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Distribution of *Chelus fimbriata* and *Chelus orinocensis* (Testudines: Chelidae)

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Abstract. – The matamatas (*Chelus fimbriata* and the recently described *Chelus orinocensis*) are the largest species in the family Chelidae, easily identified by their distinct morphological characteristics. The matamatas have a wide distribution in South America, occurring in Bolivia, Brazil, Colombia, Ecuador, Guyana, French Guiana, Peru, and Venezuela, as well as Trinidad and Tobago. However, there are many gaps in the knowledge of its distribution. The objective of this study was to present new records of occurrence for the *C. fimbriata* species complex and describe the area of distribution. We compiled data from published papers, databases in museums and other scientific collections, and research institutes and conservation organizations. From these data we mapped the species distribution, considering 3 types of river drainages based on water color in the Amazon Basin. We added 182 new records in Brazil, Venezuela, Colombia, Bolivia, and Peru, demonstrating that the *C. fimbriata* species complex has a wide distribution, totaling 6,907,551 km^2 across all 3 river types. Most records were concentrated in areas lower than 200 m above sea level.

Resumen. – As espécies do gênero *Chelus* (*Chelus fimbriata,* e mais recentemente descrita, *C. orinocensis*) são as maiores espécies da família Chelidae, facilmente reconhecidas por suas caraterísticas morfológicas, figuram entre as espécies exclusivamente carnívora. Tem ampla distribuição pela América do Sul, a saber: Bolívia, Brasil, Colômbia, Equador, Guiana, Guiana Francesa, Peru, Trinidade e Tobago e, Venezuela. Entretanto, existe muitas lacunas no conhecimento da sua distribuição. O objetivo do presente estudo é apresentar novos pontos de ocorrência para o complexo de espécies *C. fimbriata* e descrever sua área global de distribuição. Foram compilados dados da literatura científica, bem como base de dados de museus e coleções científicas, de institutos de pesquisa e organizações conservacionistas. Após essa etapa, foram mapeados os locais de ocorrência e distribuição do complexo de espécies nos três tipos de

ambientes fluviais para a bacia amazônica. No total, foram registradas 182 novas ocorrências no Brasil, Venezuela, Colômbia, Bolívia e Peru. O complexo de espécies de *C. fimbriata* tem uma ampla distribuição, totalizando 6.907.551 km^2. A maioria dos registros concentra-se em áreas com menos de 200 m de elevação.

KEY WORDS. – Chelidae; matamata; Amazon basin; Orinoco; natural history; river types; water color; species complex

Information about the natural history of some freshwater turtles is highly incomplete (Iverson 1992b; Moll and Moll 2004; Souza 2005; Bour 2008; Buhlmann et al. 2009). Chelidae is the largest family of turtles in South America, with at least 23 known species (Rueda-Almonacid et al. 2007; Páez et al. 2012). However, very little is known about aspects of the biology, basic ecology, and distribution of most species of this family (Souza 2004, 2005; Balestra et al. 2016). In particular, for species with wide distributions, such as *Chelus fimbriata* and *Chelus orinocensis*, these subjects must be evaluated across the geographic range because of possible geographic variation in biology, habitat preferences, and abundance (Stockwell and Peterson 2002). The only in-depth study on the reproduction of *Chelus* in nature is from Venezuela (Mendizábal and Correa-Viana 2015).

Knowledge of the distribution of a species, in turn, is a crucial element for assessing its threat category (Turtle Extinctions Working Group [TEWG] 2015) and for the definition of priority areas and conservation actions (Myers et al. 2000; Brooks et al. 2001; Thieme et al. 2007). Thus, documenting biological and ecological data for freshwater turtles is fundamental to evaluating their conservation status.

The Amazon basin is considered a biodiversity hotspot for freshwater turtles (Mittermeier et al. 2015). Due to its high endemism of turtles, it is considered a priority area for their conservation (Buhlmann et al. 2009). However, the Amazon has been undergoing constant changes in its landscape, including the loss of natural habitats due to deforestation, leading to severe environmental damage (Solar et al. 2015) and biodiversity loss (Fearnside 2005). Freshwater turtles are among the world's most threatened groups (Hoffmann et al. 2010; Rhodin et al. 2018; Turtle Conservation Coalition 2018), and two of the major factors that directly and indirectly affect chelonians negatively are the loss (Moll and Moll 2004; Rodrigues 2005) and the fragmentation of habitats (Reese and Welsh 1998). Knowledge about species distributions is crucial for their conservation and management (Vogt 1994), and the lack of such information and adequate spatial planning for conservation may increase the risk of extinction of many species of turtles (TEWG 2015).

The 2 species of matamata turtle, *C. fimbriata* and *C. orinocensis*, are the largest species of the family Chelidae, reaching 50 cm in carapace length (Pritchard 2008). They are easily recognized by their characteristic external morphology: triangular head, small eyes, long neck covered with many flaps of leaf-like skin, a long tubular nose, and slow movements. Vargas-Ramirez et al. (2020) split the Orinoco and Negro river populations into a new species, *C. orinocensis*. Although the species are very similar morphologically, genetically they are distinct and they are allopatric. *Chelus orinocensis* occurs in the Orinoco Basin and the upper Rio Negro (Amazon Basin) in northwestern South America, while *C. fimbriata* occurs in the remainder of the Amazon Basin. Neither species can be confused with any other turtle species in its region of occurrence, which reduces errors in describing the location that specimens were found.

Matamatas are among the few completely carnivorous turtles in the world, feeding predominately on live fish (Holmstrom 1978; Fachín-Terán et al. 1995; Vogt and Benitez 1997). They occur in a wide range of aquatic habitats, normally along the margins of rivers, lakes, or flooded forest, usually in water less than 1 m deep, but they will venture into deeper water and have been caught in trammel nets in rivers 3 m deep (Pritchard and Trebbau 1984; Pritchard 2008; Vogt 2008). They are most commonly found in shallow water where their nostrils can reach the surface to breathe without them having to leave the bottom (Vogt 2008; Morales-Betancourt and Lasso 2012). The preference for these habitat types could be related to their weak swimming ability (Pritchard and Trebbau 1984); they are more often seen walking along the bottom of water bodies rather than swimming (Pritchard 2008) and will drown if kept in water 2 m deep for a long time (F.A.G.C., unpubl. data, May 2015).

The matamatas are widely distributed in northern South America in Bolivia, Brazil, Colombia, Ecuador, Guyana, French Guiana, Peru, and Venezuela, as well as Trinidad and Tobago. Because they have been perceived to be common, localities across much of the composite range of the genus were generally left undocumented, resulting in large gaps in the published distribution maps of this species complex (Iverson 1992a; Souza 2004; Pritchard 2008, Turtle Taxonomy Working Group [TTWG] 2017). There are records of *Chelus* for the states of Beni, Pando, and Santa Cruz in Bolivia (TTWG 2017) and in Brazil from the states of Acre, Amapá, Amazonas, Goiás, Maranhão, Mato Grosso, Pará, Rondônia, Roraima, and Tocantins (Rueda-Almonacid et al. 2007; Pritchard 2008; Keller et al. 2016; Ferrara et al. 2017; TTWG 2017). In Colombia, there are records from the departments of Amazonas, Arauca, Caquetá, Casanare, Guainía, Guaviare,

Meta, Putumayo, Vaupés, and Vichada (Morales-Betancourt and Lasso 2012), and in Ecuador there are known localities in Província de Orellana (Cisneros-Heredia 2006). There are records in French Guiana from the territory of Saint-Laurent-du-Maroni (Le Gratiet 1989) and in Peru from Cusco, Madre de Dios (Catenazzi et al. 2013), Loreto, and Ucayali (TTWG 2017). In Venezuela, there are records from the states of Amazonas, Anzoátegui, Apure, Barinas, Bolívar, Cojedes, Delta Amacuro, Guárico, Monagas, Sucre, and Zulia (Mendizábal and Correa-Viana 2015; TTWG 2017).

Genetic and morphological examination in the new species description study (Vargas-Ramírez et al. 2020) demonstrated that *C. orinocensis* occurs in the following sites: Brazil: Amazonas State: Barcelos: Ariaú, Igarapé Babi (Negro River); Santa Isabel do Rio Negro: Igarapé Urupaú (Negro River); Roraima State: Boa Vista (Branco River). Colombia: Vichada Department: Puerto Carreño Municipality: Bojonawi Nature Reserve, Laguna El Peñuelo (Orinoco River); Bita River (tributary of the Orinoco River); Caño Juriepe (tributary of the Meta River). Cumaribo Municipality: Tomo River (tributary of the Orinoco River). Meta Department: La Macarena Municipality: Losada River, Guayabero River (tributaries of the Guaviare River). Arauca Department: Cravo Norte Municipality: Cravo Norte River; Cinaruquito. Arauca Department: Casanare River. Guayana: Essequibo River. Venezuela: La Unión (Orinoco River; Vargas-Ramírez et al. 2020). All other records we assume here as *C. fimbriata*. However, it is possible that most of the records from Venezuela may be *C. orinocensis*.

Specimens are rarely collected and deposited in museum collections because these turtles are large and cumbersome to collect and preserve. Also, because matamatas are common, people think it is not necessary to document new records. While many species of turtles are poorly studied due to their rarity (Smith et al. 2006), the difficulty in obtaining population data for *C. fimbriata* sensu lato, listed as Least Concern by the Tortoise and Freshwater Turtles Specialist Group and the International Union for Conservation of Nature (TFTSG/IUCN) (TTWG 2017; Rhodin et al. 2018), may be more related to its exceptional camouflage in natural environments than to low densities or rarity of the species itself (Pritchard 2008; Vogt 2008).

Because of this scenario, the objective of the present study was to identify new or overlooked occurrence records of the *C. fimbriata* complex and to map its extent of occurrence. Because the new species was only recently described, the database registers were previously all named as *C. fimbriata*. Thus, we can only indicate here the occurrence points from the localities analyzed in Vargas-Ramírez et al. (2020) as *C. orinocensis*. We hope that this study will stimulate the scientific community to contribute additional locality records and to distinguish more precisely the distribution of the 2 species.

METHODS

We compiled the known occurrence records of *Chelus* that are available in the published literature through 2018 in all databases available in the Web of Science (https://login.webofknowledge.com/) platform using as key words *Chelus fimbriata*. We also included online data provided by the EMYSystem Global Turtle Database (Iverson et al. 2003) and data from museum and scientific collections available online on Species Link (Centro de Referência em Informação Ambiental [CRIA] 2015).

To minimize problems caused by errors in georeferencing, we deleted occurrence records that were obviously erroneous, records with imprecise geographic coordinates, and generalized location descriptions. To update the occurrence localities of the species and its geographic range, we used data from scientific collections of Brazilian governmental agencies: Instituto Chico Mendes de Conservação da Biodiversidade/Centro Nacional de Pesquisa e Conservação de Répteis e Anfíbios (ICMBIO/RAN). Those data were extensively reviewed by the environmental agency prior to assessing the status of the species according to the criteria of the IUCN. We also utilized unpublished data provided by expert herpetologists from Brazil, Venezuela, and Colombia. The geographical coordinates of the new occurrence records were collected with global positioning system (GPS) technology from sites where turtles were captured during systematic studies or from opportunistic collections by experts of different countries within the distribution of the species in the Orinoco and Amazon basins. The polygon of the species complex's extent of occurrence was calculated based on the selection of basins level 5 from HydroSHEDS where the species was registered (Lehner and Grill 2013). The classification of the river types based on water color in the Amazon Basin (whitewater, blackwater, and clearwater) was developed by Venticinque et al. (2016). We used elevation data from the HYDRO 1k database derived from the United States Geological Survey's 30 arc-second digital elevation model of the world (GTOPO30). The maps were produced in ArcGIS 10.3 (Environmental Systems Research Institute [ESRI] 2015).

RESULTS

In our compilation of occurrence records, we registered 182 localities previously unknown for *Chelus* in 5 different countries. The number and percentage in each country is, respectively: Brazil 91 (49.9%), Colombia 45 (24.7%), Venezuela 44 (24.1%), Bolivia 1 (0.5%), and Peru 1 (0.5%; Fig. 1). The new distribution database increased the species extent of occurrence to 6,907,551 km^2. Thus, the genus has one of the largest distributions compared with other turtles that occur in the Amazon basin. The known range increased about 118 km to the west in Colombia and about 250 km to the east in Brazil. *Chelus* are found throughout the Amazon Basin in all river types considering water color (whitewater, blackwater, and

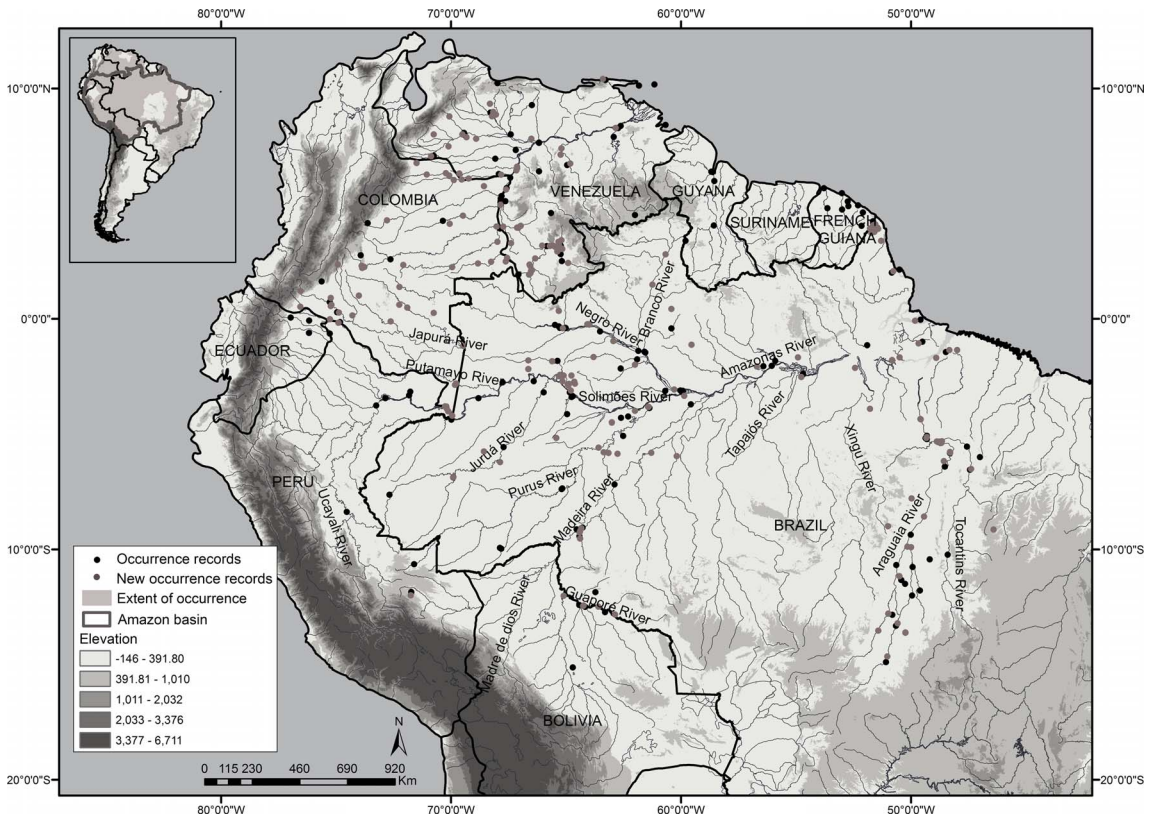

Figure 1. Map of the area of distribution and new localities for the *Chelus fimbriata* complex showing elevations where the species complex occurs in the Amazon and Orinoco river basins, respectively. Black dots show the occurrence records and gray dots show the new occurrence records.

clearwater), but primarily are recorded in whitewater systems (Fig. 1). The species occurs in areas of higher elevation in the Guiana Shield (up to 917 m); however, individuals have more frequently been found at altitudes lower than 200 m above sea level, with 89% of the known localities below that level (mean elevation of all records = 107 m). The highest altitude registered was in Venezuela (917 m) and the second-highest was in Colombia (660 m). This finding suggests that although *Chelus* are widely distributed, they are primarily restricted to low elevations. Most of the new occurrence records were from Brazil, including rivers of the southern part of the Amazon Basin: Juruá, lower Purus (southeast), Tapajós and lower Xingu (north), and Araguaia rivers (northeast). Only one locality was registered out of the Amazon Basin to the east. The previous known distribution area for Brazil was 2,890,848 km^2 for the genus and by adding these new occurrence records, the distribution area was increased to 3,790,347 km^2. The new locality records for both species are listed together in the online Supplemental File (available at http://dx.doi.org/10.2744/CCB-1398.1.s1).

In Venezuela, the species extent of occurrence increased from 178,310 to 680,732 km^2. Similarly, the distribution area of the species in Colombia increased considerably with the addition of our new records, increasing from 468,392 to 677,644 km^2, mainly due to the numerous localities in eastern and southeastern Colombia. Including the new occurrence records, the new distribution area is 768,661 km^2 in Bolivia and 690,735 km^2 in Peru. We did not register any new records in Ecuador (66,233 km^2), French Guiana (55,407 km^2), or Guyana (155,835 km^2; data from TTWG 2017). Lastly, although the literature indicated the presence of the species in Surinam, we did not find any vouchered occurrence record for this country (R. Mittermeier and A.G.J. Rhodin, *pers. comm* to R.C.V., December 2019).

Because a new species, *C. orinocensis*, was recently described as separate from *C. fimbriata*, we could not properly associate the registers from our database with the distribution of each species. However, based on Vargas-Ramírez et al. (2020), we can indicate that accounts of *Chelus* from Negro River, Branco River, Orinoco River; Bita River, Meta River, Losada River, Guayabero River, Guaviare River, Cravo Norte River, Casanare River, and Essequibo River are *C. orinocensis*, as indicated in Fig. 1. The other registers are treated as *C. fimbriata*.

DISCUSSION

Chelus fimbriata and *C. orinocensis* are widely distributed, occurring throughout and beyond the Amazon and Orinoco river basins. The occurrence records that we have compiled in this article are located in many of the gap areas previously apparent in distribution maps of the

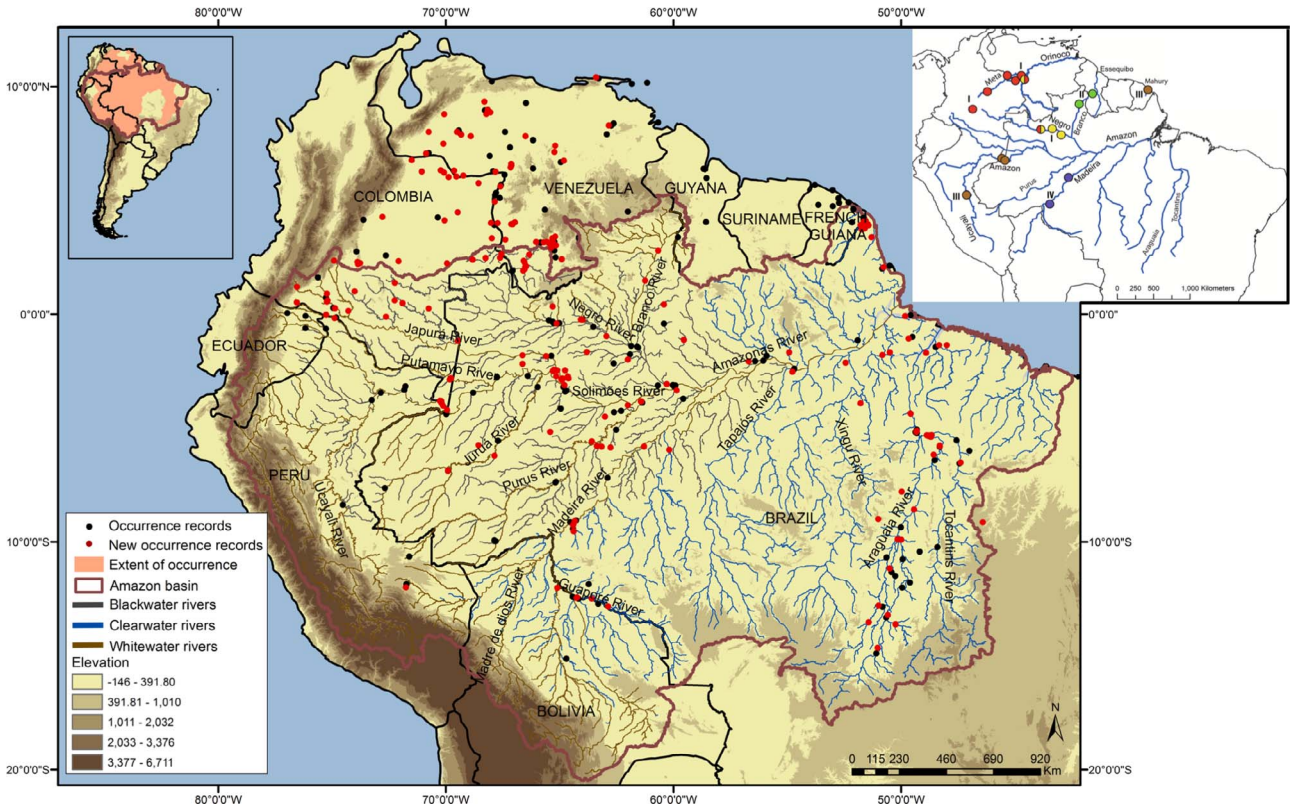

Figure 2. Map of the area of distribution and new localities for the *Chelus fimbriata* complex showing river types where the species occurs in the Amazon Basin and South America. Note in the upper right corner, the map by Vargas-Ramírez et al. (2020). It is possible to perceive the region of occurrence of *Chelus orinocensis* circles in red and yellow. (Color version is available online.)

species. We have increased the composite range of these 2 species from 6,117,760 km^2 (Santos and Blamires 2009) to 6,907,551 km^2. The widespread distribution of this species may be due to the fact that matamatas are a very ancient species that have been able to adapt and colonize regions with different environmental characteristics (Vargas-Ramírez et al. 2012). They tolerate a wide elevational gradient, occurring in different types of rivers (Fig. 2) and habitats, different currents, pH levels, and water temperatures (Pritchard and Trebbau 1984; Vogt 2008). However, matamatas are more common in some regions than in others, indicating that the species has some ecological preferences.

A large part of the distribution of matamatas is located in the sedimentary basin, at elevations below 200 m, in whitewater. Usually this river type has a slow current and high sediment load, which makes the water turbid. It is well known that matamatas prefer lakes and river areas that are shallower, without much current (Pritchard 2008), habitats that provide ideal conditions for their camouflage. Lakes with a high content of suspended sediment often have bottoms covered with a mixture of leaves, branches, and suspended particles (Lowe-McConnell 1999).

We lack natural history information for many species of freshwater turtles in South America. Here, we contribute to the knowledge of *C. fimbriata* complex distribution and hopefully will stimulate the scientific community to map additional locality records for the species to distinguish more precisely the distribution of the *C. fimbriata* and the newly described *C. orinocensis*. Future studies are needed to understand the ecological requirements of matamatas and their basic natural history. *Chelus orinocensis* has a much smaller distribution than *C. fimbriata* and it is collected for pet trade in Colombia and Venezuela. Thus, information about its distribution and exploitation should be gathered to understand its conservation status, as it is possible that the populations of this species are under substantial threat.

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