

Hermaphroditism in Marine Mussel *Perumytilus purpuratus* (Lamarck, 1819), (Mollusca: Mytilidae)

Hermafroditismo en el Chorito *Perumytilus purpuratus* (Lamarck, 1819), (Mollusca: Mytilidae)

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MONTENEGRO, V. D.; OLIVARES, P. A. & GONZÁLEZ, M. T. Hermaphroditism in marine mussel *Perumytilus purpuratus* (Lamarck, 1819), (Mollusca: Mytilidae). *Int. J. Morphol.*, 28(2):569-573, 2010.

SUMMARY: Marine bivalves are essentially gonochoric species. However, some occasional hermaphrodites specimens can be found. A histological description of two (among 179) hermaphrodites of the marine mussel *Perumytilus purpuratus* (Lamarck, 1819) that were collected in San Jorge Bay (24°S) is given. The low proportion of hermaphrodites suggests that *P. purpuratus* hermaphroditism could be an accidental phenomenon; nevertheless other causes are also discussed in the present study.

KEY WORDS: Bivalve; Hermaphroditism; *Perumytilus purpuratus*.

INTRODUCTION

Bivalves (also known as lamellibranchs or pelecypods) include groups such as clams, mussels, scallops, and oysters (Brink, 2001). Among the more than 10,000 species belonging to the class Pelecypoda may be found in different degrees of sexual differentiation from species that are strictly of separated sexes in relations to those that are almost invariably functionally hermaphroditic (Coe, 1943). Especially, freshwater bivalves are often hermaphroditic (Morton, 1991). However, hermaphroditic individuals occasionally have been found in species strictly considered gonochoric (Heller, 1993), such as clams *Ruditapes decussatus* (L.) (Delgado & Perez, 2002), *Anadara granosa* (L.) and *Anadara Antiqua* (L.), which have simultaneously male and female tissue in the same follicle (Afiati, 2007). Similarly, Ceuta *et al.* (2007) recorded hermaphroditism in two clams species *Tagelus plebeius* (Lightfoot, 1786) and *Iphigenia brasiliana* (Lamarck, 1818), Vinuesa (1977) reported the first hermaphrodite in mussel *Aulacomya ater* (Molina) and Villalón (1965) reported one of 4309 (0.023%) specimen of *Perumytilus purpuratus* (Lamarck, 1819) with male and female gonads.

Perumytilus purpuratus is a common marine mussel in the rocky intertidal habitats from Ecuador to Strait of

Magellan, extending up to the Atlantic coast of Santa Cruz, Argentina. This specie is dioecious, the female mantle is brown and the mantle of male is yellow (Osorio & Bahamonde, 1968; Paredes & Tarazona, 1980).

In the present paper, a histological description as an evidence of hermaphroditism in *Perumytilus purpuratus* from the Northern Chilean coast is recorded.

MATERIAL AND METHOD

Between September and November 2009, at low tides, 179 specimens of *Perumytilus purpuratus* were collected in lower intertidal layer along the coastal area of San Jorge Bay. The specimens were measured by using a digital caliper (precision 0.01 mm). Taking into account that reproductive tissue in mytilids expand and invade soft tissues in the visceral mass and mantle lobes (Field, 1922), sex was determined based on gonad tissue color and the mantle: male (Fig. 1), female (Fig. 2) and in the case of the hermaphrodites specimens, one lobe of the mantle was browner and the other was yellow (Fig. 3). Hermaphrodites were found in intertidal

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zone of Las Petroleras beach (23°36'S; 70°23'W). The gonads were fixed with Davidson solution, dehydrated, embedded in paraplast, sectioned at 5 µm with Microtome Minot and stained with haematoxylin and eosin (Bancroft & Steves, 1990).

RESULTS AND DISCUSSION

Mussel sizes varied from 27.77 mm to 38.72 mm. The size frequency is shown in Table I. The lengths of hermaphrodite mussels were 34.18 mm and 29.5 mm. The proportion of sexes did not differ from 1:1 ($\chi^2= 6.635$; $p < 0.01$) Zar (1996).

In the general structure of male gonads in *P. purpuratus*, the testis are formed by seminiferous follicles (Fig. 4), whose epithelium contains spermatogenic cells, organized in layers, and Sertoli cells (Pipe, 1987). In female, the ovary is organized by gonadal follicles (See figure 5); with mature oocytes inside of them (Mykhalow *et al.*, 1995). Hermaphrodites presented in the testis, follicles with fully mature sperm and other follicles with total emission of male gametes but in the stratum basale a reduced number of oocytes (Figs. 6 and 7). In summary the presence of male follicles in the lumen and the presence of oocytes, are evidences of a hermaphroditism in mussels *Perumytilus purpuratus*.

Other cases of occasional hermaphroditism in mollusks have been recorded in Cephalopods (Ortiz & Re, 2006), Polyplacophora (Scarano & Ituarte, 2009), and Gastropoda (Olivares *et al.*, 2009). The scarce records of hermaphrodite individuals indicate that it could be an accidental phenomenon (Calvo *et al.*, 1998); however, mechanisms of sexual differentiation control are not

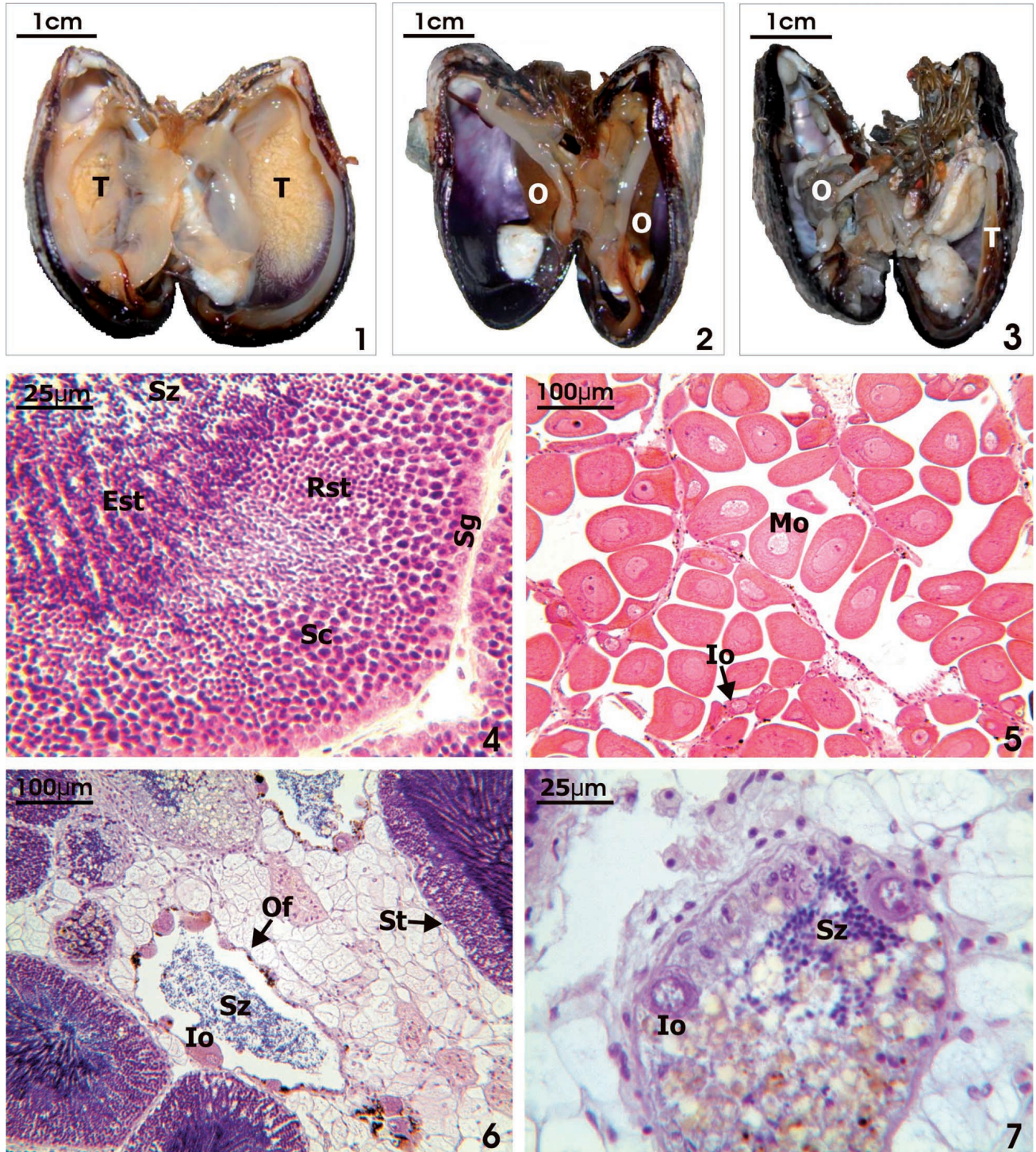
absolutes. Beninger & Le Pennec (1991) mentioned that it is possible to find low frequency of hermaphrodite specimens, even within gonochoric species. In the similar line, Coe suggested that these occasional individuals with functional hermaphroditism can all be considered as a result from deviations in developmental processes, due to the failure of the sex differentiating mechanism to function normally.

The endocrine systems of invertebrates generally regulate the same processes that are found in vertebrates such as development, growth, and reproduction (Oehlmann & Shultze-Oehlmann, 2003). Several compounds or groups are known to disrupt specific invertebrate endocrine systems, including development and reproductive function (Defur, 2004). Endocrine disruptors include organotin, organochlorine, pesticides, industrial chemical (biphenyls and polycyclic aromatic hydrocarbons) (Lintelmann *et al.*, 2003). Some authors have found incidence of ovotestis (produce eggs and sperm) in bivalves, which suggest that associations with urban, industrial, or organotin presence could be established. However, they indicate that the mode of action remains largely unclear (Chesman & Langston, 2006; Horiguchi *et al.*, 2000; Langston *et al.*, 2007; Petridis *et al.*, 2009). In our study the hermaphrodites (ovotestis) were found in a polluted location by polycyclic aromatic hydrocarbons and heavy metals (Salamanca *et al.*, 2004; CREA, 2005). Despite this, more evidence is needed to confirm that this hermaphroditism is related to pollution.

In conclusion, evidence of hermaphroditism in *Perumytilus purpuratus* is recorded. Although these hermaphrodite specimens could be an occasional occurrence in *Perumytilus purpuratus* and additional studies will be necessary to link them to pollution, endocrine disruption and the sexual development of the mussel *Perumytilus purpuratus*.

Table I. Frequencies of *Perumytilus purpuratus* by sex and size classes (mm).

Size Class	Male (M)		Female (F)		Sexual proportion	
	n	%	n	%	M/F	C ²
27.70-28.81	1	0.9	1	1.3	1.00	2.00
28.82-29.93	10	9.8	6	8	0.50	1.00
29.94-31.05	11	10.78	10	13.33	0.02	0.05
31.06-32.17	18	17.65	10	13.33	1.14	2.29
32.18-33.29	15	14.71	10	13.33	0.50	1.00
33.3-34.41	17	16.66	14	18.67	0.15	0.29
34.42-35.53	7	6.86	8	10.67	0.03	0.07
35.54-36.65	10	9.8	7	9.33	0.26	0.53
36.66-37.77	11	10.78	6	8	0.74	1.47
37.78-38.89	2	1.96	3	4	0.10	0.20



Figs. 1-3. Observation of specimens male (Fig. 1), female (Fig. 2) and hermaphrodite (Fig. 3) of *Perumytilus purpuratus*: T: testis; O: ovary.

Figs. 4-7. Gonadal histology of *Perumytilus purpuratus*. Stain Hematoxilene & Eosine.

Fig. 4. Observation of mature seminiferous tubule. Spermatogonia (Sg), Spermatocyte (Sc). Round spermatid (Rst). Elongated spermatid (Est) and spermatozoa (Sz).

Fig. 5. Ovarian follicle with a high number of mature oocytes (Mo), and immature oocytes (Io).

Figs. 6 y 7. Gonads of hermaphrodite with mature seminiferous tubule (St) and ovarian follicles(Of), contain immature oocytes (Io) and the lumen spermatozoa (Sz).

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RESUMEN: Los bivalvos marinos son principalmente especies gonocóricas. Sin embargo, ocasionales especímenes hermafroditas pueden encontrarse. Una descripción histológica de dos (de 179) especímenes hermafroditas del chorito *Perumytilus purpuratus* (Lamarck, 1819) es registrada, los que fueron colectados en la bahía de San Jorge (24°S). La baja proporción de hermafroditas de *Perumytilus purpuratus* sugiere que podría ser un fenómeno accidental, aun así otras posibles causas son discutidas en el presente estudio.

PALABRAS CLAVE: Bivalvos; Hermafroditismo; *Perumytilus purpuratus*.

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