Evidence of paraphyly in the neotropical Porcellanid genus Neopisosoma (Crustacea: Anomura: Porcellanidae) based on molecular characters

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Abstract

Molecular data were used to evaluate the validity of the genus Neopisosoma Haig, 1960. Comparisons of morphological features within Neopisosoma suggest the existence of two lineages, represented among others, by N. angustifrons (Benedict, 1901) and N. neglectum Werding (1986). Both lineages of Neopisosoma are more similar to two morphologically different species groups of the genus Pachycheles, than to congeners of the other group. Comparative morphology of larvae from N. angustifrons, N. neglectum and species of Pachycheles shows that N. angustifrons closely resembles Pachycheles species, whilst N. neglectum is set apart. Sequences of a 465 bp segment of the mitochondrial gene cytochrome oxidase I (COI) were obtained and used to infer phylogenetic relationships among N. angustifrons, N. neglectum and species of Pachycheles shows that N. angustifrons closely resembles Pachycheles species, whilst N. neglectum is set apart. Sequences of a 465 bp segment of the mitochondrial gene cytochrome oxidase I (COI) were obtained and used to infer phylogenetic relationships among N. angustifrons, N. neglectum, one species of Pachycheles and seven other species of porcelainids, representing three other genera. Results of the molecular analysis were congruent to results of comparative morphological studies of larvae: N. angustifrons grouped with the Pachycheles species, whereas N. neglectum is placed apart. This led us to the conclusion that the genus Neopisosoma is probably paraphyletic and that the criterion used by Haig (1960) is not reliable to define the genus. A revision on a world-wide basis of the genera included, and additional sequence information will be necessary to satisfactorily resolve relationships within the Porcellanidae.

Introduction

Porcellanids are small, crab-like anomurans, typically littoral or sublittoral, distributed throughout all tropical faunal regions and in a lesser degree in the neighbouring temperate regions (Haig, 1960). Roughly 90 species belonging to 12 genera are found on the American Pacific coasts and approximately 40 species, grouped in 10 genera, on the Atlantic American coasts (Werding, 1992).

Species of the genus Neopisosoma Haig (1960) occur along tropical coasts on both sides of the Americas, with 3 species in the Pacific and 4 species in the Atlantic. They are predominantly found in the wash zone of rocky shores.

The genus Neopisosoma was established by Haig (1960) to separate from the genus Pachycheles Stimpson, all species which differ in the structure of the lateral walls. The lateral walls in Pachycheles species consist of a large anterior piece and a posterior portion composed of one or more fragments separated by membranous interspaces (Fig. 1a–c). In all Neopisosoma species, the posterior portion is occupied only by a membrane (Fig. 1d). Haig (1960) herself questioned the status of the new genus Neopisosoma, suggesting that it might prove to be a subgenus of Pachycheles. Werding (1986) questioned the validity of Haig’s criterion to separate the two genera, since form and number of epimeral fragments behind the frontal piece vary widely among different Pachycheles species. For example, in P. susanae Gore & Abele there is only one large piece (Fig. 1a), in P. riisei (Stimpson) one large plate appears surrounded by smaller fragments (Fig. 1b) and in P. rugimanus A.
Figure 1. Variation in form and number of epimeral fragments behind the frontal piece in different Neopisosoma and Pachycheles species: (a) P. susanae, (b) P. riisei, (c) P. rugimanus, (d) N. neglectum.

Milne Edwards only a very small plate occurs over a large membranous portion (Fig. 1c). Comparisons of other morphological features within Neopisosoma suggest the existence of two different morphotypes that are equally represented in the eastern Pacific and in the Caribbean Sea. Both morphologically coherent groups are represented on the Caribbean coast, among others, by Neopisosoma angustifrons (Benedict, 1901) and N. neglectum Werding (1986).

Both lines of Neopisosoma species show a marked affinity with two morphologically different groups of Pachycheles, which are more similar (and subsequently more related?) among themselves than to their congeners of the other assemblage. Table 1 shows the two groups formed by members of both genera and the morphological features that characterize each assemblage.

Larval features of N. angustifrons, like the number of spinules in the antennal exopod and the arrangement of the hook-like spines in the tail fan setae in zoea I (Table 2), resemble those of several Pachycheles species (Gore, 1977; Konishi, 1987), and are different from larval features of N. neglectum (Werding & Müller, 1990).

Molecular data have contributed most significantly in areas where morphological data are inconclusive, deficient, non-existent or poorly analysed (Patterson et al., 1993). Mitochondrial DNA (mtDNA) has shown to be a useful marker to estimate phylogenetic relationships of animals at different taxonomic levels. The attraction of mtDNA derives, in part, from the relative ease with which homologous sequences can be isolated, aligned and analyzed (Harrison, 1989). The mitochondrial gene cytochrome oxidase I (COI) has been used to infer phylogenetic relationships of some crustaceans belonging to the families Penaeidae (Palumbi & Benzi, 1991), Alpheidae (Knowlton et al., 1993), Hippidae (Tam et al., 1996), Gammaridae (Meyran et al., 1997) and Palinuridae (Sarver et al., 1998).

We present results of a preliminary molecular phylogenetic study using partial sequences of the COI gene from 9 neotropical species of porcellanids, representing 4 genera, including Neopisosoma and Pachycheles. One European species, from a fifth genus, was included in the study, from which specimens of two biogeographically separated populations were sampled to have estimates of sequence divergence at the population level.

Materials and methods

Sampling

Caribbean species were collected in shallow water on the coast of Colombia, near Santa Marta. Specimens of the European species, Porcellana platycheles, were sampled on the French Atlantic coast, near Saint Malo, and on the Spanish Mediterranean coast, Costa Brava. They are designated along this paper as P. platycheles I and II, respectively. Specimens collected for this study and their respective substrates and locations are listed in Table 3. Specimens were identified using morphological traits and stored in a buffer consisting of 10%