

SHORT COMMUNICATION

**Intersexuality in the porcellanid crab *Pisidia longicornis*
(Crustacea: Decapoda: Anomura: Porcellanidae)**

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ABSTRACT. Intersex specimens of *Pisidia longicornis* (Linnaeus, 1767) are recorded for the first time and their secondary sexual characters are analyzed. Of 145 specimens of *P. longicornis* examined in this study, six were identified as intersex individuals. Of these, three presented male secondary sexual characters, well-developed male gonopores and rudimentary female gonopores, whereas the other three had female secondary sexual characters, with female gonopores being more pronounced than the male ones. The present study provides the first record of intersex porcelain crabs.

KEY WORDS. Malacostraca; porcelain crabs; sexual characters; reproductive biology.

Decapod crustaceans are typically gonochoric, with more or less pronounced sexual dimorphism. In the vast majority of decapods, gonopores are situated on the coxae of the third pereopods (P3) in females, and on the coxae of the fifth pereopods (P5) in males. However, there are intersex individuals with gonopore openings on both P3 and P5 (TURRA 2004).

Intersexual individuals of a variety of decapod crustaceans have been reported and studied in detail. In Anomura, most studies on intersexuality involve the hermit crab families Coenobitidae and Diogenidae (TURRA 2004, GUSEV & ZABOTIN 2007, FANTUCCI et al. 2007, SANT'ANNA et al. 2010). Some research has also been conducted on squat lobsters, Galatheidae (KRONENBERGER et al. 2004) and mole crabs, Hippidae (SUBRAMONIAM 1981).

Within the Porcellanidae, HAIG (1972) reported a single intersex specimen of *Pisidia dispar* (Stimpson, 1858) collected in Australia, based on the presence of both male and female pleopods, weakly developed female gonopores on the coxae of P3, and the presence of male secondary characters, such as more robust chelipeds. Based on similar criteria, GORE (1982) mentioned a presumed intersex specimen of *Pachycheles chacei* Haig, 1956 from Panama.

Intersexuality in porcellanid crabs was recently confirmed in two specimens of *Porcellana platycheles* (Pennant, 1777), a common European species (FERREIRA & GUZMÁN 2013). One of them presented gonopore openings on both P3 and P5, combined with female secondary characters, such as the shape of the abdomen and pleopods. The second individual had a single small female gonopore on P5, but also presented conspicuous male and female characters, e.g. male and female pleopods.

This paper reports on a new case of intersexuality in the porcellanid crab, *Pisidia longicornis* (Linnaeus, 1767), an east-

ern Atlantic species that is distributed from Norway to Portugal and throughout the Mediterranean Sea (D'UDEKEM D'ACÓZ 1999). One hundred and forty-five specimens of *Pisidia longicornis* from several localities, and which are deposited in the Museum of Zoology, University of São Paulo, São Paulo, Brazil (MZUSP) and National Museum of Natural History, Smithsonian Institution, Washington DC, USA (USNM), were examined under a stereomicroscope. The sex of individuals was determined based on whether the gonopores are located on P3 (males) or P5 (females). Secondary sexual characters were scored based mainly on the morphology of the sternum, abdomen and pleopods (see below). In addition, gills and abdominal chambers were examined in search of macro-parasites (e.g., bopyrid isopods and rhizocephalan barnacles).

In porcelain crabs, the most obvious external secondary characters of females are a broader sternum and abdomen, the latter having a greater number of lateral setae; furthermore, the abdomen covers the entire thoracic sternum, thus protecting the genital pore, while the telson reaches the coxae of the third maxillipeds.

Females have three pairs of pleopods, located on the third, fourth and fifth abdominal somites. The pleopods are uniramous. They are composed of a non-segmented protopod and endopod with three articulated segments; they are broader and longer in the fifth somite and smaller in the third somite. Males have highly modified pleopods (= gonopods) only on the second somite; their pleopods are biramous, with a long protopod, a well-developed endopod and a greatly reduced exopod.

Of 145 specimens of *Pisidia longicornis* examined, six individuals were determined as intersex (Table 1). Three individuals presented secondary male characters (narrow abdomen

not covering the entire thoracic sternum, gonopods), and had well-developed male gonopores and rudimentary female gonopores. The other three presented female secondary characters (broad thoracic sternum and abdomen, female pleopods), with the female gonopores more developed than the male ones. In addition, two of the three individuals with female features were ovigerous. No parasites were found in any of the intersex individuals.

Table 1. *Pisidia longicornis*, intersex individuals, with secondary sexual characters, locality and catalog number data.

Dominant sexual characters	Locality	Collection
2 males	Germany, Kiel Bay	USNM 4207
1 male	France, Chausey Islands	USNM 283078
1 ovigerous female	No locality	USNM 63404
1 female, 1 ovigerous female	England, Drake's Island	USNM 1256039

The frequency of intersex individuals among anomuran crustaceans is low, usually 2-7% in most populations (GUSEV & ZABOTIN 2007, SANT'ANNA et al. 2010, FERREIRA & GUZMÁN 2013). In *Pisidia longicornis*, the frequency of intersex individuals, however from different populations and localities, was 4.14%, thus falling in the range indicated by previous authors.

Different hypotheses have been suggested to explain intersexuality in crustaceans, including parasitism (NIELSEN 1970, GINSBURGER-VOGEL 1991), genetic abnormalities (HOUGH et al. 1992), environmental contamination (OLMSTEAD & LEBLANC 2007, MAZUROVÁ et al. 2010, FORD 2012) and social organization (TÓTH & BAUER 2008). Since no bopyrid or rhizocephalan parasites were found associated with intersex *Pisidia longicornis* individuals, and no abnormalities were found on their carapace, pereopods, abdomen or pleopods, it is unlikely that macro-parasites are the cause of intersexuality in these crabs.

According to FERREIRA & GUZMÁN (2013) when male and female characters are present in the same porcellanid crab (at least in *Porcellana platycheles*), the incidence of intersex specimens is low, and there is no evidence of parasitism, intersexuality can be attributed to a genetic abnormality.

The occurrence of intersex specimens is also frequently associated with localities where there is pollution (GUSEV & ZABOTIN 2007, FANTUCCI et al. 2009, SANT'ANNA et al. 2010, FERREIRA & GUZMÁN 2013). In the present work, intersex individuals of *Pisidia longicornis* were indeed collected in regions regularly affected by pollution caused by sunken oil tankers or by illegal fuel discharges into the sea (VOGT & SCHRAMM 1991) (Table 1). Therefore, it is possible that intersexuality in *Pisidia longicornis* in this case was caused by environmental contamination. However, since the reproductive function of intersex individuals is still largely unknown, the question whether intersexuality in decapods represents a case of true hermaphroditism or just an occasional genetic aberration remains open (GUSEV & ZABOTIN 2007).

In hermit crabs (Coenobitidae and Diogenidae), as well as in peracarids, intersexuality has been attributed to a protogynous event. The intersex individuals may be considered functionally males, since they have male secondary characters such as male-type pleopods (BROOK et al. 1994, TURRA 2004, FANTUCCI et al. 2007, 2009, SANT'ANNA et al. 2010). In contrast, FERREIRA & GUZMÁN (2013) observed that the secondary sexual characters in intersex individuals of *Porcellana platycheles* had a greater similarity to females than to males.

TURRA (2007) identified an ovigerous intersex individual of *Clibanarius vittatus* (Bosc, 1802) (Diogenidae). The fact that an intersex can be functionally a female is evidence of a sex reversal in diogenids. To the author's best knowledge, no intersex ovigerous individuals have been previously reported in porcellanid crabs. This makes the specimens of *Pisidia longicornis* of this study the first record of intersexuality in this family.

ACKNOWLEDGEMENTS

I am gratefully to Marcos Tavares (MZUSP), Rafael Lemaitre and Karen Reed (USNM) for granting me access to the collections under their responsibility and for providing a space where I could work. This study was supported by Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) in the form of a grant (2011/06230-2).

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Submitted: 1 December 2014

Received in revised form: 3 February 2015

Accepted: 28 February 2015

Editorial responsibility: Marcos D.S. Tavares