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Discovery of the first known benthic invasive species in the Southern Ocean: the North Atlantic spider crab *Hyas araneus* found in the Antarctic Peninsula

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Abstract: The Southern Ocean around Antarctica is no longer free from invasive marine species. The North Atlantic spider crab *Hyas araneus* (Linnaeus, 1758) (Crustacea: Decapoda: Majidae) has been recorded for the first time from the Antarctic Peninsula. Isolated for at least 25 million years, the endemic Antarctic Southern Ocean marine fauna is now being exposed to human-mediated influx of exotic species. Invasive species and polar warming combined can foster the probability of arrival and colonization by non-indigenous species, with unpredictable consequences for the Antarctic marine biota.

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Key words: Antarctica, alien species, ballast water, Crustacea Decapoda, Polar warming

Introduction

Unrestricted human-mediated transfer of non-indigenous marine species into new areas is now broadly recognized as a critical element of ecosystem change and is considered a major threat to global diversity (Mack *et al*. 2000, Crooks 2002, Perrings 2002). A wide variety of dispersal pathways have been documented for exotic marine species to enter new areas, including: ballast water, biofouling adhering to naval structures and floating anthropogenic debris, navigation canals such as the Suez and the Panama Canals, and the aquarium and aquaculture industries (Quayle 1964, Hanna 1966, Aron & Smith 1971, Jones 1972, Carlton 1975, Por 1978, 1990, Bourne 1979, Forster & Willan 1979, Andrews 1980, Zibrowius 1983, 1992, Sindermann 1991, Ryan & Moloney 1993, Ruiz *et al*. 2000, Wasson *et al*. 2001, Wonham *et al*. 2001, Barnes 2002a, 2002b).

Exotic marine species have colonized almost every marine ecosystem in all continents and ocean basins, except for the Southern Ocean around Antarctica (Barnes 2002a). An oceanographic survey carried out by RV *Prof W. Besnard* from the Instituto Oceanográfico, Universidade de São Paulo, in the Antarctic Peninsula, revealed however, that the marine Antarctic ecosystem is no longer free from marine invasive species. Benthic samples obtained from the Antarctic Peninsula yielded a male and a female of the majid spider crab *Hyas araneus* (Linnaeus, 1758). The species has previously been reported only from the North Atlantic and the Arctic Oceans, north of 41°N. This is the first record of a non-indigenous marine species from the Antarctic seas. The circumstances of the occurrence of *H. araneus* in the Antarctic Peninsula are presented here.

The studied material has been deposited in the collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP). Measurements are in millimetres and refer to carapace length and carapace width.

Hyas araneus (Linnaeus, 1758)
(Fig. 1)

Restricted synonymy: Christiansen 1969: 116, fig. 48; Ingle 1980: 125, figs 82, pl. 25b; Clark 1986: 90; Udekem d'Acoz 1999: 190.

Material examined: Antarctic Peninsula, PROANTAR, RV *Prof W. Besnard*, St. 4860, 61°05'93"S, 55°47'07"W, 92 m, 30 January 1986: male 41 x 28 mm, female 49 x 35 mm (MZUSP 8878).

Comparative material: *H. araneus*: Germany, Heligoland Island, North Sea, 54°8.16'N,70°54.18'E and 54°8.41'N,70°52.22'E, Senckenberg Museum collection,

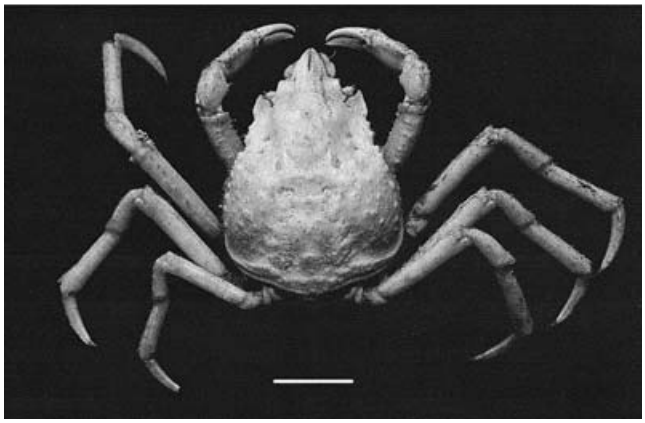

Fig. 1. *Hyas araneus* (Linnaeus, 1758), Antarctic Peninsula, young male 41 x 28 mm (MZUSP 8878). Scale bar 10 mm.

10 March 1984: male 78 x 59 mm, female 66 x 51 mm (MZUSP 6917).

Distribution: Spitzbergen, Barents Sea, Novaya Zemlya, Kara Sea, White Sea, Faeroe Islands, west coast of Sweden, Murmansk coast, Norway (including Skagerrak and Kattegat), Denmark, North Sea, south-west coast of the Baltic Sea, Iceland, Shetland Islands, British Isles, Jersey, west coast of Greenland, Nova Scotia, Canada to Rhode Island, USA. Introduced to the Antarctic Peninsula (61°05'93"S, 55°47'07"W).

Remarks

Mode of invasion

Hyas araneus is a shelf species native from the North Atlantic and Arctic Oceans, where it inhabits rocky, sandy, and muddy bottoms from the intertidal region down to 555 m depth. Truly bipolar (Ortmann 1899, Hubbs 1952, Briggs 1987) shelf species are extremely rare and examples of bipolar distribution are restricted to a few pelagic species (Briggs 1974, p. 188). We suspect that *H. araneus* entered the Antarctic Peninsula either on ships' sea-chests or through the ballast water from ships. Ballast water is known to be an effective vector for the introduction of aquatic organisms, both internationally and intraregionally (Lavoie *et al.* 1999, Ruiz *et al.* 2000, Wasson *et al.* 2001, Wonham *et al.* 2001). The ship traffic has boomed in Antarctica, mainly as a result of tourist, fishing, and oceanographic activities. It is, however, possible that other dispersal pathways may have contributed to the introduction of *H. araneus*.

Chapman & Carlton (1991, p. 387) proposed ten criteria for the recognition of marine introduced species. Most of Chapman & Carlton's (1991) criteria are of little value in Antarctica (criteria 1–6) or are loosely applicable to *H. araneus* (criteria 8 & 9). Poore (1996) discussed Chapman & Carlton's (1991) proposal in detail. We restrict our comments to criteria 7 & 10. According to Chapman & Carlton (1991), introduced species have "...widespread disjunct geographical distribution" (criterion 7) and have "...closest morphologic and genetic affinities to species groups occurring elsewhere in the world" (criterion 10). Unlike some criteria, such as Chapman & Carlton's numbers 3 and 5 which are informative *per se*, criteria 7 & 10 are applicable only with the support of thorough taxonomic and phylogenetic study. Disjunct distribution patterns can only be relied upon after taxonomic studies over a wide geographic range including the disjunct areas. Chapman & Carlton's (1991, p. 387) criterion 10 implies that the newly established disjunct population must belong to a monophyletic group living elsewhere. This means that taxonomy and phylogeny, two major components of systematic biology, are clearly critical elements in biological invasions issues. While the disjunct distribution pattern showed by *H. araneus* is supported by the direct comparison between specimens from the North Atlantic and Arctic oceans, and the Antarctic Peninsula, criterion 10 cannot be applied as the monophyletic status of the genus *Hyas* is unknown.

Hyas araneus was collected in the Antarctic Peninsula in 1986. Although a male and a female were caught, the species has not been re-collected in that region. Whether the introduction of *H. araneus* has failed or been successful but actually gone unnoticed, must await acquisition of new data. Port surveys for introduced marine species revealed that non targeted surveys may well fail to detect non-indigenous species (Maher *et al*. 1994, Hewitt & Martin 2001, Hoedt *et al*. 2001).

Warming Antarctica

Isolated for at least 25 million years, the highly endemic Antarctic Southern Ocean marine fauna (Long 1994, Brandt 1999) is now being exposed to two complementary forces:

i) human-mediated transportation of exotic species (Barnes 2002b),

ii) polar warming (Gille 2002) leading to the changes in the barrier formed by the circumpolar freezing temperatures (Barnes 2002b).

These two forces combined with the invasion potential of many non-indigenous species could have unpredictable consequences for the Antarctic marine biota.

Intrusion of sub-Antarctic waters into Antarctica

Recently, two decapod crustacean larval morphotypes attributed to *Emerita* sp. (Anomura: Hippidae) and to *Pinnotheres* sp. (Brachyura: Pinnotheridae) have been reported from off King George Island (62°14'33"S, 58°43'81"W), most probably of South American origin (Thatje & Fuentes 2003). According to Thatje & Fuentes (2003) the superficial breach of the Antarctic Circumpolar Current seems a plausible explanation for the occurrence of larvae of South American origin in the Antarctic region. They interpreted the occurrence in the same samples of the decapod larvae, sub-Antarctic copepods of the genus *Acartia*, and typical Antarctic copepods as an indication of mixture of water masses in the sampling site. The arrival of larvae of South American origin in the Antarctic region may be more common than previously suspected. De Melo (1995, p. 268) reported an adult male of *Rochinia gracilipes* A. Milne Edwards, 1875, (Brachyura: Majidae) from the Antarctic Peninsula (61°05'93"S, 55°47'87"W; MZUSP 8026), a species previously known from Rio de Janeiro (22°S) to Cape Horn.

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References

Andrews, J.D. 1980. A review of introductions of exotic oysters and biological planning for the new importations. *Marine Fisheries Review*, **42**(12), 1–10.

Aron, W.I. & Smith, S.H. 1971. Ship canals and aquatic ecosystems. *Science*, **174**, 13–20.

Barnes, D.K.A. 2002a. Human rubbish assists alien invasions of seas. *Directions in Science*, **1**, 107–112.

Barnes, D.K.A. 2002b. Biodiversity: invasions by marine life on plastic debris. *Nature*, **416**, 808–809.

Bourne, N. 1979. Pacific oysters, *Cassostrea gigas* Thunberg, in British Columbia and the South Pacific. *In* Mann, R., *ed*. *Exotic species in mariculture*. Cambridge, MA: MIT Press, 1–53.

Brandt, A. 1999. On the origin and evolution of Antarctic Peracarida (Crustacea, Malacostraca). *Scientia Marina*, **63**, 261–274.

Briggs, J.C. 1974. *Marine zoogeography*. New York, NY: McGraw-Hill, 475 pp.

Briggs, J.C. 1987. Antitropicality and vicariance. *Systematic Zoology*, 36, 206–207.

Carlton, J.T. 1975. Introduced intertidal invertebrates. *In* Smith, R.I. & Carlton, J.T., *eds*. *Light´s manual: intertidal invertebrates of the central California coast*. Berkeley, CA: University of California Press, 17–25.

Chapman, J.W. & Carlton, J.T. 1991. A test of criteria for introduced species: the global invasion by the isopod *Synidotea laevidorsalis* (Miers, 1881). *Journal of Crustacean Biology*, **11**, 386–400.

Christiansen, M.E. 1969. Crustacea Decapoda Brachyura. *Marine Invertebrates of Scandinavia*, **2**, 1–143.

Clark, P.F. 1986. *North-east Atlantic crabs*: *an atlas of distribution*. Ross-on-Wye, UK: Marine Conservation Society, 252 pp.

Crooks, J.A. 2002. Characterizing ecosystem-level consequences of biological invasions: the role of ecosystem engineers. *Oikos*, **97**, 153–166.

Forster, B.A. & Willan, R.C. 1979. Foreign barnacles transported to New Zealand on an oil platform. *New Zealand Journal of Marine and Freshwater Research*, **13**, 143–149.

Gille, S.T. 2002. Warming of the Southern Ocean since the 1950s. *Science*, **295**, 1275–1277.

Hanna, G.D. 1966. Introduced mollusks of the western North America. *Occasional Papers of the California Academy of Sciences*, **48**, 1–108.

Hewitt, C.L. & Martin, R.B. 2001. *Revised protocols for baseline port surveys for introduced marine species: survey design, sampling protocols and specimen handling*. Hobart, TAS: CSIRO Marine Research Technical Report, No 22, 46 pp.

Hoedt, F.E., Choat, J.H., Cruz, J.J. & Collins, J.D. 2001. *Sample collection methods and practical considerations for introduced species surveys at tropical ports*. Towsnville, QLD: CRC Reef Research Technical Report Series, No. 35, 41 pp.

Hubbs, C.L. 1952. Antitropical distribution of fishes and other organisms. In *Symposium on problems of bipolarity and pan-temperate faunas*. *Proceedings of the Seventh Pacific Science Congress*, **3**, 324–329.

Ingle, R.W. 1980. *British crabs*. London: British Museum (Natural History), 222 pp.

Jones, M.L. *ed*. 1972. The Panamic biota: some observations prior to a sea-level canal: a symposium. *Bulletin of the Biological Society of Washington*, No. 2, 1–270.

Lavoie, D.M., Smith, L.D. & Ruiz, G.M. 1999. The potential for intracoastal transfer of non-indigenous species in the ballast water of ships. *Estuarine, Coastal and Shelf Science,* **48**, 561–564.

Long, D.J. 1994. Quaternary colonization or Paleogene persistence? Historical biogeography of skates (Chondrichthyes: Rajidae) in the Antarctica ichthyofauna. *Paleobiology*, **20**, 215–228.

Mack, R.N., Simberloff, D., Lonsdale, W.M., Evans, H., Clout, M. & Bazzaz, F.A. 2000. Biotic invasions: causes, epidemiology, global consequences, and control. *Ecological Applications*, **10**, 689–710.

Maher, W.A., Cullen, P.W. & Norris, R.H. 1994. Framework for designing sampling programs. *Environmental Monitoring and Assessment*, **30**, 139–162.

De Melo, G.A.S. 1995. *Manual de identificação dos Brachyura (caranguejos e siris) do litoral Brasileiro*. São Paulo: Plêiade/FAPESP, 603 pp.

Ortmann, A.E. 1899. On new facts lately presented in opposition to the hypothesis of bipolarity of marine faunas. *American Naturalist*, **33**, 583–591.

Perrings, C. 2002. Biological invasions in aquatic systems: the economic problem. *Bulletin of Marine Science*, **70**, 541–552.

Poore, G.C.B. 1996. Species differentiation in Synidotea (Isopoda: Idotidae) and recognition of introduced marine species: a reply to Chapman and Carlton. *Journal of Crustacean Biology*, **16**, 384–394.

Por, F.D. 1978. Lessepsian migration – the influx of Red Sea biota into the Mediterranean by way of the Suez Canal. *Ecological Studies*, **23**, 1–238.

Por, F.D. 1990. Lessepsian migration. An appraisal and new data. *Bulletin de l´Institut Océanographique, Monaco*, No. 7, 1–10.

Quayle, D.B. 1964. Distribution of introduced marine molluscs in British Columbia waters. *Journal of the Fisheries Research Board of Canada*, **21**, 1155–1181.

Ruiz, G.M., Rawlings, T.K., Dobbs, F.C., Drake, L.A., Mullady, T., Huq, A. & Colwell, R.R. 2000. Invasion biology: global spread of microorganisms by ships. *Nature*, **408**, 49–50.

Ryan, P. G. & Moloney, C. L. 1993. Marine litter keeps increasing. *Nature*, **361**, 23.

Sinderman, C.J. 1991. Case histories of effects of transfers and introductions on marine resources. *Journal du Conséil international pour l´Exploration de la Mer*, **47**, 377–378.

Thatje, S. & Fuentes, V. 2003. First record of anomuran and brachyuran larvae (Crustacea: Decapoda) from Antarctic waters. *Polar Biology*, **26**, 279–282.

Udekem D'Acoz, C.D. 1999. Inventaire et distribution des crustacés décapodes de l'Atlantique nord-oriental, de la Mediterrannée et des eaux continentales adjacentes au nord de 25°N. *Patrimoines Naturels* (MNHN/SPN), **40**, 1–383.

Wasson, K., Zabin, C., Bedinger, L., Diaz, M.C. & Pearse, J.S. 2001. Biological invasions of estuaries without international shipping: the importance of intraregional transport. *Biological Conservation*, **102**, 143–153.

Wonham, M.J., Walton, W.C., Ruiz, G.M., Frese, A.M. & Galil, B. 2001. Going to the source: role of the invasion pathway in determining potential invaders. *Marine Ecology Progress Series*, **215**, 1–12.

Zibrowius, H. 1983. Extension de l´aires de répartition favorisée par l´homme chez lês invertebrés Marins. *Oceanis*, **9**, 337–353.

Zibrowius, H. 1992. Ongoing modification of the Mediterranean marine fauna and flora by the establishment of exotic species. *Mésogée*, **51**, 83–107.