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Rapid Communication

Presence of the Australian redclaw crayfish *Cherax quadricarinatus* (von Martens, 1868) (Parastacidae, Astacoidea) in a freshwater system in the Caribbean drainage of Costa Rica

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Abstract

Cherax quadricarinatus (von Martens, 1868) was first introduced into Costa Rica during 1985. Currently there are aquaculture holding facilities for this species in the Costa Rican Pacific drainage. This study is the first to report the presence of *C. quadricarinatus* in natural freshwater systems at the Caribbean drainage of Costa Rica. This may has been the result of accidental releases of this non-native crayfish from holding facilities. Future surveys are needed to assess the effects of this crayfish on the freshwater systems of Costa Rica and its communities.

Key words: aquaculture, Central America, freshwater crayfish, introduced species, invasive population, Neotropic, non-native species

Introduction

Freshwater crayfishes represent more than 600 species naturally occurring worldwide except in continental Africa, the Indian-subcontinent and Antarctic, and every year more species are being described (Crandall and Buhay 2008; Loughman et al. 2017; Lukhaup et al. 2017; McCormack and Ahyong 2017; Schuster and Kendrick 2017). Crayfish species have been transported outside their natural range mainly through aquaculture and the pet trade, due to unintentional or deliberate releases (Belle et al. 2011; Lodge et al. 2012; Patoka et al. 2015). Some non-native crayfish have developed invasive populations that damage natural, agricultural and recreational freshwater structures and threaten native biodiversity (Lodge et al. 2012; Kouba et al. 2014; Souty-Grosset et al. 2016).

The Australian redclaw crayfish, *Cherax quadricarinatus* (von Martens, 1868), is native to northern Australia and south-eastern Papua New Guinea (Lawrence and Jones 2002). Due to its resistance to a variety of biotic and abiotic conditions this crayfish has been widely translocated for aquaculture and ornamental purposes (Lawrence and Jones 2002; Doupé et al. 2004; Belle et al. 2011). The species has been reported in many countries, such as South Africa, Swaziland, Italy, Israel, continental USA, Mexico, Ecuador, Puerto Rico, Argentina, New Caledonia, China, Taiwan, Japan, Malaysia, Singapore and Indonesia (Harlioğlu and Harlioğlu 2006; Ahyong and Yeo 2007; Bortolini et al. 2007; Belle and Yeo 2010; Snovsky and Galil 2011; Torres-Montoya et al. 2016; Patoka et al. 2016; Nunes et

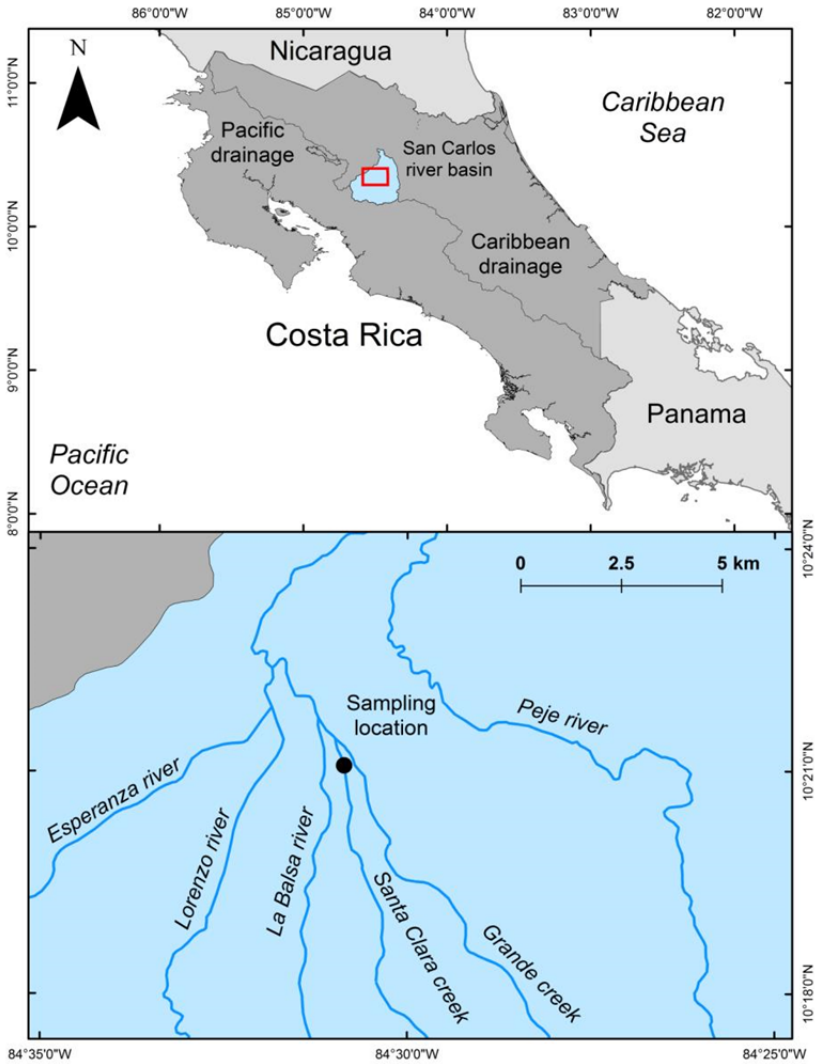

Figure 1. Sampling location (black dot) of *Cherax quadricarinatus*, at a tributary of the La Balsa River, Costa Rica. Source: Atlas Instituto Tecnológico de Costa Rica 2014.

al. 2017). Negative effects of *C. quadricarinatus* invasive populations may pose a threat by carrying viruses and parasites (Hauck et al. 2001; Bowater et al. 2002; Romero and Jimenez 2002) and probably causing food web impacts that may result in local disappearance of species (Beatty 2006; Bortolini et al. 2007; Ahyong and Yeo 2007; Belle and Yeo 2010).

Costa Rican freshwater native decapod fauna includes shrimps (Caridea: Palaemonidae and Atyidae) and crabs (Brachyura: Pseudothelphusidae) (Rólier-Lara and Wehrtmann 2011; Rólier-Lara et al. 2013; Magalhães et al. 2015). However, there are no records of Astacoid or Parastacoid crayfish naturally occurring in Costa Rica. There are currently two non-native crayfish species introduced into Costa Rica: the red swamp crayfish *Procambarus clarkii* (Girard, 1852) introduced in 1966 and presumably occurring in most Costa Rican regions (Huner 1977; Cabrera Peña 1994), and *C. quadricarinatus*, introduced in 1985 and present in the northwestern Pacific drainage (RL Lara pers. comm. in Wehrtmann et al. 2016; UTN 2016). The present study reports on the first record of *C. quadricarinatus* inhabiting a natural freshwater system on the Caribbean drainage of Costa Rica, with voucher specimens having been deposited at a museum.

Material and methods

Crayfish were manually collected in October 2016 from a small stream that flows westward through cattle farms and residential areas until reaching La Balsa river, San Carlos, Costa Rica (10º21′45.00N; 84º30′51.08W; Figure 1). Sampling was carried out during a nocturnal biological survey developed as a

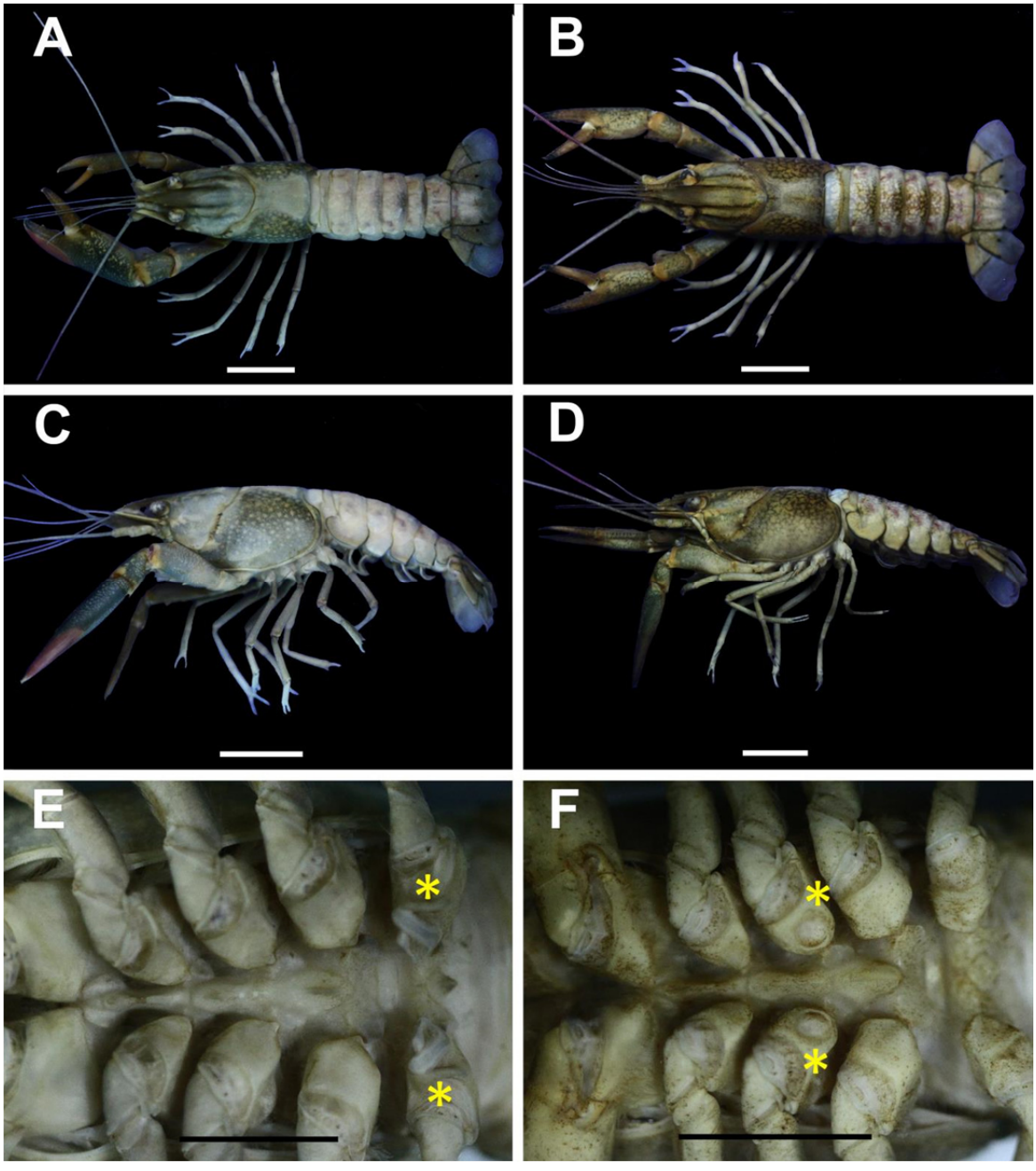

Figure 2. *Cherax quadricarinatus* specimens collected at La Balsa River, Costa Rica: **A**) Male and **B**) female dorsal view; **C**) Male and **D**) female lateral view; **E**) Male and **F**) female ventral view, depicting the gonopores (indicated by *) located on the coxal articles of the fifth and third pair of walking legs, respectively. Scale: 20 mm in **A**, **B**, **C** and **D**; 5 mm in **E** and **F**. Photographs by Juan Carlos Azofeifa Solano.

complementary activity for a course of Servicios y Actividades Ecoturísticas of Escuela Técnica Agrícola e Industrial (ETAI). Specimens were stored in 70% ethanol and identified according to Holthuis (1986). Total carapace length (distance from the distal part of the eye socket to the distal margin of the telson) was measured for each crayfish specimen. Voucher specimens were deposited at the crustacean collection of the Museum of Zoology, Universidad de Costa Rica (catalogue number: MZUCR 3503-1). Sampling was carried out with permission from SINAC-MINAET (No. 181-2016-SINAC).

Results

A total of 5 male and 2 female *C. quadricarinatus* (Figure 2A–F) were collected, with an average (± SD) total length of 64.9 ± 17.3 mm, ranging from 45.1 mm to 92.2 mm. The distal superior margin of the fixed finger of the claws is non-calcified in adult males, and bears a bright red to orange patch (Figure 2A, C). Although we did not estimate crayfish abundance, there were several more specimens in the sampled location, with both juveniles and adults present.

Discussion

A well-documented history of introductions suggests that public access to live crayfish and non-technical crayfish production often leads to releases or escapes into the wild (Lodge et al. 2012). It is likely that the presence of *C. quadricarinatus* in Costa Rican natural freshwater systems in the Pacific (RL Lara pers. comm. in Wehrtmann et al. 2016) and now in the Caribbean (present study) drainages may be the result of unintentional releases from holding facilities. Currently juveniles of *C. quadricarinatus* can be bought at aquaculture research facilities in Costa Rica, and there are training workshops for its production. Therefore, in addition to the high probability of escapes from holding facilities or deliberate releases, people's intention to benefit from this resource may lead to increased translocation to other rivers. A better control system for who is allowed to obtain crayfish juveniles and how to more safely breed this species for aquaculture must be implemented.

Crayfish aquaculture has been rising globally over the past 60 years (Crandall and Buhay 2008; Lodge et al. 2012). However, there is little information about the extent of crayfish production in Costa Rica, making it hard to fully understand the risk this might pose. Moreover, there are no studies on the ecology, distribution and possible impacts of either *P. clarkii*, or *C. quadricarinatus* populations in the region. Ecological niche modeling could predict the suitable environments that these crayfishes may invade (Palaoro et al. 2013), and help develop preventive measures against further colonization and spread. Since some crayfish species may survive in both freshwater and estuarine conditions (Vodovsky et al. 2017), future surveys considering these two habitats are urgently needed to understand the extent of crayfish presence and assess possible effects of their populations on the aquatic systems of Costa Rica and their native communities.

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