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REPTILES OF BANCO CHINCHORRO: UPDATED LIST, LIFE HISTORY DATA, AND CONSERVATION

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Abstract—One of the most useful strategies for biological conservation is the creation of protected natural areas. In addition, periodic updates of management plans are necessary to modify or improve the information and make it accessible to future research. Banco Chinchorro Biosphere Reserve is a protected atoll situated 31 km eastward from the southern coast of Quintana Roo, Mexico. A management plan published in 2000 contains a list of reptiles inhabiting the four islands of the atoll, but concerns about errors contained on the list necessitated updates and corrections. Herein, we clarify and update this list and present new life-history data for some species. We used four approaches to improve the list: interviews with staff, fishermen, and professional visitors; literature review; scientific collections; and field work conducted from 2011 to 2013. Thirteen species (1 crocodilian, 4 marine turtles, 2 iguanas, 2 geckos, 2 anoles, 1 whiptail lizard, and 1 snake) were observed in comparison to 14 species previously recorded in the management plan. Of the 13 species currently noted, 9 (69%) species appear in the International Union for Conservation of Nature Red List (7 with a threatened status), 7 (54%) are in Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendices, and 9 (69%) are protected by Mexican law. One invasive species (*Anolis sagrei*) seems to have adapted and found its niche; whereas another (*Hemidactylus frenatus*) represents a threat for another species (*Aristelliger georgensis*), and efforts to eradicate it are strongly recommended. Banco Chinchorro is the only site in Mexico where *Anolis allisoni* is present. It also hosts the most distant and isolated population of the parthenogenetic lizard *Aspidoscelis maslini* from the mainland. After this study, we promoted the inclusion of both species in the Mexican protected species list based on ecological and distribution information. Finally, we discuss considering the reptiles of the reserve as Evolutionarily Significant Units.

Resumen—Una de las estrategias más utilizadas en la conservación biológica es la creación de áreas naturales protegidas. Adicionalmente, las actualizaciones periódicas de los planes de manejo son necesarias para determinar modificaciones o mejorar la información para que esté disponible para futuras investigaciones. La Reserva de la Biosfera Banco Chinchorro es un atolón protegido localizado a 31 km al este de la costa sur de Quintana Roo, México. El plan de manejo publicado en el año 2000 presenta una lista de los reptiles que habitan las cuatro islas del atolón; sin embargo, esta lista presenta errores, por lo que es necesario corregirla y actualizarla. En este estudio rectificamos y actualizamos la lista y presentamos datos nuevos sobre la historia de vida de algunas de las especies. Utilizamos cuatro métodos para actualizar la lista; entrevistas con los empleados de la reserva, pescadores y visitantes profesionales, revisión de la literatura, colecciones científicas y trabajo de campo realizado de 2011 a 2013. Trece especies (un cocodrilo, cuatro tortugas marinas, dos iguanas, dos geckos, dos anolis, una lagartija cola de látigo y una serpiente) fueron observadas, comparadas con las 14 especies previamente registradas en el plan de manejo. De las 13 especies actualmente registradas, nueve (69%) se encuentran en la lista roja de la International Union for Conservation of Nature (de las cuales siete presentan un estatus de amenazada), siete (54%) en el apéndice de la Convention on International Trade in Endangered Species of Wild Fauna and Flora y nueve (69%)están protegidas por las leyes mexicanas. Una especie invasora al parecer encontró su nicho ecológico y se ha adaptado (*Anolis sagrei*), mientras que otra especie (*Hemidactylus frenatus*) representa un peligro para otra especie (*Aristelliger georgensis*), por lo que se recomienda considerar esfuerzos para su erradicación. Banco Chinchorro es el único lugar de México donde

habita *Anolis allisoni*. Además, alberga a la población más distante y aislada del continente de la lagartija partenogenética *Aspidoscelis maslini*. Después de este estudio, con base en la información ecológica y de distribución, se promovió la inclusión de ambas especies en la lista de especies mexicanas protegidas. Finalmente discutimos la consideración de los reptiles de la reserva como Unidades con Significado Evolutivo.

Since 2000, the number of species at risk of extinction has risen all over the world (Myers et al., 2000). Pollution, climate change, deforestation, exotic species, and modification of the environment are the principal causes of biodiversity decline (Global Environment Outlook 5, 2012). One of the principal strategies of biodiversity conservation is the creation of Natural Protected Areas (NPA) that the International Union for Conservation of Nature (IUCN, http://www.iucn.org/) define as a "clearly geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values." These NPAs permit conservation of the entire habitat, the ecological structure, and many species that inhabit the area. It has been calculated that the global network of NPAs stores $\geq$15% of terrestrial carbon (IUCN, http://www.iucn.org/). Nevertheless, the functions of an NPA depend on different characteristics such as the size and management strategy employed on the NPA itself, as well as the surrounding landscape. However, NPAs are not exempt from problems similar to those experienced in nonprotected areas, where many social and political problems (such as deforestation, habitat fragmentation, pollution, invasive species, and hunting) may be present (Figueroa and Sánchez-Cordero, 2008). These different factors could eventually affect the viability of the NPA. For that reason some theories of NPA management suggest integration of the natural area with human populations to maintain economic income and protect biodiversity (Lane, 2001) in hopes of avoiding illegal activities such as deforestation and hunting.

Biodiversity decline is a priority to both biology and the economy; some groups of organisms are used as bio-indicators to determine the effects of climate change and habitat loss on species survival and also to model the future consequences on the ecological dynamic (Gibbons et al., 2000). Some of the bio-indicators selected are ectothermic organisms (reptiles, amphibians, fish, and insects) because their dependence on climatic factors, such as temperature and humidity, make them adequate models (Gibbons et al., 2000; Bickford et al., 2010). A recent study by Sinervo et al. (2010) predicts a massive decline of reptiles due to climate change over the next 65 years. Based on the thermal requirements of reptiles, it was determined that the most affected lizard species would be those inhabiting the warmest areas of the tropics (Huey et al., 2009; Sinervo et al., 2010). This hypothesis was based on the local extinction of Mexican lizards in the Yucatan Peninsula and promotes the study of their physiological requirements (i.e., temperature), to determine their vulnerability to climate change (Sinervo et al., 2010). However, basic information (ecological and physiological) on species inhabiting the Yucatan Peninsula is scarce (Charruau et al., 2015).

Nevertheless, Mexico has the most significant herpetofaunal diversity and endemism in Mesoamerica with 864 species of reptiles, representing 75% of Mesoamerican reptiles (1,148 species [Wilson and Johnson, 2010; Wilson et al., 2013; Flores-Villela and García-Vázquez, 2014]). However, according to Wilson et al. (2013), this diversity is affected by deforestation (260,000 ha/year), which is one of the most determining factors in the decline of reptile biodiversity and justifies the importance of NPAs in biodiversity conservation. In Mexico, there are 176 NPAs covering >25,000,000 ha or 12% nationwide; whereas, 16 federal and 8 state reserves are located on the Caribbean coast of Quintana Roo, of which only 2 are categorized as Biosphere Reserve (Comisión Nacional de Áreas Naturales Protegidas http://www.conanp.gob.mx/). Conversely, island populations should be given special consideration for protection because most have little to no genetic flow with continental populations (Murphy and Méndez-de la Cruz, 2010). Additionally, island populations suffer different ecological and evolutionary pressures that promotes morphological, physiological, and behavioral differences from continental populations (Losos et al., 1997; Díaz de la Vega-Pérez et al., 2013; Siliceo-Cantero and García, 2014).

The Banco Chinchorro Biosphere Reserve (Banco Chinchorro BR), is an atoll located in the Caribbean region of Mexico 31 km from the southern coast of Quintana Roo (Fig. 1). The atoll has an important economic value for commerce and tourism; for example, Banco Chinchorro BR has been an important source of spiny lobster (*Panulirus argus*), queen conch (*Strombus gigas*) and commercially valuable fish species for >50 years (Miller, 1982; Aguilar-Perera and Aguilar-Dávila, 1993; Instituto Nacional de Ecología [INE], 2000; Hernández et al., 2008). Tourism has increased in recent years, particularly for diving to see the impressively well-preserved reef structures and numerous culturally relevant ancient and modern shipwrecks found within the reserve (INE, 2000; Ardisson et al., 2011). Furthermore, isolation, traditional fishing methods, and the biosphere reserve status of the atoll have permitted the conservation of its ecosystems (Ardisson et al., 2011). Consequently, the atoll is an important site for the conservation of marine and terrestrial threatened habitats and animal species (INE, 2000; Ardisson et al., 2011).

Banco Chinchorro was declared a biosphere reserve by a decree published on 19 July 1996 (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT] in Diario

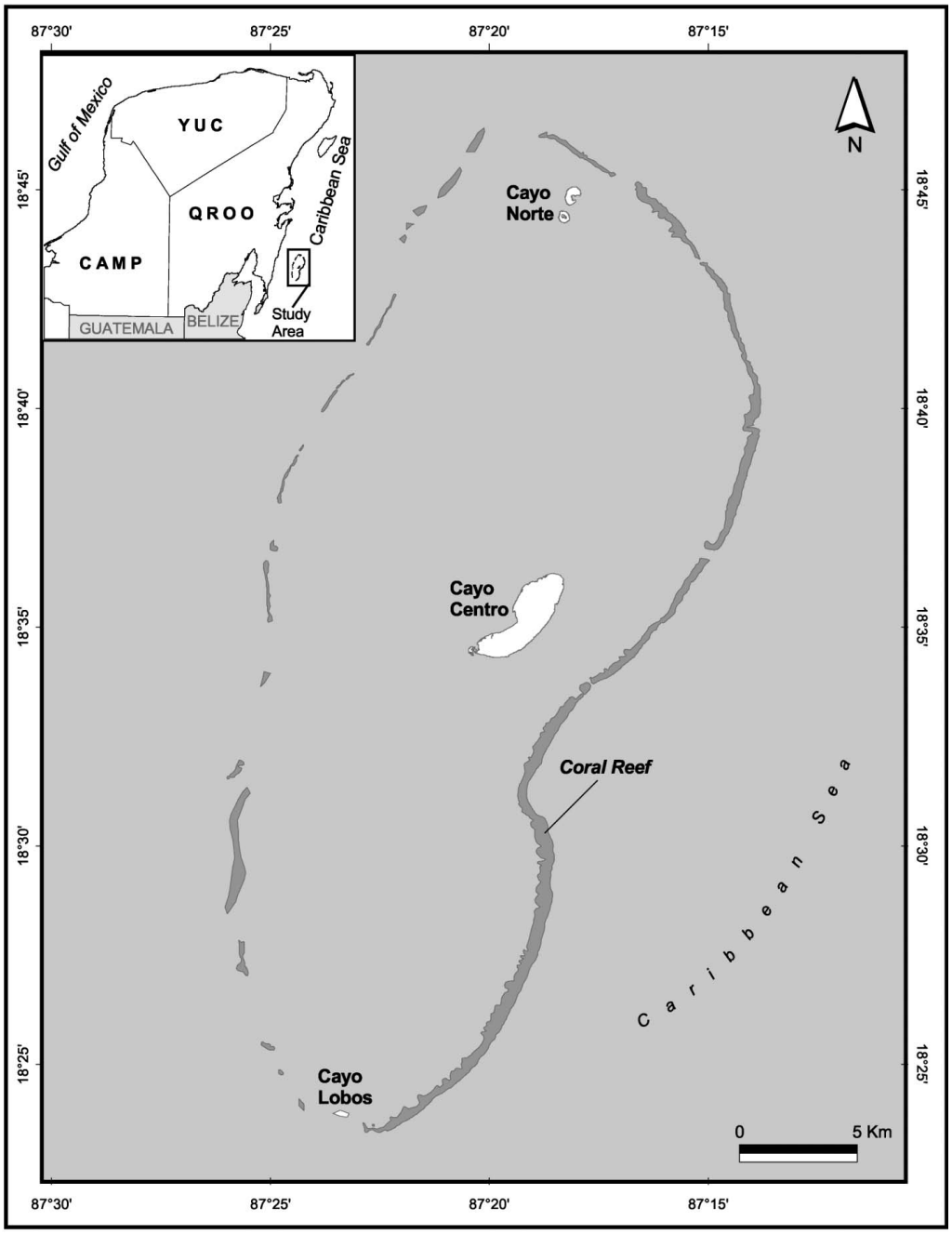

FIG. 1—Locality map of Banco Chinchorro Biosphere Reserve, Quintana Roo, Mexico.

Oficial de la Federación, 1996); a management plan for the reserve was published in 2000 (INE, 2000). This plan included a list of 14 reptile species that potentially inhabited the reserve (INE, 2000). However, some recent field observations in the cays of Banco Chinchorro cast doubt on the accuracy of this list.

Additionally, the category "biosphere reserve" is the highest level of priority to preserve as an NPA; is determined by the biological, ecological, and economic importance of a particular area; and can cover terrestrial and marine ecosystems. Those biosphere reserves are designated for research, education, economic improvement, and divulgation of information among the world web of NPA (United Nations Educational Scientific and Cultural Organization, http://www.unesco.org/). Therefore, the list of flora and fauna present is a priority to accomplish the functions of an NPA. Particularly, the Banco Chinchorro BR does not have a recent list of reptiles. Few studies have been done on reptiles of this reserve, with most studies mainly focused on crocodiles and parthenogenetic lizards (Manríquez-Morán et al., 2000; Charruau et al., 2005; Machkour-M'rabet et al., 2009; Charruau et al., 2010a, 2010b; Charruau, 2011, 2012; Pérez-Flores et al., 2011; Charruau and Hénaut,

Table 1—Terrestrial vegetation associations present in the islands of Banco Chinchorro Biosphere Reserve, Quintana Roo, Mexico.

Type	Association	Cayo
Halophyte or coastal dune vegetation	Pioneer vegetation	Norte and Centro
	Coastal brush with *Tournefortia gnaphalodes, Ipomoea alba,* and *Ipomoea pes-caprae*	Lobos
	Coastal brush with *Pithecellobium keyense*	Centro
	Low coastal forest with *Bursera simaruba*	Norte and Centro
	Secondary vegetation	Norte and Centro
Mangrove	Fringe mangrove with *Rhizophora mangle*	Norte and Centro
	Mixed mangrove with *Avicenia germinans, Conocarpus erectus, Laguncularia racemosa,* and *Rhizophora mangle*	Norte and Centro
	Mangrove with *Avicenia germinans*	Norte and Centro
	Mangrove with *Conocarpus erectus*	Centro

2012; Charruau et al., 2012, 2013; Díaz de la Vega-Pérez et al., 2013). On the other hand, it is important to mention that the State of Quintana Roo represents the highest developing rate in population growth and tourism development in Mexico. Therefore, the protected areas in this state should have proper management programs with accurate biodiversity information.

All previously mentioned arguments justify the protection of the Banco Chinchorro BR to protect the reptiles that inhabit this area. Therefore, the management plan of the reserve must be improved with accurate information about the reptiles present. We consider it relevant to investigate the reptiles of the atoll using techniques such as literature review, queries to scientific collections, interviews, and systematic field studies. Our objective was to reevaluate the reptile species present in the Banco Chinchorro BR and disseminate new life-history information for future research, in an effort to direct the conservation efforts and improve the current knowledge of reptiles of this important biological area.

Materials and methods—Banco Chinchorro Biosphere Reserve covers 144,360 ha including extensive coral reefs, reef lagoons, and adjacent oceanic waters. The atoll is separated from the continent by a canal of almost 1,000 m depth (United Nations Environment Programme/International Union for Conservation of Nature [UNEP/IUCN], 1988) and represents an important part of the Mesoamerican barrier-reef system with economic, educational, cultural, and biological–scientific relevance (INE, 2000; Ardisson et al., 2011). The reserve contains four cays: Cayo Lobos, Cayo Centro, and two cays of Cayo Norte with a total area of 582 ha, of which 435 ha are terrestrial habitats and 147 ha are interior lagoons. Cayo Norte is located at the extreme north of the reserve and consists of two cays (Cayo Norte Mayor and Cayo Norte Menor; Fig. 1) with a total area of 40 ha. Cayo Centro is the largest cay (541 ha) and is located in the center of the atoll 47 km from the mainland (Fig. 1). The fourth cay, located in the extreme south, is the 0.4 ha Cayo Lobos (Fig. 1). Cayo Centro and Cayo Norte are covered with different compositions of mangrove and halophytic or coastal dune vegetation (Fig. 1; Table 1). Cayo Lobos has coastal dune vegetation with *Tournefortia gnaphalodes, Ipomoea alba,* and *Ipomoea pes-caprae* (Table 1). The climate of Banco Chinchorro is warm subhumid with rains during summer and winter (Charruau, 2010).

Sampling Methods—We compiled a list of the reptile species present in Banco Chinchorro through literature review and direct observations during field work from 2011 to 2013 (throughout the four seasons). Additionally, PC and ADVP have worked on reptile ecology in Banco Chinchorro BR for 11 and 3 years, respectively. We conducted diurnal and nocturnal transect surveys of lizards and nocturnal surveys of crocodiles. We placed transects randomly along the islands, including paths connecting fishermen camps and each type of vegetation. On Cayo Centro, the main path extended from the southern tip of the island to ±3.5 km to the north tip following the east coast of the island, corresponding to the most elevated part of the island (5 m). For Cayo Norte Menor and Mayor, the path surrounded each island. To complete the survey, we made random transects for each type of vegetation on each island. In Cayo Centro, we spent >250 days throughout the four seasons and estimate that we visited approximately 60% of the island. In Cayo Norte Mayor, we spent approximately 10 days working, visited almost 70% of the island, and went at Cayo Norte Menor two times (one day for each time) surveying almost 80% of the island. We did not visit Cayo Lobos. During these surveys, we captured crocodiles, iguanas, and small lizards using the noose technique (Fitzgerald, 2012). We identified all species using the most recent identification keys of Köhler (2008).

Morphological Data—For crocodiles, we sexed each individual captured using the observation of genital structures (presence or absence of penis) in the cloaca, and, for adult lizards, used observation of external sex-specific characteristics. We temporarily and individually marked lizards with a permanent marker on the abdomen and took them to the field station for measurements (total length [TL], snout–vent length [SVL], cranial length [CL], and mass [M]). We measured lengths in mm with an electronic stainless steel Vernier caliper (±0.1 mm; Truper S.A. de C.V., Ciudad de México, D.F., México) or with a tape measure (±1 mm) and mass in g with a micro-line spring scale (±0.1 g and ±1 g; Pesola AG, Baar, Suisse). We released all organisms the following day at the site of capture, which we had previously georeferenced with a global positioning system (Garmin International Inc., Olathe, Kansas). The temporary mark permitted us to differentiate captures and recaptures.

Bibliographic, Scientific Collection, and Interviews Data—We searched the available literature on reptiles of Banco Chinchorro. Additionally, we searched and examined reptile specimens

from Banco Chinchorro in museum collections from El Colegio de la Frontera Sur (ECOSUR), Instituto de Biología of the Universidad Nacional Autónoma de México, and Facultad de Ciencias of the Universidad Nacional Autónoma de México. We collected voucher specimens of each species captured in Banco Chinchorro and deposited them in the reptile collection of ECOSUR campus Chetumal (ECO-CH-H). We also interviewed some fishermen and park rangers about the species they observed in Banco Chinchorro BR and about specific species such as boas, sea turtles, and house geckos. The interviews were made in a conversation form because fishermen are more "open" to that interview method, and we found that we obtain more information than with a standardized questionnaire. We were ensured that fishermen had accurately identified the species by showing them pictures or by questioning them about diagnostic characteristics of the species. We also talked with R. Herrera-Pavón, who previously studied sea turtles in the reserve, for additional information about turtle species.

Furthermore, we searched for the current protection and conservation status of each species listed by the IUCN (http://www.iucn.org/), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (2012; Appendices I, II, and III), and Mexican law (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT], NOM-059-SEMARNAT-2010 in Diario Oficial de la Federación, 2010).

Results—*Species Richness*—We generated a list of 13 reptile species at Banco Chinchorro BR based on field work, literature, museum specimens, and interviews. These species are distributed in 12 genera, 8 families, and 4 orders (Table 2). The list consisted of one crocodilian, four marine turtles, two iguanas, two geckos, two anoles, one whiptail lizard, and one snake.

First, we updated and corrected the names of species appearing in the Banco Chinchorro BR Management Plan (BCMP). *Hemidactylus tursicus* was misspelled: the correct name is *Hemidactylus turcicus*. We also corrected an error in the spelling of the genus name for species *Cnemitodhorus cozumela;* the correct name of the genus is *Cnemidophorus*. However, at present, this genus is confined to the southern species, according to the phylogenetic hypothesis of Reeder et al. (2002); therefore, all northern species currently belong to the genus *Aspidoscelis*. In fact, the presence of *Aspidoscelis cozumela* is also a mistake because the species that occurs in Banco Chinchorro is *Aspidoscelis maslini* (we discuss more in the Discussion section).

We detected nine species of reptiles on our transects: *Crocodylus acutus, Eretmochelys imbricata, Aristelliger georgeensis, Hemidactylus frenatus, Ctenosaura similis, Iguana iguana, Anolis allisoni, Anolis sagrei,* and *Aspidoscelis maslini*. We observed *Eretmochelys imbricata* in the reef lagoon 100 m from the west coast of Cayo Centro in a sea grass area. We observed *Crocodylus acutus, Aristelliger georgeensis, Ctenosaura similis, Iguana iguana, Anolis allisoni, Anolis sagrei,* and *Aspidoscelis maslini* in Cayo Norte and Cayo Centro. *Hemidactylus frenatus* is an abundant species and has only been detected at Cayo Centro on the walls of the field station. Similarly, an individual of *Boa constrictor* was recently captured (March 2015) in Cayo Centro (near of the lighthouse) by a team of the Grupo de Ecología y Conservación de Islas A.C. currently working in Cayo Centro to eliminate black rats (*Rattus rattus*). We never captured or observed *Hemidactylus turcicus, Crocodylus moreletii,* or other *Anolis* species that were mentioned in the previously compiled list. Voucher specimens of *Aristelliger georgeensis, Anolis allisoni, A. sagrei, H. frenatus,* and *Aspidoscelis maslini* have been deposited in the collection of ECOSUR museum (Table 3). The boa was taken to the Centro para la Conservación e Investigación de la Vida Silvestre of Bacalar (Quintana Roo), which is a part of the Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT).

From the museum collections, we found five species of reptiles collected in Banco Chinchorro identified as *Crocodylus acutus* (one skull), *Anolis lemurinus* (two specimens), *A. allisoni* (nine specimens), *Aristelliger georgeensis* (one specimen), and *Hemidactylus turcicus* (one specimen). These were deposited in the collections of ECOSUR or in the Facultad de Ciencias of the Universidad Nacional Autónoma de México and have been collected in the reserve between 1996 and 2010 (Table 3). After review of the specimens, we detected some errors in identification. First, the reptile collection of ECOSUR museum included a specimen of *Hemidactylus turcicus* recently collected in Banco Chinchorro (in 2010). However, after a careful review of the specimen, it was identified as *Hemidactylus frenatus*. In addition, the two specimens of *Anolis lemurinus* deposited in the same collection were neonates of *A. sagrei*.

Based on the interviews with different staff from the reserve, we were able to identify nine species: *Caretta caretta, Chelonia mydas, Eretmochelys imbricata, Crocodylus acutus, Aristelliger georgeensis, Ctenosaura similis, Iguana iguana, Anolis allisoni,* and *Aspidoscelis maslini* (Table 2). None of the fishermen or park rangers interviewed had observed boas in Banco Chinchorro BR before March 2015. Furthermore, R. Herrera-Pavón told us that in addition to the presence of *Caretta caretta*, *Chelonia mydas,* and *Eretmochelys imbricata,* $\geq$1 individual of *Dermochelys coriacea* had been captured, and other individuals observed, in the past in the Banco Chinchorro BR. Information obtained from the literature on reptiles of Banco Chinchorro BR is included in the discussion.

Ecological and Biological Data—We obtained morphological data for six species: *Aristelliger georgeensis, Ctenosaura similis, Iguana iguana, Anolis allisoni, Anolis sagrei,* and *Aspidoscelis maslini* (Table 4).

We captured specimens (11 males, 2 females, 4 young, and 3 hatchlings) of *Aristelliger georgeensis* at Cayo Centro and Cayo Norte Mayor at night between 2100h and 0120h. We captured them on the field station walls, on leaves of chit (*Thrinax radiata*) and coconut palms (*Cocos nucifera*), on branches of button mangrove (*Conocarpus*

TABLE 2—List of reptile species present in Banco Chinchorro Biosphere Reserve, Quintana Roo, Mexico. International Union for Conservation of Nature 2015 (IUCN, http://www.iucn.org/). Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT]. 2010. Norma Oficial Mexicana NOM-059-SEMARNAT-2010 *Invasive species. — Indicates no category.

Order/Family/*Species*	Spanish and/or English common names	IUCN 2012[a]	CITES 2012	NOM-059-ECOL-2010[a]	Reproduction-sex determination modes[b]	Source[c]
Crocodilia						
Crocodylidae						
Crocodylus acutus	Cocodrilo americano, cocodrilo de río, American crocodile	VU	Appendix I	Pr	Ovi-TSD	1,2,3,4
Testudines						
Cheloniidae						
Caretta caretta	Tortuga caguama, loggerhead sea turtle	EN	Appendix I	P	Ovi-TSD	1,2,3
Chelonia mydas	Tortuga blanca, green turtle	EN	Appendix I	P	Ovi-TSD	2,3
Eretmochelys imbricata	Tortuga carey, hawksbill sea turtle	CR	Appendix I	P	Ovi-TSD	1,2,3
Dermochelydae						
Dermochelys coriacea	Tortuga laúd, leatherback sea turtle	CR	Appendix I	P	Ovi-TSD	2,3
Squamata						
Gekkonidae						
Aristelliger georgeensis	Gecko pestañudo, salamanquesa, St. George Island gecko	—	—	Pr	Ovi-Chrom	1,2,3,4
*Hemidactylus frenatus**	Gecko, cuija, house gecko	—	—	—	Ovi-Chrom	1
Iguanidae						
Ctenosaura similis	Iguana gris, garrobo, iguana rayada, black iguana, common spiny-tailed iguana	LC	—	A	Ovi-Chrom	1,2,3
Iguana iguana	Iguana verde, green iguana	—	Appendix II	Pr	Ovi-Chrom	1,2,3
Dactyloidae						
Anolis allisoni	Lagartija, anolis, Allison's anole	—	—	—	Ovi-Chrom	1,2,3,4
Anolis sagrei	Lagartija chipojo, brown anole	—	—	—	Ovi-Chrom	1,3
Teiidae						
Aspidoscelis maslini	Lagartija, Picasol, Maslin's whiptail	LC	—	—	Ovi-Parth	1,2,3
Boidae						
Boa constrictor	Boa	—	Appendix II	A	Viv-FP	1,3

[a] VU: vulnerable; EN: endangered; CR: critically endangered; LC: least concern; P: in danger of extinction; A: threatened; Pr: subject to special protection.
[b] Ovi: oviparous; Viv: Viviparous; TSD: Temperature-dependent Sex Determination; Chrom: Chromosomal; Parth: Parthenogenetic; FP: Facultative parthenogenetic.
[c] 1: survey; 2: interview; 3: literature including MPBC; 4: museum specimen.

TABLE 3—Voucher specimens from Banco Chinchorro Biosphere Reserve in the reptile collections at Museo de Zoología of El Colegio de la Frontera Sur-Chetumal (ECO-CH-H) and at the Facultad de Ciencias-Universidad Nacional Autónoma de México (MZFC). — Indicates no data.

Species	Vouchers	Year collected
Crocodylus acutus	ECO-CH-H 2733	—
Aristelliger georgeensis	ECO-CH-H 2788–2789	2011
	MZFC 10653	1999
Hemidactylus frenatus	ECO-CH-H 2790–2791	2011
	ECO-CH-H 2786[a]	2010
Anolis allisoni	ECO-CH-H 2793	2011
	ECO-CH-H 1313–1318	1999
	MZFC 10652	1999
	MZFC 10175–10176	1996
Anolis lemurinus[b]	ECO-CH-H 2784–2785	2010
Anolis sagrei	ECO-CH-H 2794–2800	2011
Aspidoscelis maslini	ECO-CH-H 2792	2011

[a] Misidentified and misspelled first as *Hemidactylus tursicus*.
[b] Neonates with doubtful identification, likely neonates of *Anolis sagrei*.

erectus), and in leaf litter. During the night, the color pattern of the specimens is grey or cream; and during the day, they adopt a chocolate brown color with white cream spots and lines.

We captured 78 *Anolis allisoni* (55 males and 23 females)—62 at Cayo Centro and 16 at Cayo Norte Mayor. Males and females are green, but are able to rapidly change to a dark brown color. Their eyes are capable of focusing on distinct objects. Males have dark lines on the body and limbs and can present a blue coloration from the head to the shoulders and anterior limbs during the green color phase, which is supposedly during the reproduction season. Males have a pink dewlap, while females do not. We captured or observed individuals on the walls of the field station and fishermen's houses; on leaves; and on trunks of vegetation, particularly chit and coconut palms, button mangrove, gumbo-limbo (*Bursera simaruba*), and blackbead (*Pithecellobium keyense*).

We captured 65 *Anolis sagrei* (54 males and 11 females)—40 from Cayo Centro and 25 from Cayo Norte Mayor. Males change their color from light grey to brown and black with white spots, and their dewlap colors are from yellow-orange with a red edge to orange-red. They can also present a crest along the top of the body. Similar to *A. allisoni,* their eyes are capable of focusing on distinct objects. Females present the same color variation but can also present a light vertebral stripe pattern of chevrons, bars, and spots. Females can also present a reduced dewlap. We captured or observed individuals on chit and coconut palms, gumbo-limbo, blackbead, dead dry trunk, leaf litter, and sand. In a recent study, individuals of *A. sagrei* have been found to present abscesses on their mouth, supposedly due to alimentation on ants and eggs of ants (Díaz de la Vega-Pérez et al., 2014).

Aspidoscelis maslini was present at Cayo Norte and Cayo Centro, where we captured 6 and 40 individuals, respectively. We observed individuals on leaf litter and sand and found them actively foraging on insects during the hottest part of the day. They present light brown color at the dorsum and four yellow stripes each side of the dorsum; also present are long, white ventral scales. In some cases they also present a light blue color on the legs and tail. We observed females in gestation from March to May and, by palpation, could determine the presence of one to four eggs.

Ctenosaura similis were very abundant at Cayo Centro and Cayo Norte, especially around the field station and fishermen's camps. At Cayo Centro, fishermen and

TABLE 4—Morphological data[a] of *Aristelliger georgeensis, Anolis allisoni, Anolis sagrei,* and *Aspidoscelis maslini* collected during 2011–2013 from Banco Chinchorro Biosphere Reserve, Quintana Roo, Mexico. Data are presented as Mean ± 1 *SD* (range; *n*). — Indicates no data.

	Aristelliger georgeensis	*Anolis allisoni*	*Anolis sagrei*	*Aspidoscelis maslini*
TL (mm)				
Females	146.0 ± 7.1 (141–151; 2)	156.0 ± 18.2 (115–196; 20)	117.9 ± 31.7 (83–195; 9)	210.8 ± 32.1 (127–260; 38)
Males	151.6 ± 20.2 (132–191; 10)	198.8 ± 29.2 (123–261; 51)	150.1 ± 25.8 (96–228; 50)	—
SVL (mm)				
Females	65.0 ± 4.2 (62–68; 2)	57.7 ± 4.5 (49–65; 21)	48.5 ± 5.4 (40–59; 11)	73.7 ± 5.6 (62–84; 38)
Males	71.0 ± 7.0 (62–84; 11)	75.4 ± 11.7 (45–95; 54)	58.6 ± 6.6 (41–68; 53)	—
CL (mm)				
Females	15.2 ± 5.0 (11.6–18.7; 2)	14.6 ± 2.3 (11.1–20.4; 21)	10.7 ± 1.9 (8–14.7; 11)	—
Males	18.2 ± 4.2 (11.1–24.2; 11)	21.1 ± 4.8 (12.8–30.9; 54)	13.5 ± 1.7 (9.1–16.6; 53)	—
Mass (g)				
Females	7.3 ± 1.1 (6.5–8.1; 2)	3.5 ± 0.8 (2.2–4.8; 21)	2.1 ± 0.5 (1.2–2.8; 11)	9.2 ± 2.4 (5–15; 38)
Males	9.6 ± 3.3 (5.5–17.0; 10)	8.6 ± 3.6 (2.2–19; 53)	4.9 ± 1.7 (1.5–8.8; 52)	—

[a] TL: total length; SVL: snout–vent length; CL: cranial length.

reserve staff feed them, which explains their abundance. In August 2011, we captured five males and one female at Cayo Centro. Males had a mean TL of 783.6 mm (651–954 mm) and a mean SVL of 328.8 mm (265–360 mm). Mean mass of two males weighed was 1,800 g. The female had an SVL of 250 mm and a mass of 500 g.

Iguana iguana was very abundant in Cayo Centro and Cayo Norte, and we observed individuals in great numbers around human construction where fishermen and reserve staff feed them. They were mainly observed on the ground, but often climbed to the top of coconut palms and ciricote (*Cordia sebestena*). In Cayo Centro, we captured six males and nine females in August 2011 and April 2012, respectively. Males had a mean TL of 1,470 mm (980–1,770 mm), a mean SVL of 484.2 mm (400–540 mm), and a mean mass of 5,940 g (3,000–8,500 g). Females had a mean TL of 1,089.3 mm (960–1,295 mm), a mean SVL of 357.2 mm (310–420 mm), and a mean mass of 1,866.3 g (1,000–3,500 g).

Based on our combined survey results and information gathered since 2003 by ADVP, we found that the overall sex ratio of the captured and sexed crocodiles with a TL >30 cm was 30 females for 99 males or 1:3.3. We observed some crocodiles in both cays of Cayo Norte (two in each cay), but no survey has been made at this time to determine the density of individuals. Soldiers of the Mexican navy based at Cayo Norte Mayor also reportedly observed crocodiles in this cay (Park rangers, pers. comm.). We also observed nests of *Crocodylus acutus* and *Caretta caretta* in Cayo Centro. We found 94 nests of *Crocodylus acutus* from 2006 to 2013. We found two nests of *Caretta caretta* in a fishermen camp in August 2007, and found one in May 2013.

Most of the species identified are oviparous, and only the *Boa constrictor* is viviparous. However, the composition of reptile species in this community is diverse in terms of sex determination of the embryos displaying genetic determination, temperature-dependent determination, facultative parthenogenesis, or obligated parthenogenesis (Table 2).

Protection and Conservation Status—Of the 13 reptile species identified at Banco Chinchorro BR, 9 (69%) are included on the IUCN Red List of threatened species with 7 presented at threatened status, 7 (54%) are in Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendices, and 9 (69%) are protected by Mexican law (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT], NOM-059-SEMARNAT-2010 in Diario Oficial de la Federación, 2010; Table 2). The two most endangered species are American crocodiles and sea turtles, which are classified as Vulnerable (*Crocodylus acutus*), Endangered (*Caretta caretta, Chelonia mydas*), or Critically Endangered (*Eretmochelys imbricata* and *Dermochelys coriacea*) by the IUCN (2015). We found two invasive species of lizards with no protection status (*Hemidactylus frenatus* and *Anolis sagrei*) and potentially one single *Boa constrictor,* which is categorized as threatened by Mexican protection law. Before this study, two geographically restricted lizards had no protection status by Mexican law (*Anolis allisoni* and *Aspidoscelis maslini* [Díaz de la Vega-Pérez and Charruau, 2013; Díaz de la Vega-Pérez and Méndez-de la Cruz, 2013]).

Discussion—*Diversity of Species*—Our results, with 13 identified species of reptiles in the Banco Chinchorro BR, differ from the original list of 14 species of the BCMP. We did not observe the following species reported in the original list in the BCMP: *Anolis* sp., *Crocodylus moreletii,* and *Hemidactylus turcicus*. Additionally, we found two species that were not registered on the original list: *Dermochelys coriacea* and *Hemidactylus frenatus*. We also updated the name of one species: *Cnemidophorus cozumela,* which is now recognized as *Aspidoscelis cozumela;* however, this species only inhabits Cozumel Island. For that reason the whiptail lizard that inhabits Banco Chinchorro BR is *Aspidoscelis maslini* (Manríquez-Morán et al., 2000; Reeder et al., 2002; Manríquez-Morán et al., 2014). The updated list involves one crocodilian, four marine turtles, two iguanas, two geckos, two anoles, one whiptail lizard, and one snake. In the following paragraphs, we will discuss these results by Order (i.e., *Crocodylia, Testudines,* and *Squamata*) with the support of literature on reptiles of the reserve.

Crocodylia—Only one species occurs in the reserve: *Crocodylus acutus* (American crocodile; Charruau, 2003; Charruau et al., 2005, 2010b, 2012; Charruau and Hénaut, 2012). Although *C. moreletii* had been reported previously (Aguilar-Perera and Aguilar-Dávila, 1993), we found no evidence of its presence. It is unlikely that *C. moreletii* is a permanent resident of this area because it is primarily a freshwater crocodile, and, although the species has salt excretory glands and can tolerate brackish water >20 ppt (Taplin et al., 1985; Escobedo-Galván et al., 2008), it is very improbable that the species could survive in the hypersaline lagoons (30–65 ppt) of Banco Chinchorro (Charruau et al., 2005). It is possible that the observation of *C. moreletii* by Aguilar-Perera and Aguilar-Dávila (1993) results from an error in distinguishing between these morphologically similar, and sometimes sympatric, species of crocodiles. Several morphological differences exist between *C. acutus* and *C. moreletii,* but it can be difficult to distinguish them, even for professional herpetologists (Platt and Rainwater, 2006). Furthermore, *C. moreletii* and *C. acutus* interbreed and hybrids are fertile (Machkour-M'Rabet et al., 2009). However, the population of *C. acutus* in Banco Chinchorro appears to be genetically pure (Machkour-M'Rabet et al., 2009), which would support the absence of *C. moreletii* in the reserve.

At Banco Chinchorro, *C. acutus* has been hunted for its skin for several decades as an additional complementary

income for fishermen (Solis-Ramirez, 1966; Miller, 1982; Charruau et al., 2005; Collí-Orozco, pers. comm.). However, the hunting at Cayo Centro was not as intense as on the continent, and the cay is now the home of a relatively important and well-conserved population, which has been the subject of many studies since 2003 (population status: Charruau et al., 2005; population genetics: Cedeño-Vázquez et al., 2008; Machkour-M'rabet et al., 2009; growth rates: Charruau et al., 2010b; nesting ecology: Charruau et al., 2010a; bacterial flora: Pérez-Flores et al., 2011; age estimation: Charruau, 2011, 2012; maternal behavior: Charruau and Hénaut, 2012; Charruau et al., 2012; toxicology: Charruau et al., 2013). All of these studies indicate a stable and healthy reproductive, genetic, and population status for *C. acutus* and support that Banco Chinchorro BR is an important refuge for the species in the Yucatan Peninsula.

Testudines—Four species of sea turtles are known to be present at Banco Chinchorro: *Caretta caretta, Chelonia mydas, Eretmochelys imbricata,* and *Dermochelys coriacea*. In the original species list of the BCMP, three marine turtles were included: *Caretta caretta* (loggerhead sea turtle), *Chelonia mydas* (green turtle), and *Eretmochelys imbricata* (hawksbill sea turtle), all of which are from the Cheloniidae family (INE, 2000). These three species were observed at the reserve by Herrera-Pavón (1991), fishermen, and the reserve staff. The first author also observed several individuals of *Eretmochelys imbricata* in the reef lagoon. Furthermore, Herrera-Pavón (2001) reported a fourth species of marine turtle, *Dermochelys coriacea* (leatherback sea turtle), after having observed tracks of this species on the beach of Cayo Norte Mayor (Herrera-Pavón, 2001). This author also told us about the capture of one *Dermochelys coriacea* and observation of a few individuals in the reserve (Herrera-Pavón, pers. comm.). Thus, we included this fourth species of marine turtle on the list. Little is known about sea turtles at Banco Chinchorro, but the reserve seems to be an important feeding, reproductive, and nesting area for these species (Herrera-Pavón, 1991, 2001).

Before the establishment of the permanent ban on fishing or capture of all marine turtle species in Mexico (Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT] in Diario Oficial de la Federación 1990), turtles were fished or captured on beaches of Cayo Lobos and Cayo Norte during the nesting season by "Turtlers" (i.e., turtle-hunters) coming from Cozumel Island, Xcalak (a small village on the southern coast of Quintana Roo), and Belize (Miller, 1982). In fact, according to Miller (1982), prior to the late 1960s, trips of fishermen to Banco Chinchorro were sporadic and principally were made to capture the sea turtle *E. imbricata* and crocodiles (referred as "alligators" in the text).

Herrera-Pavón (2001) reported the nesting of *Caretta caretta* and *Eretmochelys imbricata* at Cayo Lobos and Cayo Norte Mayor, and observed tracks of *Chelonia mydas* and *Dermochelys coriacea* on the beach of Cayo Lobos and Cayo Norte Mayor, respectively, which would suggest a sporadic nesting of these species in the reserve. We also observed nests of *Caretta caretta* at Cayo Centro. Although turtle nests can be observed at Cayo Centro and Cayo Norte Mayor, Cayo Lobos appears to be the preferred nesting area by turtles at Banco Chinchorro. According to Herrera-Pavón (2001), this could be due to its close location to the coral reef breaker zone, its sparse vegetation, and its proximity to beaches with easy access. Banco Chinchorro is likely a feeding area for the four species.

Squamata—With regard to geckos, we observed *Hemidactylus frenatus* (house gecko), which is a species not listed in the BCMP. Additionally, *Hemidactylus turcicus* appeared to be misspelled (i.e., *Hemidactylus tursicus*) in the BCMP (INE, 2000) as reported by Castillo et al., (in litt.). However, *H. turcicus* has not been reported along the east coast of the peninsula, where *H. frenatus* is present (Lee, 1996; Köhler, 2008). We can consider that the report of *H. turcicus* in the reserve may have been a misidentification of *H. frenatus* because of the morphological similarity between the two species. Moreover, the specimen of *H. turcicus* deposited in 2010 at the collection of ECOSUR was later identified as *H. frenatus*. *Hemidactylus frenatus* is a small, oviparous, nocturnal gecko and an invasive species native to South Asia, which has been introduced worldwide (Case et al., 1994; Caicedo-Portilla and Dulcey-Cala, 2011). *Hemidactylus frenatus* may have been introduced in Mexico through Acapulco harbor in Guerrero state by commercial boats and then spread to other states (Valdez-Villavicencio and Peralta-García, 2008). The species was first reported in Quintana Roo in 1996 (Schmidt-Ballardo et al., 1996) but likely arrived in this state in the early 1980s (Lee, 1996). Because *H. frenatus* is strongly associated with developed areas, its arrival to the atoll almost certainly occurred through human means, hidden in material or food brought by fishermen to the atoll during the 1980s.

The only other species of gecko identified at Banco Chinchorro was *Aristelliger georgeensis,* the St. George Island gecko. This is a large, nocturnal, oviparous gecko principally occurring in offshore islands of Quintana Roo, Belize, Honduras, and scattered throughout mainland coastal localities of Quintana Roo and Belize (Lee, 1996; Köhler, 2008). This species reaches 115 mm SVL (Lee, 1996), but the largest specimen captured at Banco Chinchorro was an adult male 84 mm SVL from Cayo Centro.

Ctenosaura similis and *Iguana iguana,* the black and green iguanas, are the biggest terrestrial lizards on the reserve and are very abundant at Cayo Centro and Cayo Norte Mayor. At Cayo Centro they are abundant around the field station and fishermen camps. Color patterns of both species are similar to the pattern described by Lee (1996).

We also identified two species of anoles: *Anolis allisoni* and *Anolis sagrei*. *Anolis allisoni,* the Allison's anole, is a trunk-crown anole (Losos, 2009) and was first reported in Banco Chinchorro by Nieto-Montes de Oca et al. (1999). This insular species also occurs on Lighthouse Atoll in Belize, in Bay Islands and Cayos Cochinos in Honduras, and in Cuba (Schmidt, 1941; Ruibal and Williams, 1961; Platt et al., 1999). *Anolis sagrei,* the brown anole, is a trunk-ground anole (Losos, 2009) native to Cuba, the Bahamas, and Jamaica; and it has been introduced to many Caribbean countries and islands, including the Yucatan Peninsula, where it is widespread in coastal areas (Lee, 1996; Köhler, 2008).

The BCMP mentioned a third and undetermined species of anole (*Anolis* sp INE, 2000), which we never captured or observed during our visits to Banco Chinchorro BR. Moreover, the two specimens identified as *Anolis lemurinus* from Banco Chinchorro deposited in the reptile collection of ECOSUR are neonates of *A. sagrei*. Thus no *A. lemurinus* have been identified at Banco Chinchorro BR.

The last species of lizard identified in the reserve is *Aspidoscelis maslini,* the Maslin's whiptail. This species was not listed in the BCMP but another species of *Aspidoscelis* was listed with the former genus name *Cnemidophorus*. This species, *Cnemidophorus cozumela,* has been included into the genus *Aspidoscelis* as the *Aspidoscelis cozumela* complex with three recognized species: *Aspidoscelis rodecki, A. cozumela,* and *A. maslini* (Reeder et al., 2002). The species present at Banco Chinchorro is *A. maslini,* (Taylor and Cooley, 1995; Manríquez-Morán et al., 2000). *Aspidoscelis maslini* has the widest distribution of any parthenogenetic species of the group in the Yucatan Peninsula. This species inhabits mainly the halophyte vegetation of the beaches, but some populations occur far from the coasts in tropical rainforests (Lee, 1996). *Aspidoscelis maslini* reproduces by parthenogenesis, whereby all the individuals are female and genetically identical (Moritz et al., 1992; Manríquez-Morán et al., 2000; Manríquez-Morán, 2002). These ground-dwelling lizards are very dependent on environmental temperatures; and, although they have a high capacity of thermoregulation, their activity drops considerably during cloudy days (Díaz de la Vega-Pérez et al., 2013).

Furthermore, in 1998 Castillo et al. (in litt.) reported the presence of the boa (*Boa constrictor*) in Cayo Centro. We never observed boas during our surveys and no one interviewed has mentioned it. However, recently (March 2015), one individual was captured by GECI and delivered to park rangers. Boas are a successful invasive species (Romero-Nájera et al., 2007; Vázquez-Domínguez et al., 2012; Reynolds et al., 2013), and their presence would likely be evident in the reserve if a resident population were present. However, PC has never observed a boa in 11 years of work on the reserve. Moreover, reserve staff and fishermen who work year-round in the reserve have never observed boas. Thus, because no boas have been observed in the reserve from the report of Castillo et al. (in litt.), from 1998 to 2015, we consider that a population of this species is likely not present at Banco Chinchorro BR. However, it is likely that some individuals could arrive occasionally to the reserve by hurricanes or on floating vegetation driven by marine currents; and, although boas can reproduce by facultative parthenogenesis (Booth et al., 2011; Lara-Resendiz et al., 2013), these isolated individuals have likely not established a population in the reserve. A tissue sample was collected from the boa to determinate its genetic affinity with other populations of the region for future studies.

Protection and Conservation Status—There is no monitoring of sea turtle nests at Banco Chinchorro BR, and we strongly recommend the implementation of such monitoring there. Cayo Lobos, the main nesting site of sea turtles at Banco Chinchorro, is the only cay with no human presence, but it is used by illegal fishermen who collect eggs from nests of sea turtles (Reserve staff, pers. comm.).

With the information obtained from this study, *Anolis allisoni* and *Aspidoscelis maslini* were included in the list of protected species by Mexican law (Díaz de la Vega-Pérez and Charruau, 2013; Díaz de la Vega-Pérez and Méndez-de la Cruz, 2013). The Banco Chinchorro BR is a critical protected area for both species. The Banco Chinchorro BR is the only site in Mexico where populations of *Anolis allisoni* occur (Nieto-Montes de Oca et al., 1999) with a distribution area of almost 5.8 km^2, representing 0.0003% of the national area. This species is categorized as "subject to special protection" by the NOM-059-ECOL, which will be published (Díaz de la Vega-Pérez and Charruau, 2013).

In the case of *Aspidoscelis maslini,* the organisms inhabiting Banco Chinchorro BR are geographically and genetically isolated from the closest continental population in Mahahual (Manríquez-Morán et al., 2014). Banco Chinchorro provides adequate environmental characteristics for these lizards; their abundance in the reserve is high compared with many continental populations affected by the environmental modifications caused by tourist infrastructure (Díaz de la Vega-Pérez et al., 2013). *Aspidoscelis maslini* after this study is categorized as "threatened" by the Mexican biodiversity protection law, NOM-059-ECOL (Díaz de la Vega-Pérez and Méndez-de la Cruz, 2013).

Anolis sagrei and *Hemidactylus frenatus* have no protection or conservation status (Table 2). *Anolis sagrei* is the most abundant and widespread species of the Caribbean anoles (Schoener and Schoener, 1980; Losos et al., 1993) and has colonized or been introduced in many countries (or islands) of this region, but also in other parts of the world, such as Taiwan (Norval et al., 2002) and Hawaii (Goldberg et al., 2002). As an introduced species, it can be a threat to autochthonous lizard species by competing

for resources or by consuming smaller lizard species (Campbell, 1999; Echternacht, 1999; Gerber and Echternacht, 2000). However, *A. sagrei* has likely been established at Banco Chinchorro BR for a long time, and our observations do not suggest that this species is a threat to other species.

Hemidactylus frenatus has been responsible for the displacement or extinction of several native or introduced lizards (principally geckos) on worldwide islands and continents (Case et al., 1994; Petren and Case, 1996; Cole et al., 2005; Dame and Petren, 2006; Caicedo-Portilla and Dulcey-Cala, 2011). It is a serious threat for *Aristelliger georgeensis* at Banco Chinchorro, its eradication from Cayo Centro is strongly recommended, and precautions must be taken to prevent its spread to Cayo Norte.

The black rat and the feral cat (*Felis catus*) are also present at Cayo Centro and Cayo Norte, respectively (Charruau, 2003). These invasive species are a serious threat to reptile populations, especially to lizards. Fortunately, a program of rat and cat eradication is currently ongoing at Banco Chinchorro. The removal or control of the exotic coconut palm is also recommended because it displaces and replaces native vegetation and serves as a refuge for rats.

Moreover, reptile habitat at Banco Chinchorro BR has been severely damaged by the passage of tropical cyclones in recent years, beginning with Hurricane Dean, which directly struck the cays of Banco Chinchorro in 2007 (Charruau et al., 2010a). Since that time, coastal dune vegetation and black mangrove (*Avicenia germinans*) forest are recovering rapidly, while red mangrove (*Rhizophora mangle*) recovery has been slow. A restoration program of the red mangrove fringe at Banco Chinchorro has been implemented and its total recovery could take several decades. Quintana Roo is the Mexican state with the highest frequency of tropical cyclones of all intensity categories (INE, 2000), and the frequency of higher category hurricanes is expected to increase in the future due to global warming (Knutson et al., 2010). During recent decades, the frequency of major hurricanes of category 3, 4, and 5 increased at Banco Chinchorro, while frequency of hurricanes of category 1 and 2 decreased (Charruau, 2010). This increase in major hurricane occurrence at Banco Chinchorro could be a threat to the reptiles of the reserve. Thus, studies on effects of tropical cyclones on reptile species at Banco Chinchorro must be undertaken in the future.

Finally, nonintroduced reptiles from Banco Chinchorro are candidates for consideration as Evolutionary Significant Units (ESU). Although several definitions for ESUs have been developed since its original formulation (Fraser and Bernatchez, 2002), three criteria can be used to define an ESU: a current geographical separation, a high degree of genetic differentiation, and locally adapted phenotypic traits. In Banco Chinchorro, populations of terrestrial reptiles are completely separated from the continent, which suggests a very low gene flow between them and continental populations. In the case of crocodiles, although they can swim long distances in open ocean (Groombridge, 1987), Machkour-M'rabet et al. (2009) revealed a high genetic differentiation among populations of *Crocodylus acutus* along the coast of Quintana Roo. Thus, we might expect greater genetic differentiation from other reptile species (with the exception of sea turtles) justified by the fact that they presumably have lower capabilities to disperse between Banco Chinchorro and the continent than crocodiles. Populations of *Aspidoscelis maslini* in the Yucatan Peninsula, composed of clonal organisms, are geographically and genetically separated, and the population inhabiting Banco Chinchorro BR could represent specific ecological and physiological characteristics, implying that each clonal population could be considered as an ESU. Nevertheless, other species could strongly differ from the continental populations because of isolation; therefore, we strongly recommend studies comparing the behavior, physiology, and ecology of the mainland and island populations to better understand their evolution (Losos et al., 1997; Losos and Ricklefs, 2009; Díaz de la Vega-Pérez et al., 2013; Siliceo-Cantero and García, 2014). The isolation of reptile populations from Banco Chinchorro, the reduced area in the island, and the specialized environmental conditions on the island (e.g., high salinity with no freshwater source, lower resource diversity) may lead to local adaptation. Taken together, several populations of reptiles at Banco Chinchorro may be considered ESUs. However, genetic and phenotypic studies are necessary to accurately identify ESUs on the reserve.

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