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Egg production in *Eurypodius latreillii* Guérin, 1828 (Decapoda: Majidae) in the Straits of Magellan, southern Chile*

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SUMMARY: Egg production and reproductive investment were studied in the spider crab *Eurypodius latreillii* from the Straits of Magellan, southern Chile. A total of 66 ovigerous females were analyzed, ranging in size from 29.0 to 62.9 mm carapace length. *E. latreillii* produced up to 15886 embryos, and clutch size increased with maternal size. Initial egg size was large (0.162 mm^3), and the embryo volume increase during the incubation period was 32 %. Brood mortality was substantial (83 %), and since egg volume increase could not compensate for the egg loss, average egg mass volume decreased considerably during embryogenesis. The average brood mass at laying accounted for 13 % of the maternal body mass (on a wet mass basis), and this value coincides with previous findings concerning energy allocation for egg production in other brachyuran crabs. In general, our data regarding *E. latreillii* correspond well with those from spider crab species inhabiting the northern hemisphere. The large egg size of *E. latreillii* compared with majids from other geographical regions may be an indication of a latitudinal gradient in the reproductive biology of majid crabs. Future studies with spider crabs from the southern hemisphere are desirable to substantiate this assumption.

Key words: egg production; energy allocation; brood mortality; southern hemisphere, Majidae.

RESUMEN: PRODUCCIÓN DE HUEVOS EN *EURYPODIUS LATREILLII* GUÉRIN, 1828 (DECAPODA: MAJIDAE) EN EL ESTRECHO DE MAGALLANES, SUR DE CHILE. – Se estudió la producción de huevos y la inversión reproductiva del cangrejo araña *Eurypodius latreillii* proveniente del Estrecho de Magallanes, sur de Chile. Se analizaron un total de 66 hembras ovígeras con un rango de tamaños entre 29,0 y 62,9 mm de longitud de caparazón. *E. latreillii* produjo hasta un máximo de 15886 embriones, y el número de huevos aumentó con el tamaño de la hembra. El tamaño inicial del huevo fue grande (0,162 mm^3) y el aumento del volumen embrionario durante el período de incubación fue de 32 %. La mortalidad de huevos fue considerable (83 %), y como el aumento en el volumen de los huevos no pudo compensar la pérdida de huevos, el promedio del volumen de la masa de los huevos disminuyó de forma considerable durante la embriogénesis. La masa de huevos representó un 13 % de la masa corporal de la madre, y este valor coincide con observaciones previas sobre la asignación de energía para la producción de huevos en otros braquiuros. En general, nuestros datos sobre *E. latreillii* concuerdan con datos sobre especies del cangrejo araña del hemisferio norte. El tamaño grande de huevos de *E. latreillii* comparado con Majidae de otras regiones geográficas podría ser interpretado como una indicación de un gradiente latitudinal en la biología reproductiva de cangrejos májidos. Para corroborar esta interpretación se requerirían estudios futuros con cangrejos araña del hemisferio sur.

Palabras clave: producción de huevos; asignación de energía; mortalidad de huevos, hemisferio sur, Majidae.

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INTRODUCTION

Majidae are among the commonest families of decapod crustaceans reported from the southern hemisphere (see Kensley, 1981). Referring to South America, the Chilean Pacific coast seems to support considerably more spider crabs (16 species: Báez, 1985) than the Atlantic coast of Argentina (8 species: Boschi *et al.*, 1992). Several life history aspects such as population dynamics (e.g., Hartnoll *et al.*, 1993), breeding biology (e.g., Hinsch, 1968; Hines, 1982; Bryant and Hartnoll, 1995), and larval ecology (e.g., Anger, 1991) have been fairly well studied in a number of species of majid crabs from the northern hemisphere. By contrast, apart from some descriptions of the larval development of spider crabs (see Wehrtmann and Báez, 1997), virtually nothing is known about the ecology of representatives of Majidae occurring in the southern hemisphere.

The majid crab *Eurypodius latreillii* Guérin, 1828 has a wide known geographical distribution, ranging from Peru to the Straits of Magellan, and the species has also been recorded along the Atlantic side from the tip of South America to the Gulf of San Matías, Argentina, from the Falkland Islands, and also from Rio de Janeiro, Brazil (Garth, 1957; Retamal, 1973, 1974). *E. latreillii* prefers sandy sediments and is typically covered with a variety of epizoans, mainly sponges, algae and hydroids (Garth, 1957; Retamal and Yáñez, 1973). Recent studies regarding the decapod fauna in waters off Patagonia and Tierra del Fuego, South America, revealed that *E. latreillii* is one of the predominant shallow water species, and accounted for 19 % of the total number of decapods collected in the Straits of Magellan (Arntz *et al.*, 1999). Thus, *E. latreillii* can be considered a key species of the shallow water ecosystems surrounding the southern tip of the Americas. To contribute to a better understanding of life history traits of decapods inhabiting the waters in the vicinity of the Antarctic, which connect the Atlantic and Pacific Oceans, we studied the reproductive biology of *E. latreillii* in the Straits of Magellan and compared our results with those obtained from other brachyuran crabs.

MATERIAL AND METHODS

The specimens of *E. latreillii* were obtained during the Joint Chilean-German-Italian Magellan "Victor Hensen" Campaign which operated between October - November 1994 in the waters surrounding the southern tip of the Americas (see Arntz and Gorny, 1996). All the ovigerous females analyzed in the present study (n = 66) stem from one sample, Station 816 (52°58'S, 70° 42'W, 125 m water depth); individuals were preserved on board in 10% formaldehyde solution. In the laboratory, carapace length (CL) and width (CW) were measured for all egg-carrying females. Subsequently, all eggs carried by each female were separated and the developmental stage of the embryos was assessed according to the three stages described by Bustos and Retamal (1975). The entire egg batch was weighed, and approximately 10% of the egg mass was separated and divided into three aliquots; the number of embryos per subsample was assessed and each aliquot was weighed. Based upon these values we estimated the fecundity (egg number per brood) of *E. latreillii*. To obtain a rough estimate for brood mortality during embryogenesis, average egg numbers per stage were compared and the differences between stages were expressed as percentages. Length and width was measured for ten eggs in each of 15 females (five per embryonic stage) under a microscope with the aid of a calibrated ocular micrometer to calculate the egg volume (V) using the formula for oblate spheroids $V = 1/6\ (p\ d_1^2 \times d_2)$ (see Turner and Lawrence, 1979). The average volume per egg was multiplied by the total number of eggs to estimate the egg mass volume (EMV) of the female. The wet mass of females and their egg batch was determined with an analytic balance (Sartorius). The estimate for the reproductive output (RO) is based upon the wet mass of females carrying recently extruded eggs (Stage I), utilizing the following formula (see Clarke *et al.*, 1991): RO = (wet mass of total egg batch of the female / wet mass of the female without embryos). Average values are indicated with standard deviation (± SD).

RESULTS

Egg-bearing females of *E. latreillii* ranged in size from 29.0 to 62.9 mm CL and from 21.0 to 42.5 mm CW (Table 1). The average sizes of females carrying eggs in Stage I and II were identical, while females with embryos close to hatching were slightly but not significantly (Student's t test; $p > 0.05$) smaller (Table 1). Clutch size independent of the development stage of the embryos varied between 201 and

TABLE 1. – Size (carapace length, CL; carapace width, CW) of egg-carrying *Eurypodius latreillii* females, and clutch size and egg dimension per embryonic stage. S.D. = standard deviation; n = number of observations.

	Average	± S.D.	Minimum	Maximum	n
STAGE I					
CL (mm)	40.8	3.37	34.0	47.5	14
CW (mm)	29.5	3.66	25.0	37.4	14
Egg number	9384	2812.0	6510	15866	14
Egg length (mm)	0.678	0.007	0.668	0.689	10
Egg width (mm)	0.677	0.005	0.668	0.680	10
STAGE II					
CL (mm)	40.8	5.63	29.0	62.9	45
CW (mm)	28.1	3.93	21.0	42.5	45
Egg number	6422	1892.1	2424	9887	45
Egg length (mm)	0.706	0.019	0.680	0.750	10
Egg width (mm)	0.703	0.018	0.680	0.741	10
STAGE III					
CL (mm)	37.7	2.56	33.0	40.8	7
CW (mm)	26.8	3.14	22.0	31.7	7
Egg number	1627	1602.0	201	4505	7
Egg length (mm)	0.750	0.012	0.732	0.769	10
Egg width (mm)	0.745	0.007	0.732	0.750	10

15886 eggs (Table 1) and increased with maternal size (Fig. 1). Average egg number per stage decreased from 9384 to 1627 (Table 1); thus, females lost 83 % of their initially-spawned embryos, and brood loss was more pronounced in the final phase of embryogenesis (75 %) than between Stages I and II (32 %). The mean volume of recently-produced eggs was 0.162 mm^3 (± 0.001 mm^3), and at the end of the incubation period eggs reached a mean volume of 0.214 mm^3 (± 0.008 mm^3), which represented a total volume increase during embryogenesis of 32 %. During the same time, the average egg mass volume decreased from 1524.0 mm^3 (± 456.7 mm^3) to 348. 2 mm^3 (± 342.8 mm^3) (see Fig. 2). The average RO was 0.134 (± 0.009; n = 14), and ranged from 0.023 to 0.365.

DISCUSSION

Several species of spider crabs are considered to have a determinate growth, including a terminal molt (e.g., Hartnoll, 1985). However, the occurrence of a wide size range of presumably mature spider crab females casts doubt on the assumption of a terminal molt (see Elner and Beninger, 1995, and references cited therein). The fact that ovigerous females of *Eurypodius latreillii* varied between 29.0 and 62.9 mm carapace length does not provide support for the idea of a terminal molt in this species. It should be stressed, however, that the reproductive biology of *E. latreillii* and all other spider crabs from temperate waters around South America is almost completely unknown.

Clutch size in *E. latreillii* increased sharply with maternal size, corroborating similar findings regarding both spider crabs from the northern hemisphere and brachyuran crab species from other families (Hines, 1982, 1991; Ivanova and Vassilenko, 1987). Our results thus provide further support for the hypothesis that female body size is the principal determinant of fecundity in brachyuran crabs (Hines, 1982).

Hines (1982) studied different parameters of the reproductive biology of six species of spider crabs from California and Delaware, USA, and concluded that species of Majidae produce fewer but larger eggs than representatives of several other brachyuran families. Our findings concerning *E. latreillii* corroborate his conclusion: (1) clutch size of *E. latreillii* is within the range of other spider crabs (Hines, 1982), and (2) egg size of *E. latreillii* is, as in other Majidae, substantially higher than that of most other brachyuran crabs (Hines, 1982, 1991; Reid and Corey, 1991). Among the Majidae, *E. latreillii* seems to produce the largest embryos so far reported (see Hines, 1982), but freshly-hatched larvae do not present signs of an abbreviated development (Campodónico and Guzmán, 1972). This suggests a possible latitudinal cline of egg size within the Majidae, a pattern which has been described for a variety of other decapod species (e.g, Clarke, 1987, 1992, 1993; Jones and Simons, 1983; Gorny *et al.*, 1992; Wehrtmann and Kattner, 1998). Although *E. latreillii* from the southern tip of the Americas spawns considerably larger eggs than spider crabs inhabiting waters located at lower latitudes in the northern hemisphere, additional data from other southern hemisphere spider crab species will be required to substantiate the possibility of latitudinal gradients in the reproductive biology of Majidae. The presence of at least 16 spider crab species along the Chilean coast (Báez, 1985) is an excellent basis for further studies concerning general trends in the reproduction of majid crabs.

E. latreillii appear to suffer high egg losses during the incubation period (83 %) when compared to other brachyuran crabs (Kuris, 1991). However, our estimate for brood mortality may have been biased by the fact that ovigerous females of *E. latreillii* carrying embryos in Stage III were smaller than those with less advanced eggs (Fig. 1). Moreover,

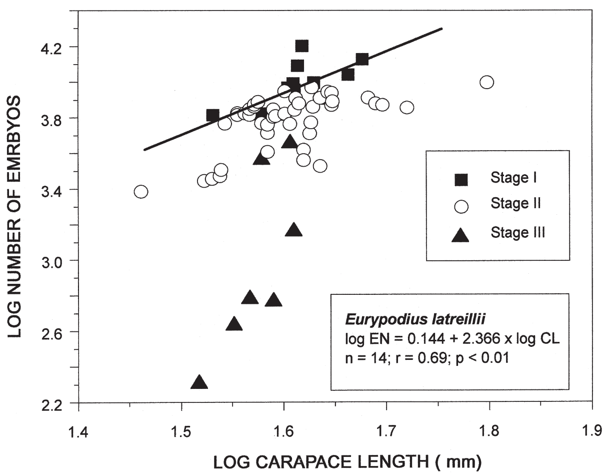

FIG. 1. – *Eurypodius latreillii*: relationship between maternal size (log CL) and clutch size (log egg number) for three embryonic stages. Equation with statistical values (n = number of observations) and regression line refer to the relation between log CL and recently spawned embryos (log egg number in Stage I).

mechanical abrasion during the trawling operation may have been more pronounced in females with eggs close to hatching because the funiculi have already been stretched out. Typically, egg volume increase compensates at least partially for the egg loss or vice versa (see Kuris, 1991). In the case of *E. latreillii*, embryos increase their volume during embryogenesis by 32% which is not sufficient to counter-balance the estimated brood mortality. As a consequence, our data revealed a clear reduction of

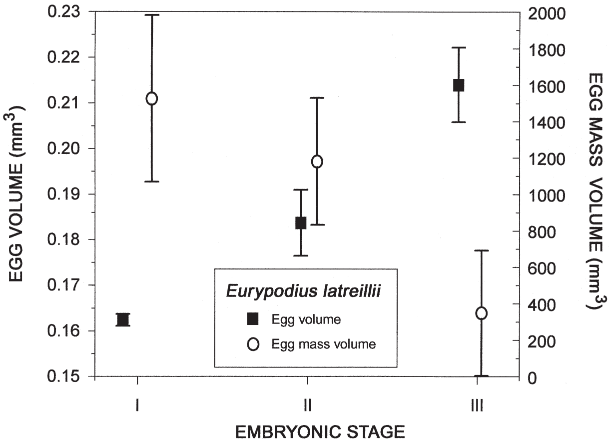

FIG. 2. – Development of egg volume (mean EV ± standard deviation) and egg mass volume (mean EMV ± standard deviation) during the incubation period of *Eurypodius latreillii*.

the EMV during the incubation period (Fig. 2). Thus, substantial brood loss in *E. latreillii* is suggested, but not necessarily proven.

E. latreillii invests 13 % of the female body mass in egg production, and this value coincides with the results of similar studies: among brachyuran crabs, reproductive investment comprises typically about 10% of the maternal body mass (e. g., Hines 1982, 1991), although some exceptions from this general trend have been documented (Hines, 1988, 1992). Compared to other decapods inhabiting temperate waters in the southern hemisphere, the RO of *E. latreillii* is considerably higher than that of the anomuran crab *Petrolisthes laevigatus* (see Lardies and Wehrtmann, 1996) and some caridean shrimp species (Lardies and Wehrtmann, 1997; Lardies, 1995; Wehrtmann and Andrade, in press; Wehrtmann, unpubl. data). However, there are clear indications that both caridean shrimps and anomuran crabs from central-southern Chile are able to produce at least two egg batches per year (Wehrtmann, unpubl. data). Other spider crab species compensate their relatively low egg output per clutch by a greater than average number of broods per year (Hines, 1982). Referring to *E. latreillii* from the Straits of Magellan, the breeding cycle is unknown and we thus do not know the number of broods per breeding season.

In conclusion, our data concerning egg production and reproductive output in *E. latreillii* inhabiting the waters of the southernmost tip of the Americas are in good agreement with those obtained from species living in temperate zones of the northern hemisphere. Perhaps the most striking result is the large egg size of *E. latreillii* compared to other majid crabs which may be interpreted as an indication for latitudinal gradients within the reproductive biology of spider crab species.

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