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Reproductive investment and fecundity of the Red rock crab (*Grapsus adscensionis*) in Tenerife (Canary Islands, Atlantic Ocean) (Decapoda, Grapsidae)

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RESUMEN: En el presente estudio se analizó la biología reproductiva del cangrejo moro (*Grapsus adscensionis*) a partir de material recolectado en la isla de Tenerife (islas Canarias, España) a lo largo del período de muestreo, Junio 2010-Mayo 2011. La proporción de machos y hembras capturados varió a lo largo del año de estudio, elevándose la proporción de hembras durante la época de puesta, que coincide con el mayor número de hembras ovígeras. Se observó una alta correlación positiva entre el peso y la talla de las hembras ovígeras y el nº total de huevos. Se calculó la fecundidad de 12 ejemplares, que registraron una media de 975 ± 108 huevos por gramo de hembra y un nº medio total de 69.000 huevos por hembra.
Palabras clave: Crustacea, *Grapsus adscensionis*, supramareal, intermareal, Tenerife, islas Canarias, océano Atlántico.

ABSTRACT: Red rock crabs (*Grapsus adscensionis*) were collected along the coast of Tenerife (Canary Islands, Spain) throughout the sampling period, June 2010-May 2011, to investigate the breeding cycle and reproductive bi-

ology of this species. Sex ratio varied throughout the study period. The proportion of females raised during the spawning period, when the maximum number of ovigerous females was observed. A high positive correlation was found between the weight and size of ovigerous females and total number of eggs. Fecundity was calculated for 12 individuals, displaying a mean value of 975 ± 108 eggs per g of female, and obtaining a mean value of 69,000 eggs per female.
Keywords: Crustacea, *Grapsus adscensionis*, reproduction, biology, intertidal, Tenerife, Canary Islands, Atlantic Ocean.

INTRODUCTION

Grapsus adscensionis is a poorly studied species of the family Grapsidae inhabiting the eastern and central Atlantic. Only recently this species was established, since up till then it was identified as widely distributed *Grapsus grapsus* (Linnaeus, 1758). Manning & Chace (1990) pointed out the existence of a separate old name - *G. adscensionis* (Osbeck, 1765), distributed along the coasts of eastern and central Atlantic, from southern Portugal to Namibia, including Madeira, Azores, Canary Islands, Cape Verde, Ascension and Saint Helena islands. Guerao *et al*. (2001) compared zoeae of *G. grapsus* and *G. adscensionis* and found morphological differences, confirming the distinct taxonomic status of these two species.

The colour pattern of *G. adscensionis* varies according to the habitat. Adults have bright-red chelas with yellow-orange legs, brownish-red or spotted brown carapace, whilst juveniles crabs are dark-brown or almost black and camouflage well in black lava coasts. Individuals spend most of its time out of the water, in the splash zone, and often move up and down the shore with the tide (Burggren & McMahon, 1988). During the low tide animals move down to graze on algae remaining on the shore (Hartnoll, 2009). This species is an omnivorous opportunistic feeder and, apart from algae, it preys on any other available food (worms, mollusks, dead animals, food wastes and other crustaceans).

According to Hartnoll (2009), *G. adscensionis* breeds continuously throughout the year. Females have the ability of storing sperm (in the spermathecae), usually lay their eggs shortly after copulating and ovaries become mature again when eggs have completed incubation. Egg batch is estimated to be laid every 24 days (Hartnoll, 2009), developed to zoeae and released by female directly to the sea.

Despite the low commercial interest as food for human consumption, this species is becoming popular in aquaculture, where *Grapsus* zoeae is being experimentally widely used as life prey for commercially-valued species, such as the octopus (Carro, 2004). Therefore, general biology and specific reproduction related information of the species will support a sustainable use of this fishery resource to avoid overexploitation.

MATERIAL AND METHODS

Specimen capture, transport and culture conditions

The capture of 217 broodstock individuals was conducted in Tajao (28º06´N/16º28´W SE Tenerife) and in Tacoronte coast (28º30´N/16º25´W N Tenerife) at night, with new moon conditions and during low tide. 95 crabs were captured in 2010 (11th and 25th June), 48 in 11th March 2011 and 74 crabs in 19th and 25th May 2011. Torches and headlights were used to catch crabs. After being captured, animals were transported to the culture facilities of the Spanish Institute of Oceanography (IEO - Centro Oceanográfico de Canarias) in 30 L containers without water.

All *G. adscensionis* individuals were cultured in 3,000 L cylinder-conical tanks of fibre glass, under natural photoperiod and temperature conditions (21.8 ± 1.2°C). Water column level was low (~10 cm) and water flow was 6 L/minute. Some refuges (stones, net boxes and pvc tubes) were set in tanks to act as shelters and diminish territorial competition, allowing crabs to stay out of the water. Animals were daily fed *ad libitum* on a diet of frozen mackerel and squid.

Data acquisition and analysis

Sex differentiation was determined after each field trip by checking abdomen; females displayed an abdomen with a round shape, while males presented an abdomen with a narrow triangle. The sex ratio was calculated as the percentage of males by females.

Presence of eggs in the three sets of captured crabs was monthly observed by carefully rising up of abdomen. The first set of crabs was reared in captivity from June 2010 to April 2011. In March 2011, 48 new crabs were taken in a 2nd trip, from them only females were measured and the presence of eggs was also checked (2nd March bar in Fig. 2). Then these females were placed together with the first individuals. Therefore, data of April corresponds to the mixture of crabs from the 2 first field collections, while data from May 2011 corresponds only to the 3rd set.

For body size determination, the carapace width (CW) of all 83 females from 36 to 70 mm was measured. Thirty two females (with a CW of 40 - 70 mm), displayed eggs.

Reproductive investment (RI) was calculated as eggs wet weight/female wet weight x 100, in 12 females bearing eggs, with a size range of 46 - 63 mm CW and 41 to 118 g. Egg sampling was accomplished by anaesthetizing females in cold seawater (-1°C) for one minute. Eggs were then carefully removed by scrapping the pleopods with tweezers and scalpel, but taking care not to cause any injury to the animals.

Fecundity (eggs/female) was determined by counting the amount of eggs that existed in 10 - 15 mg and extrapolating this data for the whole egg mass of each female. The mean fecundity weight (eggs/ female weight) was estimated according to weight of female and expressed as the amount of eggs per g of female mass.

Exponential regression were applied to verify the best relationship between female weight and egg number, female size and egg number and, finally, between female size and weight.

RESULTS

Sex ratio (Fig. 1) varied throughout the studied year, between 68.4% females and 31.6% males in June (1:2.2), 41.7% females and 58.3% males in March (1:0.7) and 45.9% females and 54.1% males in May (1:1.2).

Egg production throughout the year clearly reflected two spawning periods (Fig. 2), one from December to March and another from March to September, with main peaks in June-May (52.3% and 57.5%), when animals were captured, and in February (50%). In October no ovigerous females were observed.

Carapace width (CW) of 83 females varied from 36 mm to 70 mm, with a mean CW of 53 ± 8 mm, where ovigerous females ranged from 40 mm to 70 mm, with a mean of 55 ± 6 mm.

Total number of eggs and reproductive investment (RI%) were estimated for 12 females. RI% ranged from 3.9 - 9.2%, with a mean value of 6.6 ± 1.9%, for ovigerous females with a size range of 46 - 63 mm CW (54 ± 6.1 mm) and weight from 41 to 118 g (69.8 ± 24 g), respectively. Fecundity was calculated as 975 ± 108 eggs per g of female body mass, with a mean value of 69,000 eggs per female.

Data regarding egg number and female size showed a strong positive correlation (Fig. 5), with the smallest female (46 mm CW) holding 43,000 eggs and the largest one (6.3 cm CW) displaying 135,600 eggs (Fig. 3). A positive correlation between weight of ovigerous females and total number of eggs was found to be exponential ($R^2 = 0.93$; Fig. 4). Moreover, female weight was positively correlated with body size (Fig. 6) showing an exponential pattern ($R^2 = 0.96$).

DISCUSSION

The relationship among monthly occurrence of mature males and females and the monthly distribution of individuals, according to size classes and sex, has been widely investigated in brachyuran crabs (Pathre & Meena, 2010). In the present study of *G. adscensionis* reproduction biology, it was found a transition of sex ratio throughout the studied period. The proportion of females reached its maximum during the summer months (June-July), while male crabs were more abundant than females (1:0.7) in March. By the beginning of spawning season, the percentage of females increased and, in May, the sex ratio changed to 1:1.2, while in June the amount of females was found to be almost 70% (1:2.2). An increase in the capture of females, which also corresponded to a peak of egg production, indicates that the species is migrating to the spawning areas during this month.

The egg laying pattern was clearly divided into two seasons: December to March and March to September, with maximum values in February and May. Carro (2004) observed the same trend for individuals collected in Gran Canaria (Canary islands), with an increase of ovigerous females in summer (May-August) and Ayza *et al*. (2010), also in the Canary islands, reported the reproductive activity for the species to be from December to September.

In this study, the body size of 83 measured females varied from 36-70 mm. Ayza *et al*. (2010) presented body size data for the species from other Canary islands (803 crabs

from La Gomera and 1,009 from Gran Canaria) differing in the size range (11.7-84.3 mm CW). According to Hartnoll (2009), the size of *G. adscensionis* from Ascension Island (U.K.) is from 28 mm to 74 mm for females and from 25-74 mm for males, which is similar to the results of our study.

The body size of ovigerous females ranged from 40-70 mm with a mean value of 55 ± 6 mm, while Hartnoll (2009) pointed that the onset of sexual maturity of females from Ascension Island starts at 43 mm CW. Ayza *et al*. (2010) reported data of higher sizes for females from La Gomera (50.1 mm) and Gran Canaria (54.6 mm).

The results of this study show that *G. adscensionis* from Tenerife have smaller size and, therefore, maturation occurs in smaller specimens compared to individuals from other islands of the archipelago and of Ascension Island.

Reproductive output per brood for *G. adscensionis* was strongly correlated with body size and weight in this study. Fecundity ranged from 43,000 to 135,600 eggs, with a mean value 69,000 eggs per female. Carro (2004) established very similar data providing a value of 68,000 eggs.

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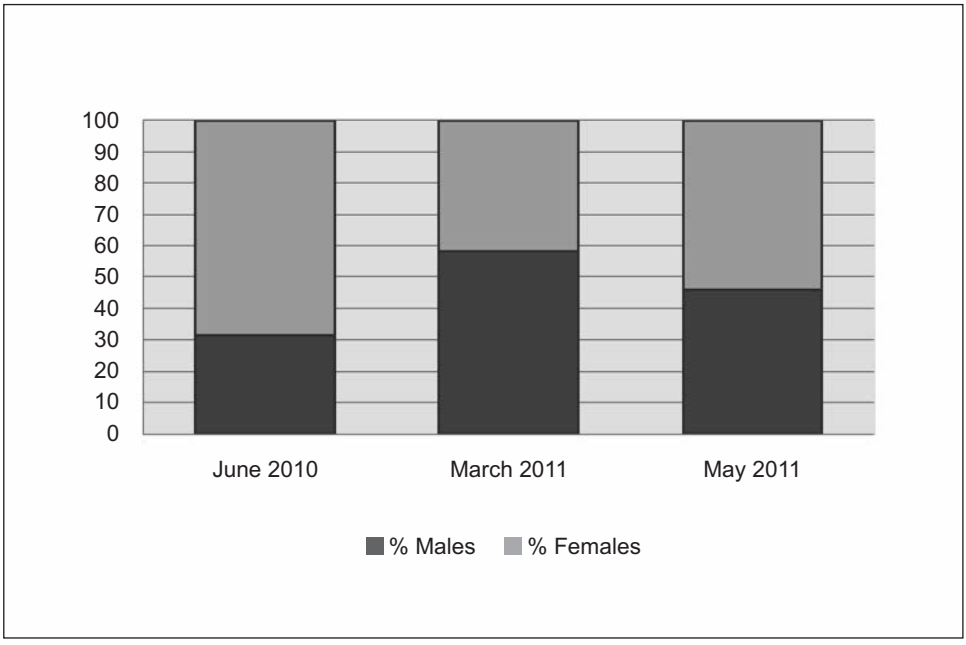

Figure 1.- Sex ratio of *Grapsus adscensionis* individuals throughout the study period.

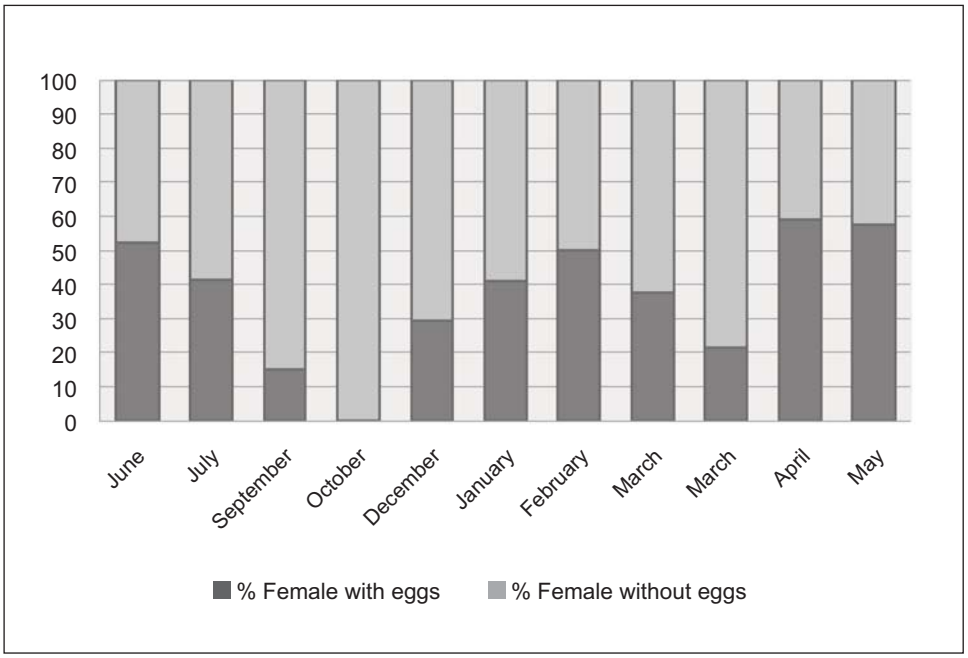

Figure 2.- Ratio of ovigerous and non-ovigerous females throughout the study period.

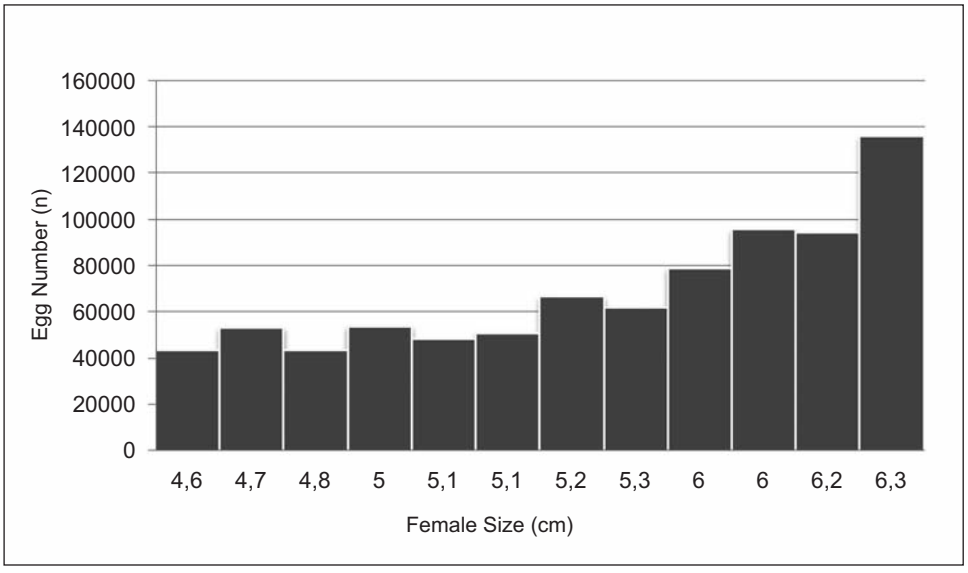

Figure 3.- Total number of eggs and female size (cm).

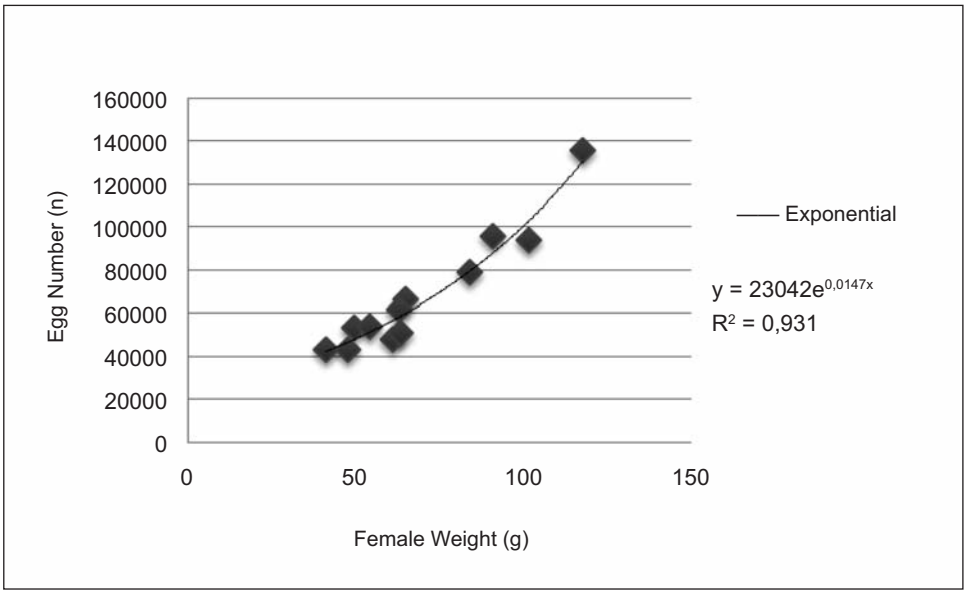

Figure 4.- Correlation between ovigerous female weight and total number of eggs.

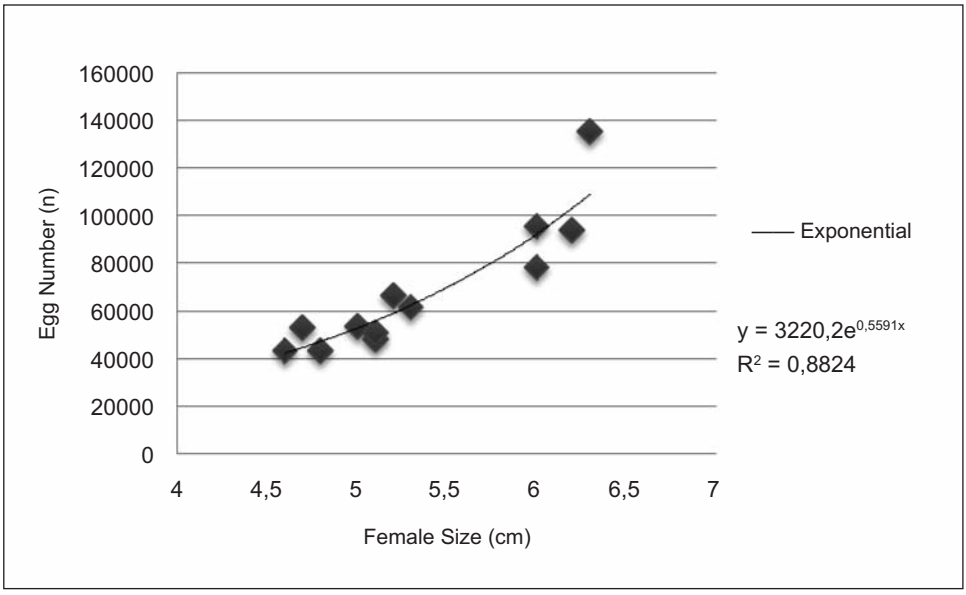

Figure 5.- Correlation between ovigerous female size and total number of eggs.

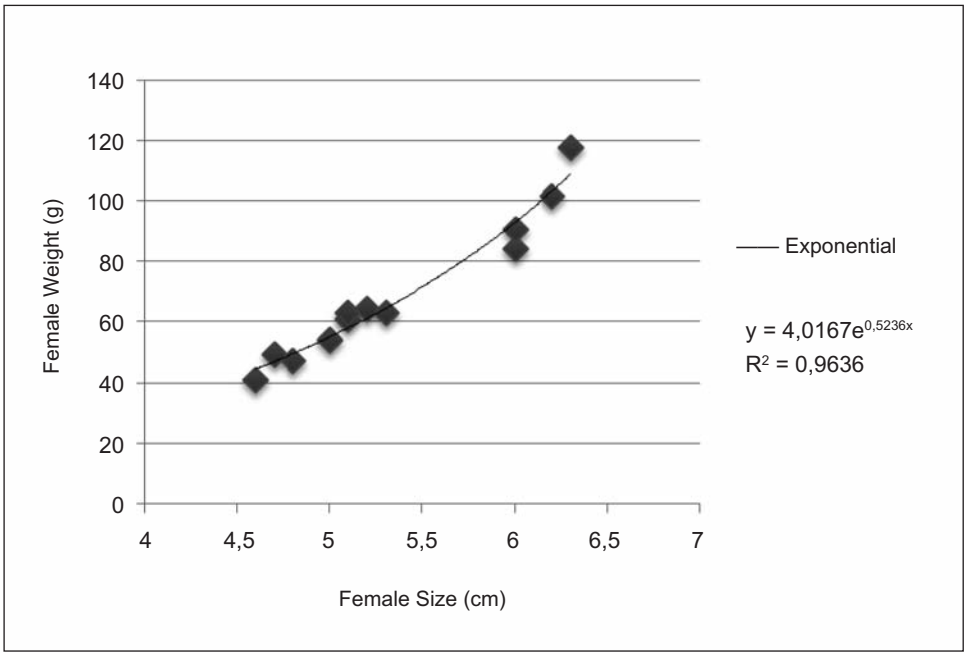

Figure 6.- Correlation between female weight and size.

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