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Notas / *Notes*

New records of the Chinese turtles *Mauremys reevesii* (Gray, 1831) and *Mauremys sinensis* (Gray, 1834) (Testudines, Geoemydidae) in southern Spain

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ABSTRACT

The trade of freshwater turtles as pets and their eventual release or escape has led to new naturalized alien species that eventually form invasive populations in aquatic ecosystems. The import of alien *Mauremys* spp. species implies a new threat to the conservation of aquatic ecosystems, due to their ability to hybridise with the native species *Mauremys leprosa*. In this work, 16 new records of naturalised specimens of the Asian turtles *Mauremys reevesii* and *Mauremys sinensis* in Andalusia (southern Spain) are documented. Most of them (13) were found in artificial aquatic environments associated with urban areas, although the rest were found in protected natural areas sharing the habitat with natural populations of *M. leprosa*. These new records recreate the pattern of sale-release-naturalization-invasion that has already occurred with other alien turtle species. The number of alien *Mauremys* specimens imported into Spain (more than 100,000 since 2006) suggests that the current number of naturalised specimens could be much higher than reported in publications.

Keywords: pet trade; turtles; naturalisation; invasion; hybridisation.

RESUMEN

Nuevas citas de los galápagos chinos *Mauremys reevesii* (Gray, 1831) y *Mauremys sinensis* (Gray, 1834) (Testudines, Geoemydidae) en España

El comercio de quelonios acuáticos como animales de compañía y su eventual liberación o escape ha conllevado la detección de especies exóticas naturalizadas o formando poblaciones invasoras en ecosistemas acuáticos. La importación de *Mauremys* spp. exóticos implica una nueva amenaza para la conservación de los ecosistemas acuáticos, debido a su capacidad de hibridarse con la especie nativa *Mauremys leprosa*. En este trabajo se documentan 16 nuevos registros de ejemplares asilvestrados de los galápagos asiáticos *Mauremys reevesii* y *Mauremys sinensis* en Andalucía (sur de España). La mayor parte de ellos (13) corresponden a ambientes acuáticos artificiales asociados a áreas urbanas y el resto se encontraron en espacios naturales protegidos con poblaciones naturales de *M. leprosa*. Estas nuevas citas ponen de manifiesto que los nuevos taxones comercializados reproducen el patrón de venta-abandono-naturalización-invasión ya acaecido con otras especies exóticas de galápagos. El número de ejemplares de *Mauremys* exóticos importados en España (más de 100.000 desde 2006) sugiere que el número real de ejemplares asilvestrados podría ser bastante mayor al documentado en los trabajos publicados.

Palabras clave: comercio de mascotas; tortugas; naturalización; invasión; hibridación.

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The pet trade is one of the main introduction pathways of invasive alien species. Exotic freshwater turtles are a worldwide paradigm of invasion from imported pets that are later abandoned into aquatic ecosystems by their owners or escape confinement (Lockwood *et al*., 2019). In Spain, alien turtles outcompete the native endangered terrapins: the European pond turtle, *Emys orbicularis* (Linnaeus, 1758), and the Spanish terrapin, *Mauremys leprosa* (Schweigger, 1812)) (Polo-Cavia *et al*., 2010a, 2010b, 2011). The trade of red-eared slider *Trachemys scripta* subsp. *elegans* (Wied, 1838) was banned in Europe in 1997 following salmonellosis outbreaks in children and biodiversity concerns (Woodward *et al*., 1997). However, other freshwater turtle species such as *Chrysemys picta* (Schneider, 1783), *Graptemys* spp., *Macrochelys temminckii* Troost, 1835, alien *Mauremys* spp., *Pelomedusa subrufa* (Bonnaterre, 1789), *Pelusios* spp., or even a subspecies of the banned taxon (*Trachemys scripta* subsp. *scripta* (Thunberg, 1792)) have been imported into Spain (Cites Trade Database, 2020) although they may also be reservoirs of pathogens and invade aquatic ecosystems (e.g., Martínez-Silvestre *et al*., 2015; Sancho *et al*., 2015; Back *et al*., 2016). In 2013, the Spanish legislation (Royal Decree 613/2013) banned the trade of *Trachemys scripta* (Thunberg in Schoepff, 1792), *Chrysemys picta* and *Pseudemys peninsularis* Carr, 1938. Three years later, the list of invasive alien species of Union concern also banned *Trachemys scripta* according to the Commission implementing regulation 2016/1141. Despite these regulation advances, many unbanned pond turtle species have been imported in the last two decades, including some dangerous species such as the snapping turtle *Chelydra serpentina* (Linnaeus, 1758) (Cites Trade Database, 2020). To date, up to 21 freshwater alien chelonian taxa have been reported in Spanish natural, seminatural or artificial wetlands: *Apalone ferox* (Schneider, 1783), *Chrysemys picta, Chelydra serpentina, Graptemys ouachitensis* (Cagle, 1953), *Graptemys pseudogeographica* (Gray, 1831), *Macrochelys temminckii, Mauremys mutica* (Cantor, 1842), *Mauremys reevesii* (Gray, 1831), *Mauremys sinensis* (Gray, 1834), *Pseudemys concinna* (Le Conte, 1830), *Pseudemys nelsoni* Carr, 1938, *Pseudemys rubriventris* (Le Conte, 1830), *Pelodiscus sinensis* (Wiegmann, 1835), *Pelomedusa subrufa, Trachemys decussata* (Gray, 1831), *Trachemys emolli* (Legler, 1990), *Trachemys ornata* (Gray, 1831), *Trachemys scripta* subsp. *elegans*, *Trachemys scripta* subsp. *scripta, Trachemys scripta elegans x Trachemys scripta scripta*, and *Trachemys scripta* subsp. *troostii* (Holbrook, 1836) (Mateo *et al*., 2011; Balmori, 2014 and references therein; Campos-Such *et al*., 2015; Cruz *et al*., 2015; Martínez-Silvestre *et al*., 2015; Poch *et al*., 2020).

The case of alien taxa of the genus *Mauremys* is of particular concern due to their ability to hybridise with the native species *Mauremys leprosa* (Nickl, 2015; Sancho *et al*., 2020). Between 2006 and 2019, 55,825 live individuals of Reeves' pond turtle *Mauremys reevesii* and 45,320 live individuals of the Chinese stripe-necked turtle *Mauremys sinensis* have been imported into Spain, mainly from China, Hong Kong, Taiwan and Japan (Cites Trade Database, 2020). Although these species have been imported more recently and in much smaller quantities than *Trachemys scripta elegans* (up to 900,068 individuals until the year 2000; Cites Trade Database, 2020), their eventual release into the natural environment represents a conservation concern, particularly for the native *Mauremys leprosa*. Until now, the presence of naturalised specimens of *M. sinensis* was documented in the regions of Valencia and Catalonia (Campos-Such *et al*., 2015; Martínez-Silvestre *et al*., 2015, 2019), whereas *M. reevesii* was cited in Galicia (Ayres, 2016) and Catalonia (Poch *et al*., 2020).

Considering that early detection is an essential tool for efficient management, new citations of *Mauremys reevesii* and *Mauremys sinensis* from southern Spain were compiled from different sources (mainly naturalists, amateurs or nature managers) between 2009 and 2020. All records were georeferenced, using the UTM projection and the ETRS1989 reference system, in extended zone 30, in accordance with European standards. Only those citations that could be validated through photographs or captured specimens were included. In total, 15 new validated records were collected: seven records corresponded to *M. reevesii* and eight records to *M. sinensis* (Table 1; Fig. 1). All *M. reevesii* records showed the characteristic yellowish striping and blotching extending down the neck from the snout, whereas *M. sinensis* showed the characteristic parallel, narrow yellow stripes on their heads, necks and parts of their legs (Fig. 1).

In sum, the new records included five of the eight provinces of Andalusia. Most of them (12/15) were found in artificial lakes, while the rest were found in protected areas (the 'Arroyo Negro' and 'Laguna del Portil' natural reserves), sharing the habitat with natural populations of *M. leprosa*. All locations were adjacent to urban centres, which may favour the reception of abandoned pets. Both species constitute new records to Andalusia.

The results suggest that the introduction of *Mauremys reevesii* and *M. sinensis* is not an anecdotal fact, but rather reproduces the 'sale-release-naturalisation-invasion' process that has already occurred with other exotic freshwater turtles marketed as pets and other regions (Sancho & Lacomba, 2016; Poch *et al*., 2020). There are several limitations for a new record to be reported: (i) the taxon must 'cross' a person's view or be captured, and detectability decreases at low population size (Metha *et al*., 2007). In fact, the *M. sinensis* specimen found at 'Laguna del Portil' Natural Reserve was captured after six days of an alien turtle control campaign that used six baited fyke

nets per day (lake surface = 12 ha). (ii) The taxon must be differentiated from a native taxon and be correctly identified. For this purpose, a high-quality picture or a captured specimen is needed, as well as certain expertise. (iii) The new record must be published. As a consequence, the current abundance of alien *Mauremys* spp. in the field may be much higher than documented in publications (García-de-Lomas *et al*., 2016; Vall-llosera & Cassey, 2017). Therefore, further surveillance of aquatic ecosystems is recommended to detect the presence of alien *Mauremys* species early and to implement rapid response actions.

Moreover, the increasing records of alien *Mauremys* spp. in Spain provides further evidence that all the turtle

Fig. 1.— Specimens of *Mauremys reevesii* observed in Málaga (left) and *Mauremys sinensis* found in Laguna del Portil Natural Reserve, Huelva (right). Photos by Juan Pablo González de la Vega©.

Fig. 1.— Ejemplares de *Mauremys reevesii* observados en Málaga (izquierda) y *Mauremys sinensis* encontrado en la Reserva Natural Laguna del Portil, Huelva (derecha). Fotos de Juan Pablo González de la Vega©.

Table 1.— New records of *Mauremys reevesii* and *Mauremys sinensis* in Andalucía (southern Spain). All records corresponded to adult specimens. Coordinates are indicated in UTM projection, datum ETRS1989, zone 30, according to European standards.

Tabla 1.— Nuevas citas de *Mauremys reevesii* y *Mauremys sinensis* en Andalucía (sur de España). Todos los registros correspondieron a ejemplares adultos. Las coordenadas se indican en la proyección UTM, datum ETRS1989, zona 30, conforme a los estándares europeos.

Species	Date	UTM X	UTM Y	Altitude (m)	Locality, Province	Habitat type	Source (observer)
Mauremys reevesii	08/06/2020	290484	4008421	2	Arroyo Negro Natural Microreserve, La Línea de la Concepción, Cádiz	Natural	Cerpa-González, R.M.
Mauremys reevesii	11/03/2020	368539	4064327	45	Botanic Garden, University of Málaga	Artificial	Fernández-Meléndez, E.
Mauremys reevesii	05/05/2018	363185	4050784	20	'La Paloma' garden, Benalmádena, Málaga	Artificial	González-de-la-Vega, J.P.
Mauremys reevesii	12/11/2019	373292	4064806	13	Garden beside the Cathedral, Málaga	Artificial	González-de-la-Vega, J.P.
Mauremys reevesii	30/09/2019	443450	4105640	779	'Parque de la Estación', Otura, Granada	Artificial	Marín-Escribano, J.M.
Mauremys reevesii	18/08/2017	445899	4113838	660	'Parque Federico García Lorca', Granada	Artificial	Fernández-Cardenete, J.R.
Mauremys reevesii	07/05/2017	363672	4052553	96	Garden at 'Altos del Olivar' urbanisation, Torremolinos, Málaga	Artificial	González-de-la-Vega, J.P.
Mauremys sinensis	20/06/2019	234901	4145340	5	'Parque del Alamillo', Sevilla	Artificial	Verdejo-Díaz, P.A.
Mauremys sinensis	01/10/2020	141119	4126066	6	'Laguna del Portil' Natural Reserve, Punta Umbría, Huelva	Natural	Rodríguez-Andrés, J.L.
Mauremys sinensis	30/10/2020	445899	4113838	660	'Parque Federico García Lorca', Granada	Artificial	Luna-Fernández, A.
Mauremys sinensis	05/06/2019	151751	4124665	15	Botanic Garden 'José Celestino Mutis', Palos de la Frontera, Huelva	Artificial	Bonaño-Quiñones, L.
Mauremys sinensis	22/02/2009	141180	4125741	5	Open land beside 'Laguna del Portil' Natural Reserve, Punta Umbría, Huelva	Natural	González-de-la-Vega, J.P.
Mauremys sinensis	19/06/2016	363185	4050784	20	'La Paloma' garden, Benalmádena, Málaga	Artificial	González-de-la-Vega, J.P.
Mauremys sinensis	11/06/2019	237678	4144578	8	'Miraflores' garden, Sevilla	Artificial	Verdejo-Díaz, P.A.
Mauremys sinensis	05/10/2017	308951	4074854	602	Garden in Arriate, Málaga	Artificial	Melgar-Gómez, R.

taxa marketed as pets are prone to be released and become a conservation threat. This fact suggests that banning particular species in the form of 'blacklists', far from solving the problem, may favour the trade of unbanned species (García-de-Lomas & Vilà, 2015). Thus, banning the movement and sale of all freshwater alien turtles apart from specifically permitted non-invasive, non-harmful species (in the form of a 'white' list) could help reverse the current trend of naturalisation and invasion.

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