), who state that 'this crustacean does not occur today anywhere on James Ross Island or the surrounding area', our field observations confirm that *B. gaini* is widely distributed in the ice-free areas on James Ross and Vega islands. The lakes in which *Branchinecta* populations have been found belong to three types: stable shallow lakes on higher lying levelled surfaces, shallow coastal lakes and stable lakes in old moraines (Nedbalová *et al.* 2013). These lakes are characterized by massive photoautotrophic mats that serve as a food source for *B. gaini*. The absence of such mats probably limits its distribution in kettle and cirque lakes.

The current climate on James Ross Island shows strong continental features with higher temperature variability and lower annual mean temperatures in comparison with the western Antarctic Peninsula (Hrbáček *et al.* 2016). The requirement of liquid water for at least *c.* 2.5 months is considered to be the main physiological constraint on the distribution of *B. gaini* (Hawes *et al.* 2008). Since the temporal window available for non-cyst life stages can reach three months in coastal areas (Váczi *et al.* 2011), the sites on James Ross Island are at present suitable for *B. gaini* development. However, populations at higher altitudes probably survive at their physiological limits.

Although Björck *et al.* (1996) were not able to date the disappearance of *B. gaini* from Boulder (= Monolith) Lake exactly, it was attributed to the arrival of a harsher climate that restricted the availability of liquid water. It was also hypothesized that the increased deposition of minerogenic matter impaired the growth of benthic mats (Björck *et al.* 1996). We cannot ascertain if *B. gaini* did disappear from James Ross Island for a certain period. Valuable data could be gained from further analysis of sediment cores from both islands. Molecular phylogeography could also elucidate the dispersal history of *B. gaini* within its current range.

The north-eastern Antarctic Peninsula is experiencing a period of rapid warming that began *c.* 600 years ago (Mulvaney *et al.* 2012). Generally, the biota, including *B. gaini*, is likely to benefit from these changes, which could be reflected in its abundance in this region at present. However, accelerated desiccation of shallow ponds (Váczi *et al.* 2011) due to warming might have adverse effects on the long-term persistence of this species (Hawes *et al.* 2008).

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Author contribution

All authors performed the field surveys, LN wrote the manuscript, JML and JE co-ordinated projects focused on lake research in the region.

References

Björck, S., Olsson, S., Ellis-Evans, C., Håkansson, H., Humlum, O. & de Lirio, J.M. 1996. Late Holocene palaeoclimatic records from lake sediments on James Ross Island, Antarctica. *Palaeogeography Palaeoclimatology Palaeoecology*, **121**, 195–220.

Gibson, J.A.E. & Bayly, I.A.E. 2007. New insights into the origins of crustaceans of Antarctic lakes. *Antarctic Science*, **19**, 157–163.

Hawes, T.C. 2009. Origins and dispersal of the Antarctic fairy shrimp. *Antarctic Science*, **21**, 477–482.

Hawes, T.C. 2015. Antarctica's geological arks of life. *Journal of Biogeography*, **42**, 207–208.

Hawes, T.C., Worland, M.R. & Bale, J.S. 2008. Physiological constraints on the life cycle and distribution of the Antarctic fairy shrimp *Branchinecta gaini*. *Polar Biology*, **31**, 1531–1538.

Hrbáček, F., Oliva, M., Láska, K., Ruiz-Fernández, J., de Pablo, M.Á., Vieira, G., Ramos, M. & Nývlt, D. 2016. Active layer thermal regime in two climatically contrasted sites of the Antarctic Peninsula region. *Cuadernos de Investigación Geográfica*, **42**, 457–474.

Mulvaney, R., Abram, N.J., Hindmarsh, R.C.A., Arrowsmith, C., Fleet, L., Triest, J., Sime, L.C., Alemany, O. & Foord, S. 2012. Recent Antarctic Peninsula warming relative to Holocene climate and ice-shelf history. *Nature*, **489**, 141–144.

Nedbalová, L., Nývlt, D., Kopáček, J., Šobr, M. & Elster, J. 2013. Freshwater lakes of Ulu Peninsula, James Ross Island, north-east Antarctic Peninsula: origin, geomorphology and physical and chemical limnology. *Antarctic Science*, **25**, 358–372.

Váczi, P., Barták, M., Nedbalová, L. & Elster, J. 2011. Comparative analysis of temperature courses in Antarctic lakes of different morphology: study from James Ross Island, Antarctica. *Czech Polar Reports*, **1**, 78–87.