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Redescription of *Petrolisthes edwardsii* (de Saussure) and description of a new, sibling species from the eastern Pacific based on different colour, morphology and genetic identity (Crustacea: Anomura: Porcellanidae)

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Abstract

Petrolisthes edwardsii (de Saussure, 1853) has been viewed as a morphologically variable species with a wide distribution in the tropical and subtropical eastern Pacific. The original description of this species is rather inaccurate, and for more than a century there has been confusion regarding the final repository of type specimens. Material recently collected in the tropical eastern Pacific revealed two different colour morphs, also distinguishable through subtle discrete and continuous differences. Detailed examination of the adult morphology of these two morphotypes and phylogenetic analysis of DNA sequences of a fragment of the mitochondrial COI gene were consistent in the separation of the two forms, irrespective of the geographic origin of the specimens. Therefore, we treat these forms as different species. One form is newly described as *Petrolisthes donadio* n. sp., the other redescribed as *P. edwardsii*. The two species live in sympatry across most of their geographic range, and occupy similar habitats. A possible geographical mode of speciation is discussed.

Keywords: Crustacea; Porcellanidae; *Petrolisthes edwardsii*; *Petrolisthes donadio* n. sp.; Mitochondrial COI gene; Sibling species

Introduction

Porcellanids are marine crab-like decapods, typically littoral or sublittoral, with most species distributed in tropical regions. The eastern Pacific fauna is one of the richest, with 92 of ~260 species recognised worldwide (Haig 1960; Hiller et al. 2004). *Petrolisthes* Stimpson, 1858 is the largest and most morphologically diverse genus in the family, with nearly 100 species worldwide. Ortmann (1897) divided it into different natural groups, based on comparative adult morphology. Haig (1960) redefined those groups, establishing five morphological lines into which most *Petrolisthes* species tend to fall. *Petrolisthes edwardsii* (de Saussure, 1853) belongs to the *P. galathinus–P. lamarckii* group, which is characterised by teeth or spines on the chelipeds, carapace and walking legs. This group is interesting from an evolutionary and biogeographic perspective, as it contains sympatric and allopatric species pairs in the eastern Pacific, and across the Isthmus of Panama and the Atlantic, some of which constitute sibling species diagnosable by conspicuous colourations and subtle morphological differences (see Hiller et al. 2006). Therefore, this group of porcellanids is ideal for

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conducting evolutionary studies on the role of intrinsic and extrinsic barriers in speciation processes.

Sibling species, i.e. reproductively isolated species that are "near the invisible end of the spectrum of morphological species differences" (Mayr and Ashlock 1991), appear to be common in several groups of marine taxa (Knowlton 1993). Molecular markers have extraordinary potential for diagnosing sibling species and other closely related taxa, where morphological or other traditional markers are ambiguous or have failed (Avise 1994). The mitochondrial COI gene has proven useful in identifying previously unrecognised species and in giving taxonomic resolution within different groups of decapod crustaceans (Sarver et al. 1998; Mathews et al. 2002; Pérez-Losada et al. 2002; Macpherson and Machordom 2005).

P. edwardsii was described by de Saussure (1853) as *Porcellana edwardsii*, from a small collection of crabs from Mazatlán, Mexico. It is one of several porcellanid species with a wide distributional range in the eastern Pacific, reported from the Bay of Santa María, Baja California, and Puerto Peñasco, Gulf of California, to Salinas, Ecuador (Hiller et al. 2004).

Apparently, de Saussure did not designate any type material, and its final repository has been a matter of confusion for more than a century. Boyko (2000) presented three *P. edwardsii* specimens from Mazatlán, deposited in the Academy of Natural Sciences of Philadelphia (ANSP), as probable syntypes. One of the clues followed by this author is a list of specimens from Mazatlán, Mexico, donated by a member of the ANSP, Dr. Thomas Bellerby Wilson, before 1857. However, the list included all taxa cited by de Saussure (1853), except *Porcellana edwardsii*, which Boyko added to Wilson's list, arguing that "Because no other likely candidates for types of this taxon have been found, and because Wilson did not always donate all the taxa from the same author or publication together … it seems very probable that these are the syntypes … donated to ANSP by Wilson". While looking for type material of *P. edwardsii* we were referred to ANSP (C.B. Boyko, personal communication 2004), from where these three specimens were sent to us for examination. This material is extremely fragile and partially fragmented because of its dry-conservation.

Haig (1960) was the first to clearly allude to the intraspecific morphological variation in *P. edwardsii*. She mentioned the presence or absence of a supraocular spine, highlighting that "at least its position [is] clearly marked by a small lobe", and referred to the proximal tubercles along the outer margin of the cheliped's manus as "usually" produced into spines.

Material sampled during a recent field trip to the Pacific coast of Colombia revealed two different colour forms morphologically matching *P. edwardsii*. These forms were collected in sympatry. A more careful examination of the Colombian material led us to discover constant morphological differences corresponding to each colour morph, allowing for a clearer distinction of the two forms. One of them, designated as "Violet" because this colour predominates on the carapace and extremities, lacks a supraocular spine and has a relatively more robust appearance. The other form was designated as "Orange", because the distal segments of the walking legs are bright orange, and the background of carapace and chelipeds has a greater amount of orange than violet; this form has a supraocular spine, and compared to the "Violet" form, it has a more gracile appearance. Differences in colour pattern, most evident on the distal segments of the walking legs (carpus, propodus and dactylus), and additional morphological characters further distinguish the "Violet" from the "Orange" form. Despite these differences, distinction of the two morphotypes becomes ambiguous if colouration has faded in alcohol-preserved material. Judging from personal collection data and museum material, the geographic distributions of the two forms overlap broadly and their ecological requirements are similar.

Colour photographs of the two species can be viewed at: http://www.uni-giessen.de/porcellanidae/#pictures1.

In the present study we analysed in detail the adult morphology of the two *Petrolisthes* morphotypes by examining museum and personal material from different localities along the American Pacific coast. Additionally, a phylogenetic analysis of DNA sequences of the mitochondrial COI gene was conducted. The resulting phylogenetic trees were used to explore boundaries between the two *P. edwardsii* forms, to evaluate their species status, and to corroborate the validity of colour and colour pattern for their distinction. Results showed two clearly separated clades that support species status for each morphotype. Therefore, we describe one of them as a new species. Because the morph lacking a supraocular spine, which matches the "Violet" variant, corresponds to the one drawn by de Saussure (1853, pl. 12, fig. 3), and because it seems to be better documented than the other form (Boone 1932, fig. 10; Haig 1960, pl. 21), we propose to assign it as *P. edwardsii*. We provide a redescription of this species, considering the brief description and poorly detailed drawing given by its author as well as the confusion concerning the type material. Among the three probable syntypes present in ANSP (see above), one corresponds to the morphotype lacking a supraocular spine, and the other two to the form with such a spine. Therefore, we accept Boyko's (2000) argument for type status and designate the ANSP specimen of *P. edwardsii* as the lectotype.

Material and methods

Specimens were collected in different localities of the Colombian Pacific, including Gorgona and Malpelo