

# INTRODUCTION OF THE RED SWAMP CRAYFISH *PROCAMBARUS CLARKII* (CRUSTACEA, DECAPODA) IN SÃO MIGUEL, AZORES, PORTUGAL

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CORREIA, ALEXANDRA M. & ANA C. COSTA 1994. Introduction of the red swamp crayfish, *Procambarus clarkii* (Crustacea: Decapoda) in São Miguel, Azores, Portugal. *Arquipélago. Life and Marine Sciences* 12A:67-73. Ponta Delgada. ISSN 0870-6581.

This paper reports the presence of *Procambarus clarkii* in Lagoa do Peixe in the island of São Miguel (Azores, Portugal), due to introduction by man. Samples were taken for three consecutive days in order to obtain preliminary data on the population structure, length-weight relationships and mean size of sexual maturity. The population sampled (n=218) was composed of animals with carapace length (CL) ranging from 16 to 56 mm and approximately 60% of the population was immature. 55.8 % of the total (54 % of the males and 57.9 % of the females), were smaller than the minimal harvestable size of 35mm CL. Mean size (CL) of sexual maturity was 36.4 mm and 36.2mm for males and females respectively. The male/female sex-ratio was 1.04. Length/weight relationships showed a non-isometric growth for males plus mature and immature females. Further introduction of *P. clarkii* to other lakes should be prevented as they may constitute a threat to the freshwater ecosystem of the Azores.

CORREIA, ALEXANDRA M. & ANA C. COSTA 1994. Introdução do Lagostim vermelho da Louisiana *Procambarus clarkii* (Crustacea: Decapoda) em São Miguel, Azores, Portugal. *Arquipélago. Ciências Biológicas e Marinhas* 12A:69-75. Ponta Delgada. ISSN 0870-6581.

Este trabalho relata a introdução de *Procambarus clarkii* na Lagoa do Peixe na ilha de S.Miguel (Açores, Portugal). Durante três dias consecutivos fizeram-se amostragens no sentido de obter dados preliminares sobre a estrutura da população, relações comprimento-peso e tamanho médio de maturação sexual. A população estudada (n=218) era constituída por animais com um comprimento de carapaça (CL) entre 16 e 56 mm. 55.8% da população total, 54.1% dos machos e 54.1% das fêmeas eram menores do que o tamanho mínimo comercial. Cerca de 60% da população era constituída por indivíduos imaturos e 40% por maduros. O tamanho médio de maturação sexual era 36.4mm (CL) para os machos e 36.2mm (CL) para as fêmeas. O "sex-ratio" machos/fêmeas foi de 1.04. As relações comprimento-peso mostram um crescimento não isométrico para os machos e para as fêmeas maduras e imaturas. A introdução de *P. clarkii* noutros lagos deve ser evitada dado que esta espécie constitui uma ameaça para os ecossistemas duçaquícolas dos Açores.

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## INTRODUCTION

The introductions of exotic species often cause severe problems for native organisms and provoke irreversible alterations to natural ecosystems through competition with, and predation on such native fauna and flora. Such activities may result in displacement of indigenous species and cause shifts in species diversity. Furthermore, introduced species may be vectors of diseases, to which they themselves are immune, but may be highly detrimental to native species (UNESTAM 1975; HOLDICH 1987; THOMPSON 1990).

*Procambarus clarkii* (Girard, 1852) is native to southern USA and northeast of Mexico (PENN 1943), but has been widely introduced into other areas throughout the world including Central America, South America, Europe, Africa and Asia (HOBBS III et al. 1989). It has a great adaptive capacity, readily spreading and colonizing new environments (HOLDICH 1987; HOBBS III et al. 1989; LAURENT et al. 1991); and as an r-strategist (HOLDICH 1987), its control or eradication from areas where it has been introduced is almost impossible.

The negative impact of species introductions are often greater than the benefits.

Probably by accidental escape from Spanish aquaculture sites, *Procambarus clarkii* was introduced to mainland Portugal in the late 1970s (RAMOS & PEREIRA 1981). Suitable habitats, rapid populations growth and transplantation by man were responsible for its swift spread, mostly in marshes and rice fields (CORREIA 1993). Population structures and their reproductive conditions may be helpful in accessing the populations and predicting their harvestable potentials (MOMOT & ROMAIRE 1981).

The objective of this study was to obtain preliminary data on population structure, length/weight relationships and mean size of sexual maturity of the population.

### Site description

São Miguel, situated between 37° 42'N and 37° 55'N and 25° 08'W and 25° 52'W, is the largest

island of the Azores archipelago. As the Azores are of volcanic origin, São Miguel possesses several craters which are often filled with water and form most of the island's lakes. The meteorological conditions are determined by the subtropical Azorean anticyclone, resulting in monthly average air temperatures between 12°C and 23°C. As a result, water temperatures in São Miguel lakes are very stable.

Lagoa do Peixe (Fig. 1), the small circular lake where *Procambarus clarkii* was first observed in August 1993, is situated in the Serra Devassa, a hilly area in the western part of the island. The lake has an area of approximately 4060m<sup>2</sup> and its maximal depth is 1.5m. The substrate is mainly mud and while no aquatic plants are presently found, there is evidence to suggest the presence of *Potamogeton*, at some time in the past. Only one fish species, the cyprinid *Rutilus macrolepidoptus* is found in the lake. The shoreline is mainly pastureland, but there is a small plantation of Japanese-cedar, *Cryptomeria japonica*, on the western end of the lake.

## METHODS

Crayfish were captured with iron traps (42 cm x 22.5 cm), baited with sardines, during three consecutive days in September 1993. Five traps were set out (approximately equidistant from each other) along the perimeter of the lake in the littoral zone. The traps remained in place from nightfall to dawn during each 24-hour period, because crayfish are more active at night. On the first two days, all animals captured were marked and returned to the lake (51 and 76 respectively). On the third day all animals captured (92) were collected and taken to the laboratory.

Total length (TL, from tip of rostrum to tip of telson) and carapace length, from tip of rostrum to posterior margin of cephalothorax were measured to the nearest millimetre. The animals were weighed (WTW, wet weight only of animals with a complete set of chelae) to the nearest milligram. The animals were sexed and their maturation stage determined. Form I males were



Fig. 1 - Site location of the lake (S. Miguel island).

identified by the hooks on the ischia of the third and fourth pereopods (SUKÔ 1953, HOBBS, JR. 1974; 1989). Sexually mature females were distinguished by the presence of tan, brown and black eggs in the ovary (ROMAIRE & LUTZ 1989) and by the grooved annulus ventralis (HUNER & BARR 1991). Post-ovigerous females were also considered mature.

Length-weight relationships were determined according to the equation:  $W=aL^b$ , where  $W$  is the weight,  $L$  the total length,  $a$  and  $b$  are constants. These constants were obtained by the logarithmic transformation of the data using a GM Regression (RICKER 1973):  $\log W = \log a + b \log L$ . The value of the constant  $b$  will be 3 ( $b=3.0$ ) when growth is isometric (RICKER 1975).

## RESULTS

### Population structure

The carapace lengths (CL) of the crayfish sample studied ( $n=218$ ) ranged from 16 to 56 mm (Fig.2), and 70% of the individuals had carapace lengths between 32 and 39 mm. (Fig 2). The

modal classes were 38 mm CL for males ( $n=111$ ) and 37 mm CL for females ( $n= 107$ ) and 44% of the populatons had >35 mm, i.e. of harvestable size. However, mature individuals of both sexes had a mean carapace length (36.4 mm for males and 36.2 mm for females) that exceed the harvestable limit. The largest male captured was 56 mm CL while the largest females measured 41 mm CL.

The maturation stage of both sexes is shown in Fig. 3. Non reproducing males (Form II - FII) represented 64.9% of the male population and immature females represented 60% of the female population. Thus, in September 1993, approximately 60% of the population was immature and 40% was mature. The male/female sex-ratio was 1.04.

### Length-weight relationships

The regression analysis of  $TL/WTW$  relationships (Table I) showed a non-isometric growth ( $b>3.0$ ) for both sexes, whether mature or not, with the  $WTW$  increasing faster than the  $TL$ .

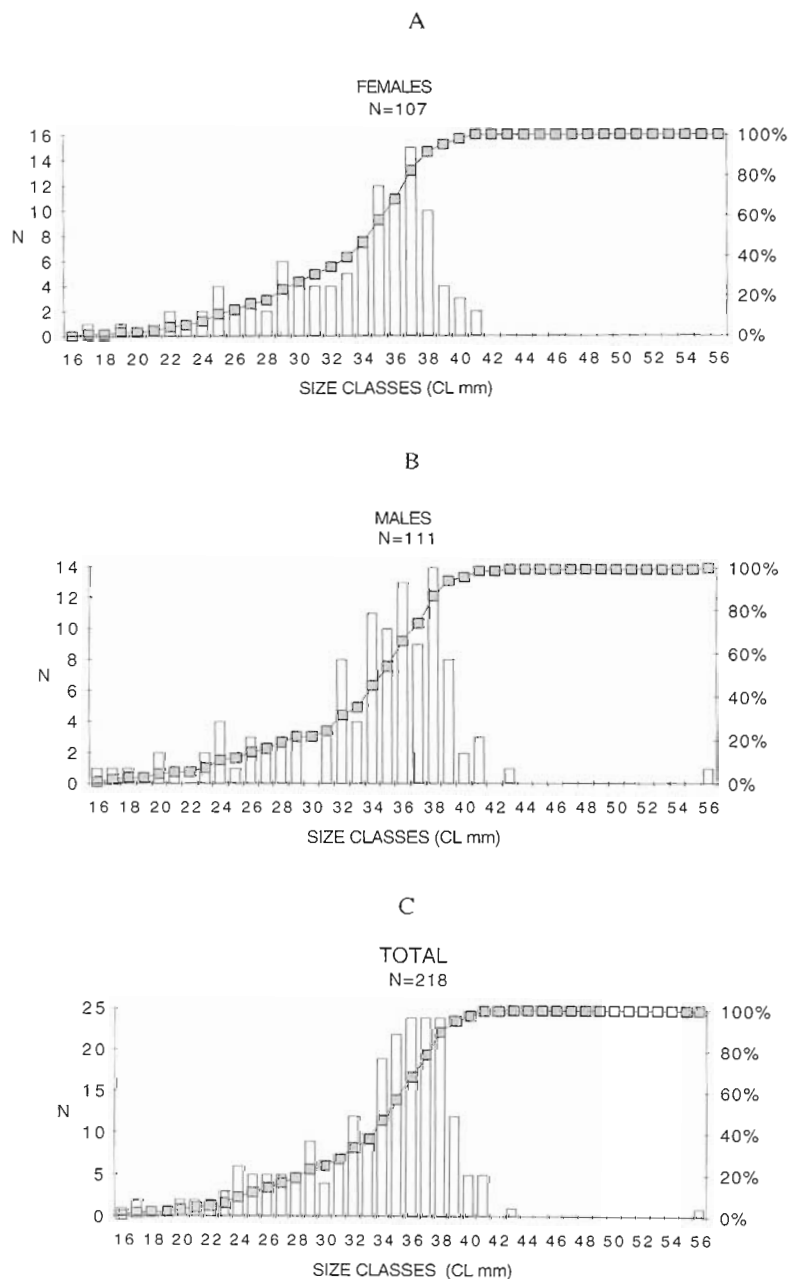


Fig. 2 - Size frequency histograms. A - Females; B - Males; C - Total.

### Mean size of sexual maturity .

Mean size of sexual maturity was 36.4 mm (CL)/ 72.7 mm (TL) for males and 36.2 mm (CL)/

72.7 mm (TL) for females (Table 2). The smallest mature male and females measured 31 mm (CL)/ 62 mm (TL) and 29 mm (CL)/58 mm (TL), respectively.

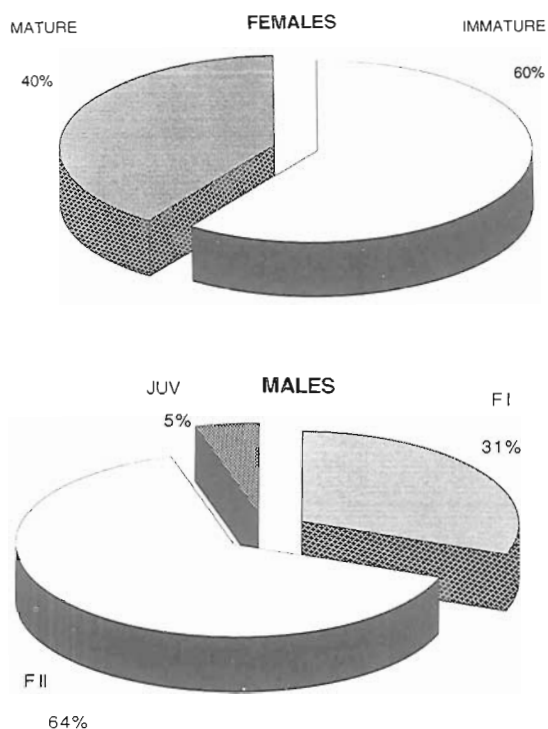


Fig. 3 - Maturation stage of female and male populations.

Table 1

Length-weight relationships in *Procambarus clarkii*.

	N	Equation	R <sup>2</sup>	SE
FI males	6	$\log W = \log 11.8 + 3.3 \log L$	0.865	0.0949
FII males	48	$\log W = \log 10.4 + 3.1 \log L$	0.973	0.0891
Mature Females	35	$\log W = \log 10.9 + 3.1 \log L$	0.896	0.0733
Immature Females	41	$\log W = \log 10.9 + 3.1 \log L$	0.971	0.0889

N= number of individuals; R<sup>2</sup>= determination coefficient ; SE= standard error.

Table 2

Mean size of sexual maturity (TL and CL) of *P. clarkii* in Lagoa do Peixe.

	N	TL (mm)	SD	Min (mm)	CL (mm)	SD	Min (mm)
Males	34	72.7	5.3	62	36.4	2.65	31
Females	42	72.7	5.0	58	36.2	2.41	29

N= number of individuals; TL= total length; CL= carapace length; SD= standard deviation; Min= minimum value.

## DISCUSSION

The size structure of a population is useful in predicting its stunting and harvestable potential (MOMOT & ROMAIRE 1981). Length-frequency histograms showed that 55.8 % of the total population (54.0 % of males and 57.9 % of females) were smaller than the minimal acceptable harvestable size of 35mm CL (ROMAIRE & LUTZ 1989). This may indicate the presence of a stunted population, and low yields might be expected if crayfish from this lake were taken for commercial purposes. However, a long term study is needed in order to clarify the reproductive strategy of this population and to support this statement.

The length-weight relationships analysis showed non-isometric growth for FI, FII males, mature and immature females. ROMAIRE et al. (1977) and CORREIA (1993a) reported similar results for Louisiana (USA) and Portuguese crayfish populations, respectively.

Mean size of sexual maturity is a good indicator of crayfish potential growth within a specific environment (HUNER 1975, 1978) and is important in assessing the effects of environmental conditions on natural populations (WENNER et al. 1974). Mature animals from favorable habitats are larger than those from habitats with high densities, reduced food availability, erratic water levels and poor water quality (HUNER & ROMAIRE 1978). The estimated mean size of sexual maturity (36.4 mm CL for males and 36.2 mm CL for females) was smaller

than that obtained by OLUOCH (1990) in Kenya and by CORREIA (in press) in mainland Portugal. These results are similar to those reported by HUNER & ROMAIRE (1978) in Louisiana natural areas (roadside ditches) and by SOMMER (1984) in California rice fields.

No marked animals were recaptured during the mark-recapture experiments, so we were not able to estimate the population density.

Although the study area was surveyed for burrow construction, no burrows were found at the time.

The results are preliminary and further studies should be carried out. The monitoring of the population development in the studied lake is important to determine the capacity for *P. clarkii* to establish in São Miguel. The topography of the island and its hydrographic characteristics do not seem propitious for the natural spreading of this species. However, human intervention may result in introduction of *P. clarkii* in other lakes and these should be sampled to determine its presence and thus its distribution in the island. Since no information on the effects of *P. clarkii* on the existent fauna and flora is available, it is recommended that transplantation of this species into other areas of the island or to other islands should be prevented. The introduction of this species in areas next to the taro (*Colocasia esculenta*) plantations should be avoided since the red swamp crayfish is known to do damage to these in Hawaii (UNESTAM 1975).

## ACKNOWLEDGEMENTS

We thank Prof. Vasco Garcia for inviting us to work on the subject of this paper. We thank Pedro Pereira for his field assistance and José Azevedo for his support. We also thank Dr. João Tavares and Dr. Ferraz de Carvalho for their readiness in granting us logistic support. Special thanks are due to Prof. Jeremy McNeal and Dr. Douglas Hunter for precious suggestions and corrections of the manuscript. The study was funded by Secretaria Regional de Habitação e Obras Públicas (Açores, Portugal) and by the Universidade dos Açores.

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Accepted 28 September 1994.

