

*Short Communication*

**Wild populations of the invasive Australian red claw crayfish  
*Cherax quadricarinatus* (Crustacea, Decapoda) near the northern  
coast of Jalisco, Mexico: a new fishing and profitable resource**

**Fernando Vega-Villasante<sup>1</sup>, José J. Ávalos-Aguilar<sup>1</sup>, Héctor Nolasco-Soria<sup>2</sup>  
Manuel A. Vargas-Ceballos<sup>1</sup>, José L. Bortolini-Rosales<sup>3</sup>, Olimpia Chong-Carrillo<sup>1</sup>  
Martín F. Ruiz-Núñez<sup>1</sup> & Julio C. Morales-Hernández<sup>4</sup>**

<sup>1</sup>Laboratorio de Acuicultura Experimental, Centro de Investigaciones Costeras  
Universidad de Guadalajara, Puerto Vallarta, Jalisco, México

<sup>2</sup>Centro de Investigaciones Biológicas del Noroeste (CIBNOR), La Paz, Baja California Sur, México

<sup>3</sup>Departamento de Biología Comparada, Facultad de Ciencias

Universidad Nacional Autónoma de México (UNAM), México City, México

<sup>4</sup>Centro de Estudios Meteorológicos de la Costa, Centro Universitario de la Costa  
Universidad de Guadalajara, Guadalajara, México

Corresponding author: Héctor Nolasco-Soria (hnolasco2008@hotmail.com)

**ABSTRACT.** The red claw crayfish *Cherax quadricarinatus* is native to freshwater habitats of northern Australia and Papua New Guinea. Its high reproductive and adaptive capacity in different environments allows it to be cultivated, where escaped individuals have established wild populations in countries far from their natural range. In the late 90's and beginning of the 21st century, this crayfish was introduced illegally along the coast of southern Jalisco. Mismanagement led to escape and dispersion. Currently there are wild crayfish in the Cajón de Peñas Reservoir and surrounding streams in northern Jalisco, Mexico. The aim of this study was to evaluate the presence of *C. quadricarinatus* in fisheries in this area of Jalisco and analyze its importance in generating economic benefits for fishermen, comparing these results with those of the fishery for *M. americanum*, whose fishery is traditional. To catch specimens, traps were set for 24 h in the La Sanja Stream and the Cajón de Peñas Reservoir. The results of the survey showed that *C. quadricarinatus* is an important part of the crustacean catch in this area: 32% of the total catch in the stream corresponded to *C. quadricarinatus* and the rest to *M. americanum*. While 85% of the catch in the dam corresponded to *C. quadricarinatus*, only 15% referred to *M. americanum*. Crayfish fishing in the reservoir is now an important part of the productive activity of local families dependent on fishing. The ecological consequences of wild crayfish proliferation remain to be studied.

**Keywords:** *Cherax quadricarinatus*, crustacean, introduced species, invasion, fishery, Mexico.

**Poblaciones silvestres invasoras de langosta australiana de pinzas roja  
*Cherax quadricarinatus* (Crustacea, Decapoda) cerca de la costa norte de  
Jalisco, México: un nuevo y rentable recurso pesquero**

**RESUMEN.** La langosta australiana de agua dulce *Cherax quadricarinatus* es un crustáceo nativo de ríos del norte de Australia y Papua Nueva Guinea. Su alta capacidad de reproducción y adaptación a diferentes ambientes le ha permitido establecer poblaciones silvestres en países lejanos a su área de distribución natural. A fines de los años 90 y comienzo del año 2000, este crustáceo se introdujo ilegalmente a lo largo de la costa del sur de Jalisco, México. La mala gestión motivó la fuga y dispersión de este crustáceo. Actualmente, se encuentran ejemplares en el embalse Cajón de Peñas y arroyos circundantes en el norte de Jalisco. El objetivo de este estudio fue evaluar la presencia de *C. quadricarinatus* en las capturas realizadas en la zona de Jalisco, y analizar su importancia en la generación de beneficios económicos para los pescadores, en comparación con la pesquería de *M. americanum*, que es una actividad tradicional. Para la captura de los especímenes, las trampas se colocaron durante 24 h en el arroyo La Sanja y en el embalse Cajón de Peñas. Los resultados mostraron que esta especie

es parte importante de la captura de crustáceos en esta área. El 32% de la captura total en el arroyo correspondió a *C. quadricarinatus* y el resto a *M. americanum*. Mientras que el 85% de la captura en el embalse, correspondió a *C. quadricarinatus* y 15% a *M. americanum*. La pesca de esta langosta en el embalse es un componente importante de la actividad productiva para el sostenimiento de las familias locales. Sin embargo, no han sido aún investigadas las consecuencias ecológicas de su proliferación en los ríos y embalses de la región.

**Palabras clave:** *Cherax quadricarinatus*, crustáceo, especie introducida, invasión, pesquería, México.

The Australian red-claw crayfish *Cherax quadricarinatus* (Von Martens, 1868) is native to freshwater habitats of northern Australia and Papua New Guinea (Lawrence & Jones, 2002). The species is currently one of the most important commercially farmed freshwater crayfish in the world because it has many advantages, including omnivorous feeding behavior, fast growth, and easy cultivation (Bortolini *et al.*, 2007). This species is cultivated in New Caledonia, Africa, China, Taiwan, Japan, Malaysia, Israel, Italy, United States, Mexico, the Caribbean, Puerto Rico, Ecuador, and Argentina (Ahyong & Yeo, 2007).

The red clay crayfish is a highly invasive species due to its high reproductive capacity and to its ability to adapt to many environments, when it can escape from captivity. Wild populations have been reported from Jamaica, Mexico, Puerto Rico, Singapore, and South Africa (Ahyong & Yeo, 2007), Israel (Snovsky & Galil, 2011), and Slovenia (Jaklic & Vrezec, 2011). Taken into consideration its popularity in aquaculture, recreational activities, and ability to displace native species, *C. quadricarinatus* is of high concern regarding its potential to distribute globally (Harlioglu & Harlioglu, 2006). Bortolini *et al.* (2007) published the first report of wild populations in Mexico in the States of Tamaulipas and Morelos, where its cultivation is well-established. The species has been cultivated also in the states of Veracruz and Baja California Sur (INAPESCA, 2012, 2013). Although not officially cultivated in the State of Jalisco, inhabitants of the coastal zone mentioned that, starting in the late 90', some incipient farms were installed along the southern coast of Jalisco without official authorization. The interest in this crayfish by small aquaculture farmers led to a poorly planned and inadequately managed transfer of crayfish to other ponds. The poor management of the ponds favored the escape of *C. quadricarinatus* into natural and artificial freshwater bodies hundreds of miles north of the sites where they were originally introduced (García de Quevedo, *pers. comm.*). According to local fishers who traditionally exploited the native prawns, particularly *Macrobrachium americanum* (Bate, 1868), trapping red claw crayfish was a rare and sporadic event several years ago. During the past three years, however, catches of *C. quadricarinatus* increased progressively (Cajón de

Peña Fisheries Cooperative, *pers. comm.*). During our survey, red claw crayfish were caught in fishing traps in La Sanja, a local stream (20°00'N, 105°27'W) and in Cajón de Peñas (20°00'N, 105°06'W), a moderately large reservoir. Both sites are near the northern coast of Jalisco. Simultaneous capture of the native caucque river prawn *M. americanum* was also part of the survey to compare the relative abundance of the two species. The aim of this study was to evaluate the presence of *C. quadricarinatus* in fisheries in this area of Jalisco and analyze its importance in generating economic benefits for fishers, comparing these results with those of the traditional fishery for *M. americanum*.

*Cherax quadricarinatus* and *M. americanum* were collected at two sites near the town of Tomatlán, Jalisco: 1) La Sanja Stream: February 2014; traps were locally made from 20 L plastic buckets with conical inlets at the top, 2) Cajón de Peñas Reservoir: April 2014; traps (of cubic shape) were locally made from PVC pipes and covered with mesh with a conical entry on one side. Coconut pulp was used as bait in both locations.

Ten traps were placed at each site in the morning and removed 24 h later. In the stream and in the reservoir we performed trapping operations five times and three times on different days, respectively. The total number of crayfish per catch was counted and classified by sex and species. Using a Vernier caliper, the total length of crayfish and prawns was recorded (in cm) by measuring the distance from the tip of the rostrum to the extreme end of the telson. The weight was recorded (in g) with a digital field scale. Interviews with fishers from the local fishing cooperative provided information regarding the costs of fishing and sale prices of both species during the different fishing seasons.

In the stream, a total of 105 decapods were captured; 72 individuals of *M. americanum* (38 males and 34 females; mean weight of  $19.2 \pm 6.1$  g and mean length of  $9.8 \pm 2.2$  cm) and 33 of *C. quadricarinatus* (6 males and 27 females; mean weight of  $24.7 \pm 6.1$  g and mean length of  $9.6 \pm 2.5$  cm). Of the 34 specimens collected in the reservoir, five were *M. americanum* (5 males; mean weight of  $25.4 \text{ g} \pm 8.2$  and mean length of  $13.4 \text{ cm} \pm 4.5$ ) and 29 *C. quadricarinatus* (14 males and 15

**Table 1.** Crayfish fishery and its economic value in Cajón de Peñas Reservoir during low and high fishery seasons. \*Low season is from mid-November to June. \*\*High season is from October to early November, about 45 days. Price: US\$3.3 kg<sup>-1</sup>. Total corresponds to 40 fishermen.

	Daily catch (kg)	Monthly catch (kg)	Total catch (kg)	Sales profit per season (US\$)	Total annual sales (US\$)
Crayfish catch low season*					
Fisherman average	4	120	720	2,376.00	
Total	160	4,800	28,800	95,040.00	
Crayfish catch high season**					
Fisherman average	18	540	810	2,673.00	
Total	720	21,600	32,400	106,920.00	201,960.00

**Table 2.** Prawn fishery and its economic value in Cajón de Peñas Reservoir during low and high fishery seasons. \*Low season is from mid-November to June, \*\*High season is from October to early November, about 45 days. Price: US\$13.3 kg<sup>-1</sup>. Total corresponds to 40 fishermen.

	Daily catch (kg)	Monthly catch (kg)	Total catch (kg)	Sales profit per season (US\$)	Total annual sales (US\$)
Prawn catch during low season*					
Fisherman average	0.5	15	90	1,197.00	
Total	20	600	1,800	23,940.00	
Prawn catch during high season**					
Fisherman average	2.5	75	112.5	1,496.25	
Total	100	3,000	4,500	59,850.00	\$83,790.00

females; mean weight of 29.2 g ± 10.2 and mean length of 11.7 ± 2.9 cm).

The results confirm that wild populations of red claw crayfish represent a significant proportion of the freshwater decapod catch with high commercial value. There are obvious differences between the two surveyed sites: large populations of native caucue prawn are located in drainage channels because these shrimps require access to downstream estuaries to complete their reproductive cycles (Bauer, 2013). These well-established populations may favor the explosive expansion of the red claw crayfish, because at the reservoir caucue prawns depend on the annual arrival of juveniles migrating upstream from the estuaries. These migrations are difficult or nearly impossible without a channel to bypass the dam, which in this case is almost 70 m high (Rodríguez-Uribe *et al.*, 2014). In contrast, red claw crayfish can maintain stable populations or expand its territory because the species does not require migration to brackish water to complete its reproductive cycle (Ghanawi & Saoud, 2012). This situation may represent a possible threat to wild populations of caucue prawns in this reservoir, especially considering that both are benthic species and prefer places with shelters such as stones, galleries and

driftwood (Jones & Ruscoe, 2001; García-Guerrero & Apun-Molina, 2008).

Although the red claw crayfish is known to be invasive and a potential disruptor of the wetland systems when cultured outside their natural range, one Mexican government agency still includes it as a species with potential for commercial aquaculture (INAPESCA, 2013).

Ponce-Palafox *et al.* (1999) discussed the economic feasibility of raising red claw crayfish in Mexico, but also described the risks of accidentally or intentionally introducing the species into native ecosystems. FAO (2014) discussed technical and marketing aspects of the species cultivation, as well as its invasive character, its global spread for more than two decades, and that the impacts of dispersion have not been well studied. They concluded that these impacts are “despicable” without citing documented cases of significant ecological consequences, including displacement or competitive exclusion of native species. In contrast, another federal government agency from Mexico classified red claw crayfish as a “high risk species” that affects other species (CONABIO, 2013).

Fishing and marketing of the crayfish is an important economic activity at both sampling sites of

the present study. At the reservoir, there is an official fishing cooperative that keeps records of crayfish catches. The fishing records for crayfish are resumed in Table 1. During the low season (mid-November through June), fishers collected 4,800 kg per month (190,000-240,000 crayfish per month). During the high fishing season (October and early November; about 45 days), fishers obtained 32,400 kg (about 1,620,000 crayfish). The situation of the native prawn fishery in this reservoir is resumed in Table 2. During the low season (same as above) the fishers collected 600 kg per month (about 30,000 prawns per month). In the peak season, the fishers obtained 4,500 kg (225,000 prawns during the season). The total annual sales of the catch per year was US\$280,750 of which 70.7% came from the sale of red claw crayfish and 29.3% originated from the sale of native cauque prawns. In these calculations, the fishing season is nine months because July through September is an officially closed season for catching prawns of the genus *Macrobrachium*. Although the red claw crayfish is not covered by this prohibition, fishers are not allowed to place traps under penalty of prosecution.

In its 2011 report, INAPESCA considered 2010 as the year with a historical maximum aquaculture production of 15 ton of red claw crayfish in Mexico, while trapping of red claw crayfish in the reservoir was about 66 ton per year. For the stream location, there are no records available for comparison because these independent fishers do not report catches. Still, it is likely that fishing *C. quadricarinatus* in this stream provides significant economic benefits to the fishers because it has a large regional demand and attractive sale prices. The records of red claw crayfish in Mexican water bodies should be reviewed and updated by the government. Jalisco is not officially listed as a state producing red claw crayfish. Harvesting crayfish in reservoirs, streams, and irrigation channels is already an important activity and should be acknowledged and monitored by the government. Moreover, the ecological consequences of this invasive expansion should be thoroughly studied. While red claw crayfish aquaculture can positively contribute to the local economy, crayfish farming must be coupled with measurements to prevent dispersal and damage to the native ecosystems. This can only be achieved by concerted efforts in education and sharing scientific information and public cooperation (Peay, 2009).

#### ACKNOWLEDGEMENTS

We thank Ira Fogel of CIBNOR for providing important editorial services. Special thanks to Ingo Wehrmann for his kind edition of the manuscript, and

to anonymous referees of LAJAR for improving the quality of our work. The authors thank the fishermen of the Cajón de Peñas Fisheries Cooperative (particularly "Chendo") for the information provided. Also, we thank Rafael García de Quevedo for the oral transmission of the origins of this biological invasion in Jalisco.

#### REFERENCES

- Ahyong, S.T. & D.C.J. Yeo. 2007. Feral populations of the Australian red-claw crayfish (*Cherax quadricarinatus* Von Martens) in water supply catchments of Singapore. *Biol. Invas.*, 9: 943-946.
- Bauer, R.T. 2013. Amphidromy in shrimps: a life cycle between rivers and the sea. *Lat. Am. J. Aquat. Res.*, 41: 633-650.
- Bortolini, J.L., F. Alvarez & G. Rodríguez-Almaraz. 2007. On the presence of the Australian redclaw crayfish, *Cherax quadricarinatus*, in Mexico. *Biol. Invas.*, 9: 615-620.
- Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO). 2013. Anexo 1. Listado de especies a considerar para la convocatoria para elaborar diagnósticos sobre el estado de las invasiones biológicas de especies exóticas en algunos ecosistemas de México, ubicados dentro de áreas prioritarias para la conservación, 2013. [[http://www.conabio.gob.mx/institucion/proyectos/doctos/Anexo1\\_Especies\\_2013.pdf](http://www.conabio.gob.mx/institucion/proyectos/doctos/Anexo1_Especies_2013.pdf)]. Reviewed: 10 February 2014.
- Food and Agriculture Organization of the United Nations (FAO). 2014. *Cherax quadricarinatus* (Von Martens, 1868). Cultured Aquatic Species Information Programme. *Cherax quadricarinatus*. In: FAO Fisheries and Aquaculture Department Rome. [[http://www.fao.org/fishery/culturedspecies/Cherax\\_quadricarinatus/](http://www.fao.org/fishery/culturedspecies/Cherax_quadricarinatus/)]. Reviewed: 10 May 2014.
- García-Guerrero, M.U. & J.A. Apun-Molina. 2008. Density and shelter influence the adaptation of wild juvenile cauque prawns *Macrobrachium americanum* to culture conditions. *North Am. J. Aquacult.*, 70: 343-346.
- Ghanawi, J. & I.P. Saoud. 2012. Molting, reproductive biology, and hatchery management of redclaw crayfish *Cherax quadricarinatus* (Von Martens, 1868). *Aquaculture*, 358: 183-195.
- Harlioglu, M.M. & A.G. Harlioglu. 2006. Threat of non-native crayfish introductions into Turkey: global lessons. *Rev. Fish. Biol. Fish.*, 16: 171-181.
- Instituto Nacional de Pesca (INAPESCA). 2011. Carta Nacional Acuicola, Diario Oficial de la Federación, 31 de enero de 2011. Instituto Nacional de la Pesca, Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. Ciudad de México.

- [[http://www.inapesca.gob.mx/portal/documentos/publicaciones/2011/SAGARPA\\_CNA.pdf](http://www.inapesca.gob.mx/portal/documentos/publicaciones/2011/SAGARPA_CNA.pdf)] Reviewed: 10 December 2014.
- Instituto Nacional de Pesca (INAPESCA). 2012. Carta Nacional Acuícola, Diario Oficial de la Federación, 6 de junio de 2012. Instituto Nacional de la Pesca, Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. Ciudad de México. [[http://www.inapesca.gob.mx/portal/documentos/publicaciones/2011/SAGARPA\\_CNA.pdf](http://www.inapesca.gob.mx/portal/documentos/publicaciones/2011/SAGARPA_CNA.pdf)] Reviewed: 10 December 2014.
- Instituto Nacional de Pesca (INAPESCA). 2013. Actualización de la Carta Nacional Acuícola, Diario Oficial de la Federación, 9 de septiembre de 2013. Instituto Nacional de la Pesca, Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. Ciudad de México. [[http://www.inapesca.gob.mx/portal/documentos/publicaciones/2011/SAGARPA\\_CNA.pdf](http://www.inapesca.gob.mx/portal/documentos/publicaciones/2011/SAGARPA_CNA.pdf)] Reviewed: 10 December 2014.
- Jaklic, M. & A. Vrezec. 2011. The first tropical alien crayfish species in European waters: the redclaw *Cherax quadricarinatus* (Von Martens, 1868) (Decapoda: Parastacidae). *Crustaceana*, 84: 651-665.
- Jones, C.M. & I.M. Ruscoe. 2001. Assessment of five shelter types in the production of redclaw crayfish *Cherax quadricarinatus* (Decapoda: Parastacidae) under earthen pond conditions. *J. World Aquacult. Soc.*, 32: 41-52.
- Lawrence, C. & C. Jones. 2002. *Cherax*. In: D.M. Holdich (ed.). *Biology of freshwater crayfish*. Blackwell Science, Oxford, pp. 645-666.
- Peay, S. 2009. Invasive non-indigenous crayfish species in Europe: recommendations on managing them. *Knowl. Manage. Aquat. Ecosyst.*, 3: 294-395.
- Ponce-Palafox, J.T., J.L. Arredondo-Figueroa & X. Romero. 1999. Análisis del cultivo comercial de la langosta de agua dulce (*Cherax quadricarinatus*) y su posible impacto en América Latina. *Contactos*, 31: 54-61.
- Rodríguez-Urbe, M.C., F. Vega-Villasante, M. Guzmán-Arroyo & L.D. Espinosa. 2014. Efectos de una barrera antrópica sobre la migración río arriba del langostino anfídromo *Macrobrachium tenellum* (Smith, 1871) (Decapoda: Palaemonidae) en la costa del Pacífico mexicano. *Gayana*, 78: 10-20.
- Snovsky, G. & B.S. Galil. 2011. The Australian redclaw crayfish *Cherax quadricarinatus* (Von Martens, 1868) (Crustacea: Decapoda: Parastacidae) in the Sea of Galilee, Israel. *Aquat. Invas.*, 6(Suppl.1): 29-31.

*Received: 4 November 2014; Accepted: 27 May 2015*