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Crustaceana 85 (8) 1007-1011

CRUSTACEANA



## NOTES AND NEWS

### LAND CRABS (DECAPODA, BRACHYURA, GECARCINIDAE) ON ISABEL ISLAND, MEXICO, INCLUDING A NEW RECORD, AND ITS RELATION TO THE REMOVAL OF INVASIVE RATS

BY

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#### INTRODUCTION

Isabel Island, located in the mouth of the Gulf of California, Mexico, is a National Park. It supports a rich biodiversity and is internationally recognized as an important seabird breeding site (RAMSAR, 2011). Until 2008 two species of land crabs were common and widespread: the anomuran hermit crab *Coenobita compressus* (H. Milne Edwards, 1837) (cf. Guillén, 1992; Osorno et al., 1998) and the brachyuran red land crab *Johngarthia planata* (Stimpson, 1860) (cf. Rathbun, 1899; A. Samaniego, pers. obs.), the latter formerly referred to as *Gecarcinus planatus* before 2008 (Ng et al., 2008).

As part of a long term restoration project, a baseline monitoring including several species of vertebrates as well as land crabs began in 2007 aiming to (a) develop an eradication plan for the invasive ship rat *Rattus rattus* (Linnaeus, 1758) and (b) assess the status of the insular ecosystem in order to compare it with a later condition after the rat eradication. Species to be monitored were chosen based on potential vulnerability to rat presence (Townsend et al., 2006) and potential interference with eradication procedures (Wegmann, 2008; Varnham, 2010). Land crabs met both criteria. A successful rat eradication operation was conducted in May 2009 (Samaniego-Herrera et al., 2010); post-eradication monitoring of native fauna continued until September 2011. Here we update the list of land crabs for this island, include a new record, and describe changes in their population abundance regarding both, year seasonality and time after the eradication of an invasive predator, the ship rat.

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## MATERIAL AND METHODS

Two types of monitoring were applied to assess both diversity and abundance of land crabs: systematic and casual monitoring. In order to detect changes both were conducted before (April, July and November 2008; January and April 2009) and after (April and November 2010; April and September 2011) the rat eradication (May 2009). The systematic monitoring consisted of one 300 m × 6 m permanent plot in the middle of the native forest, walked for three consecutive nights during each month of monitoring. Density was recorded as the number of nocturnal surface-active brachyuran crabs per hectare. As land crab activity is minimal during the dry months, annual results were grouped into dry (January-May) and wet (June-December) seasons. Differences in abundance between the three wet seasons (November 2008, November 2010 and September 2011) and the two species recorded were compared by two-way ANOVA followed by Tukey's post hoc test.

The casual monitoring consisted of recording any land crab species not registered before 2007. In order to achieve the goals of the restoration project diverse activities were carried out at night all over the island, so observations were undertaken during any night work. A total of 89 nights of field work between 2007 and 2011 were accumulated.

## RESULTS AND DISCUSSION

Two brachyuran species were recorded, *Johngarthia planata* and *Gecarcinus quadratus* de Saussure, 1853. The latter represents a new record for the island; the former the first one published since 1899 (Rathbun, 1899) as it does not appear in any subsequent publication regarding either the distribution of the species or the biodiversity of Isabel Island (e.g. Canela, 1991; Hendrickx, 1995; CONANP, 2005). This increases the official list of land crabs on Isabel Island (CONANP, 2005) from one (*C. compressus*) to three species.

*G. quadratus* (one individual) was first recorded in July 2008 during the casual monitoring before the rat eradication. Despite efforts to locate more individuals in that and other subsequent field trips, success was not achieved until the casual monitoring in November 2010, coinciding with major ecological changes after 19 months of the rat eradication. This time 66 individuals, out of a larger group, were marked and released in an area of approx. 0.5 ha in the native forest. On the rest of the island the species was present but scarce and was not recorded during the systematic monitoring. By September 2011, 29 months after the rat eradication, *G. quadratus* was as commonly observed as *J. planata* over the island. The



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systematic monitoring resulted in an average of  $117 \pm 12.4$  individuals/ha for *G. quadratus*.

*J. planata* was abundant and widespread both before and after the rat eradication, always with high densities (individuals/ha) of active crabs during each wet season ( $147.8 \pm 34.6$  in 2008;  $73.4 \pm 6.9$  in 2010;  $230.2 \pm 19.1$  in 2011) and becoming scarce during the dry seasons ( $7.9 \pm 9.1$  in 2008;  $3 \pm 3.3$  in 2009; 0.0 in 2010 and 2011). The density of *J. planata* in 2011 was significantly higher than that of *G. quadratus* ( $F = 77.18$ ; d.f. = 1, 14;  $p < 0.001$ ;  $\alpha = 0.05$ ), and densities were significantly higher for 2011 compared to 2008 and 2010 ( $F = 39.31$ ; d.f. = 2, 14;  $p < 0.001$ ;  $\alpha = 0.05$ ).

We suggest that the main reasons for *G. quadratus* not having been recorded before are (1) the scarcity of terrestrial invertebrate studies and (2) the extremely low abundance of the population before the rat eradication in 2009. Ship rats were introduced at least as early as the beginning of the 1900s (Canela, 1991), so all ecological studies on the island have taken place on a rat-present situation. Because the pre rat eradication situation on Isabel Island is similar to the current one on other Mexican islands (Samaniego-Herrera et al., 2011), the existence of unrecorded populations of land crabs on tropical islands along both coasts of the country is a possibility.

The fact that *J. planata* was common and widespread even in the presence of rats, and that *G. quadratus* became ubiquitous just after the rat eradication, suggests that vulnerability to rat presence might be different for each brachyuran land crab species. It is possible that the smaller size of *G. quadratus* compared to *J. planata* made it more vulnerable to predation by rats. Differences in behavior or microhabitat preferences might also play a role, although no contrasting habits or responses have been observed on these populations. Both species are nocturnal, have been observed in the same areas in mixed groups, and typically respond defensively if disturbed.

Little has been documented regarding impacts of invasive rats on island invertebrates; land crabs being taken into account in just a few studies (St Clair, 2011). Accounts of insular land crab populations recovering after rat eradications include *Gecarcinus ruricola* (Linnaeus, 1758) on Sainte-Anne Islets, French West Indies (Towns et al., 2006) and Hardy Islet, Martinique (Lorvelec & Pascal, 2006), and *Geograpsus grayi* (H. Milne Edwards, 1853) and *Ocypode kuhlii* (De Haan, 1835) on Raoul Island, Kermadec Islands, New Zealand (Bellingham et al., 2010). We conclude that the increases in population abundance for both land crab species on Isabel Island, and especially the dramatic case of *G. quadratus*, strongly suggest that invasive ship rats were, either directly through predation or indirectly through resources competition, or both, negatively impacting these insular populations.

## ACKNOWLEDGEMENTS

The research presented here is part of the Isabel Island Restoration Project in which all our colleagues at Grupo de Ecología y Conservación de Islas, A.C. are involved. Several Mexican and international institutions provided financial support. The Direction of the Isabel Island National Park-CONANP facilitated several logistic aspects. We thank Dr. Michel E. Hendrickx and Dr. Francisco Correa Sandoval for identifying the specimens collected and for providing useful information and references. We also thank three anonymous reviewers for improving the manuscript. A. S.-H. thanks CONACyT for the doctoral scholarship and WWF for the EFN fellowship.

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