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Natural dispersion and introductions of African hemidactyl geckos called Mabouya in the Caribbean and in South America, and first mentions of the Mourning gecko (*Lepidodactylus lugubris* Duméril and Bibron, 1836), after that of the Tokay gecko (*Gekko gecko* Linnaeus, 1758), Asian geckos recently introduced to Martinique, and remarks on their current distributions in the Caribbean and their presumed impacts on biodiversity

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Abstract

Globally, geckos (Gekkonidae) are among the most prolific families of Sauria reptiles in terms of their natural ability to disperse and de facto to establish themselves as exotic species in relation to newly invaded territories.

Thus, African Mabouya, Hemidactyl geckos have dispersed naturally from West Africa to America since estimated geological times of -16 to -6 My. For millions of years, therefore, the Mabouya *Hemidactylus palaichthus* has coexisted with the endemic American Caribbean Big Mabouya *Thecadactylus rapicauda*.

Other African Mabouya such as *Hemidactylus mabouia* present in Caribbean America have been introduced in passive and anthropochoric mode ; and the chronology and dating of these introductions is debated. Because the African Mabouya *Hemidactylus mabouia* also coexists with the endemic *Thecadactylus rapicauda*, would then be present much earlier in America and therefore in the Caribbean than we think.

Martinique since 1970 is unfortunately the first theater in the eastern Caribbean, following an intentional introduction of a first species of Asian gecko, the *Gekko gecko* (Linnaeus, 1758), a destructive invasion of this exotic reptile occupying niches ecological not only of the endemic herpetofauna, but also consumer of insects, but also predator for the avifauna. This intentional introduction in Martinique having also obviously, since the year 2000, also impacted Guadeloupe and constituting a serious threat to the biodiversity of the entire Caribbean.

Today, in the greater Caribbean region, for more than 70 years, introductions of Asian Geckos have been reported. There are then three new exotic species inventoried in the greater Caribbean region, the Tokay *Gekko gecko* (Linnaeus, 1758), the Mourning gecko, *Lepidodactylus lugubris* (Duméril and Bibron, 1836), and the common house gecko, *Hemidactylus frenatus* (Duméril, 1836) which for the time being has a limited distribution and has probably been the subject of a more recent introduction.

Keywords: Mabouya, Mabouia, Mabuya, bantu, geckos, Sauria, Africa, Eastern Caribbean, Asia, lizards, non-indigenous, passive anthropochory, intentional introductions, invasive alien species, hemidactyls, Gekko, Lepidodactyls, parthenogenesis, ecological niche, biodiversity.

The term Mabouya in various Bantu African languages as well as in Taino languages is a name that refers to different things. It is used to name a species of skink found in Martinique called Greater Skink of Martinique : *Mabuya mabouya*, species extinct today. Mabuya or Mabouia, is also the generic term for naming geckos in general in the Caribbean and in West and South Africa.

The Mabuya then refer to mysterious reptiles with nocturnal habits, capable of vocalizing and emitting sounds, and which, thanks to their tapetum lucidum, have phosphorescent eyes ; they are evocative in the mythologies of African and Caribbean peoples of the “spirits of the night”.

African Mabouya, Hemidactyla geckos dispersed naturally from West Africa to America since geological time

The African Mabouya *Hemidactylus sp.* dispersed across the Atlantic, from geological time estimated between -16 to -6 My well before the very existence of humans. *Homo sapiens sapiens* having appeared about 80,000 years ago, and the oldest human presence on the American continent being attested more than 35,000 years ago at the site of Pedra Furada on the Atlantic coast of northeastern current Brazil.

This fact of a transatlantic biological connection, by crossing the ocean on a plant raft of hemidactyl propagules, which washed up on the emerged lands of the proto-Caribbean, is attested and confirmed by molecular biology data for Brazil. (Carranza and Arnold, 2005), Saint Lucia (Ilets Maria), and Trinidad, having generated the species *H. brasiliensis* and *H. palaichthus*, well after the geological separation between Africa and South America, it –105 to –119 My ago (McLaughlin, 2001).

It must be said that the quality of the limestone of the eggs of hemidactyls as in general those of the Gekkonidae, compared to those of other squamates, prove to be more resistant to exposure to salt water; and that this proven resistance makes it quite possible to cross long distances at sea and therefore the Atlantic on rafts of plants. (Carranza and Arnold, 2005).

It should be noted that this period considered by Carranza and Arnold, from -16 My to -6 My corresponds globally to the revised dates of the formation of the Isthmus of Panama, leading to the separation of the water masses of the Pacific Ocean with those waters of an Atlantic ocean with new directions of emerging currents. Indeed from - 25 My to -10 My, up to - 8 My we witness tectonic and volcanic geological phenomena, leading to the formation of the Isthmus of Panama to the gradual closing of the straits which until then gave access to the waters and ocean currents of the Pacific. Isthmus of Panama whose date of complete closure would be much older than previously thought, dating from -10 My instead of -4 to 3 My. (Sepulchre P. et al. 2014).

This separation between water masses of the Pacific and Atlantic oceans will fundamentally modify circulation and marine currents ; the Gulf Stream will configure itself in the dynamics of these profound upheavals naturally impacting the evolution of fauna and flora.

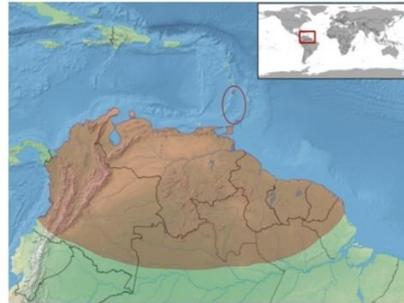
This dating of an attested dispersal of hemidactyls for Brazil and globally for the north of the South American continent (Carranza and Arnold, 2003) is therefore applicable for the eastern Caribbean, and particularly demonstrated for Saint Lucia and Trinidad.

It remains to deepen the studies relating to hemidactyls considered as *H. mabouia* present in the eastern Caribbean, with this complexity of possible hybridizations between these different hemidactyls all originating from the Atlantic coasts of Africa.

The presence of *H. palaichthus*, on Major Maria islet in Saint Lucia and Trinidad, as in Brazil and in the north of the South American continent, has been attested by David Corke since 1987 (Corke, 1987).



Mabouya *Hemidactylus palaichthus*, on Major Maria islet in Saint Lucia and Trinidad



Aire de répartition de l'espèce
Hemidactylus palaichthus selon l'UICN

Thus for millions of years the Mabouya *Hemidactylus palaichthus* has cohabited with the endemic American Caribbean Big Mabouya *Thecadactylus rapicauda* Houttuyn, 1782.



Thecadactylus rapicauda here specimen on the Sainte-Anne peninsula south-east of Martinique

Comments relating to the chronology of the passive introductions of African Mabouya

The African Mabouya *Hemidactylus mabouia*, as in the whole of the Caribbean, is present in nature throughout the territory of Martinique, it is observable in arid and dry environments, as in humid environments, for example isolated on the limestone islets of Sainte-Anne, or in the petrification savannah and on the Limestone hills of Sainte-Anne, or in the mangroves and in the three types of forest (xerophilous, mesophilic, hygrophilous), where it cohabits with the endemic American Caribbean Big Mabouya *Thecadactylus rapicauda* Houttuyn, 1782; as it is also very widespread inside homes with different phenotypes. It has been identified in the Eastern Caribbean by several authors, first in Saint Vincent in 1818.

The Hemidactyles observed by ourselves in the wild in Martinique during herpetological surveys as part of the IBR (Rapid Biological Inventory) initiated by the city of Lamentin for studies of the bay of Génipa in cooperation with Cuban biologists, and by elsewhere for the CD2S (Caribbean Center for Sustainable and Solidarity Development) as part of preliminary work in 2013 for the A.B.C. (Atlas of

Communal Biodiversity) of SAINTE-ANNE, in humid mangroves, in dry and arid environments of the peninsula of South East Martinique, taking refuge under rocks, presumed to be the same species of African Mabouya *Hemidactylus mabouia*, present phenotypes and patterns very diverse and varied, compared with those of the Hemidactyls living and breeding in general around and in dwellings.

The massive and certainly homogeneous introduction of hemidactyls from several geographical areas of West and South Africa, an introduction linked to the activity of the so-called "triangular slave trade", i.e. recent passive anthropochoric introductions of hemidactyls accompanying the transatlantic deportation of Africans on slave ships to America to be enslaved there, since 1492 (-500 years), would explain the phenotypic diversity observed today in the Eastern Caribbean of Mabouya considered as *H. mabouia*; this phenotypic variety is probably the consequence of biological reconnections between hemidactyls introduced in the last 500 years and hemidactyls originating from the same African coasts already introduced before the slavery period; African mabouya *Hemidactylus mabouia* is indeed present in America and therefore in the Caribbean much earlier than we think.



Three specimens of adult *Hemidactylus mabouia* and one juvenile, all observed on the Sainte-Anne peninsula

The mere fact that the same word Mabouya or Mabouia, is existing and used in idioms to name the same reality among both African and American peoples before European colonization, is significant for admitting the anthropochoric introduction by Africans of *Hemidactylus mabouia* in Taino country long before Christopher Columbus landed in Gwanahani, which he baptized San Salvador. Linguistically, a certain number of other facts should be noted regarding the similarities of African and Amerindian terms for identical names for subjects, animals, plants, objects and utensils before the European presence. This is the case of similarity between African and Amerindian idioms for terms such as: yam, yanm, meaning yam; n'yambi meaning sweet potato; for the term gwanin, designating a species of metal alloy based on gold existing both in West Africa and Central America before colonization by Europeans. The use by peoples of the term Mabouya both in Caribbean America and in Africa, is then part of a series of historical and archaeological facts, of linguistic data, constituting bundles of evidence of an African presence before 1492 in the say Americas. We refer to the work of the Mexican historian Riva PALACIO, "History of America before Christopher Columbus" published in 1900; by Joël ROGERS, in his book "Africa's gift to America"; by Léo WIENER, "Africa and the discovery of America" in three volumes published in 1920, 1922, by the historian John D. BALDWIN in his work "Ancient America" published in 1971; but also to the work of Jean MAZEL, specialist in Mediterranean Civilizations, author of "Presence of the Black World" (1975); without forgetting the work of Ivan VAN SERTIMA "They came before Columbus".

Let us quote Jean MAZEL commenting on the work of WIENER, extract from the chapter "Blacks in the Americas before Christopher Columbus" without having knowledge at the time in 1975 of the archaeological and molecular biology data relating to the site attesting to a human presence coming directly from Oldest Africa in America at Pedra Furada in northeast Brazil:

"It is therefore impossible to deny the presence of blacks in pre-Columbian America. Whether it's Olmec statues, whether it's pottery found everywhere in burials, in the Mayan pyramids. It would seem that from the moment the Aztecs prevailed over the Mayans, from the moment the Aztec civilization took hold, there was a kind of erasure of the old black presence in the Americas. It is generally admitted, at present, that the American continent was originally populated by Indians who came from Asia, through the Bering Strait, at different very ancient times. And it is also now accepted that navigators from the Old World reached the shores of the Americas long before Columbus. It suffices first of all to look at a map to realize that the shortest distance which connects the Eurafrikan continent to the Americas is indeed the passage which separates the tip of Cape Verde at the north-eastern extremity of Brazil and to the south of the West Indies. We know very well, too, that the regime of trade winds and currents almost necessarily brings to this zone a sufficiently solid boat from the coasts of present-day Senegal. (...)

Moreover, it seems inscribed in the geography of the West Indies and of all the islands of this coral fringe, the advanced shield of America towards the east, that they would serve as a bridgehead for the approach and penetration, by the Africans, from the American continent; free approach and free penetration in the oldest times, then, at the time of the slave trade, forced approach and penetration.

In any case, it is via the Antilles that African seeding has always occurred, around the Caribbean Sea in Central America and North America, as in Colombia and even in Peru where we have unearthed a quantity of art objects representing obviously Negro-African human types. »

Thus, Central American sites, notably Mexican, just as prehistoric but more recent than the South American site of Pedra Furada in Brazil, lead to the same conclusions: the ancestors of Amerindians from Amazonia and Central America are also African, crossed the Atlantic and inhabited the American coasts from Brazil to Yucatan. The work of Douglas WALLACE then largely questioned the so-called Asian origin of the first Americans or Paleo-Americans; By focusing on the mitochondrial DNA of Native Americans, he succeeded in proving:

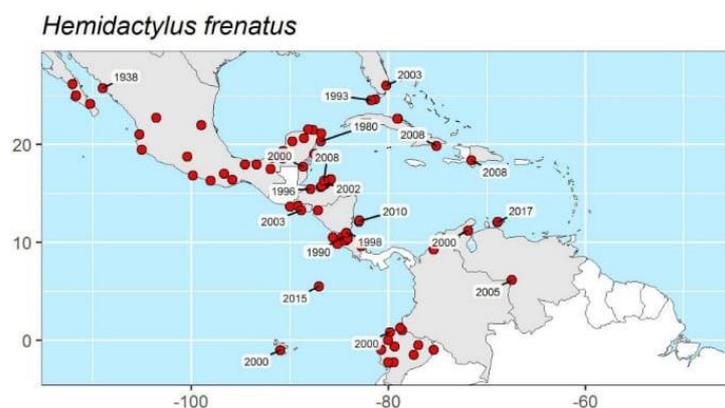
- That the settlement of America was made in several migratory waves, the oldest of which dates back, according to the most recent archaeological studies, to 45,000 years ago with the implication of crossings of the Atlantic by "navigators" or "drifts" coming from Africa ;
- That successive and massive migrations came from Asia (Behring Strait), but also to a lesser extent from Europe (DNA traces of European or Caucasian having migrated by crossing the North Atlantic).
- That an Australoid origin (Melanesian or African) is therefore observed on human skeletons discovered in several prehistoric sites in South and Central America.

Recent introductions of Asian geckos in America and the Caribbean

The Tokay gecko, *Gekko gecko* (Linnaeus, 1758), was intentionally introduced in Martinique by a so-called "defender of nature and birds" in the early 1970s during the period when the Washington Convention was drawn up and signed; a certain M. Bon Saint-Côme, although founding president at the time of the SEPANMAR association (approved by the State), then released into the wild on the territory of Saint-Joseph (Bois Neuf) and Lamentin (Bélème) of the Gecko Tokay that he had brought back from Southeast Asia.

The other two species of Asian Geckos *L. lugubris* and *H. frenatus* have been known to have been introduced into the American Caribbean in passive mode and anthropochory; they have had a wide distribution in the greater Caribbean region for more than 70 years, they have only been reported in the insular Caribbean during the last decade. Comparatively, the dynamics of introductions and dispersal of *G. gecko* on the insular Caribbean are similar to those of *L. lugubris* and *H. frenatus*.

Among the three new exotic species, the Mourning gecko, *Lepidodactylus lugubris* (Duméril and Bibron, 1836), recorded in South America, Pacific coast in Peru since year 1963, has the largest distribution on Curaçao and is probably established since the Longer. The common house gecko, *Hemidactylus frenatus* (in Duméril, 1836) has a limited distribution and was probably a more recent introduction.

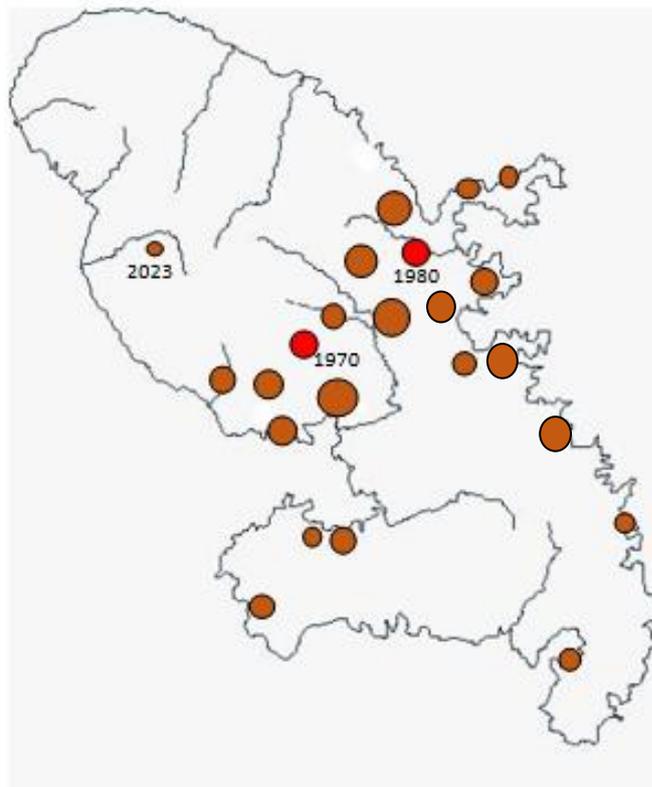


Distribution in the greater Caribbean region of *Hemidactylus frenatus*

It is therefore highly probable and predictable that Martinique will record the introduction of this third exotic species of Asian gecko.

The Tokay Gecko, *Gekko gecko* intentionally introduced to the eastern Caribbean first in Martinique

To the responsibility of intentional introduction of M. Bon Saint-Côme in the early 1970s, is added that of a second introduction to the Usine du Galion district in Trinité, on the occasion of hurricane David in 1979, Tokay Geckos have escaped from their enclosure. This second wave of introduction of Gecko Tokay in Martinique is the responsibility of a seasonal employee of the Usine du Galion, a Dutchman who came to Martinique several times during the sugar campaign, who collected said pets, kept aquariums containing different species of reptiles (snakes, lizards, geckos, etc.) which he also traded or trafficked; since he also devoted himself to capturing mabouyas and lizards endemic to the country to transport them and sell them elsewhere.



In red the two sites attested to intentional introductions, release into the wild of *G. gecko* in 1970 at Saint-Joseph, in 1980 at Trinité (Galion). In orange brown locations of sites where the Tokay Gecko proliferate ; last report at the beginning of June 2023 in the town of Morne Vert.



Distribution of the *Gekko gecko* in the Caribbean (June 2023). Martinique is the first island in the Caribbean where this Asian species was intentionally introduced in 1970 ; and the populations of *G. gecko* introduced in Guadeloupe most likely come from Martinique.

Dwarf Gecko, Mourning *Lepidodactylus lugubris*

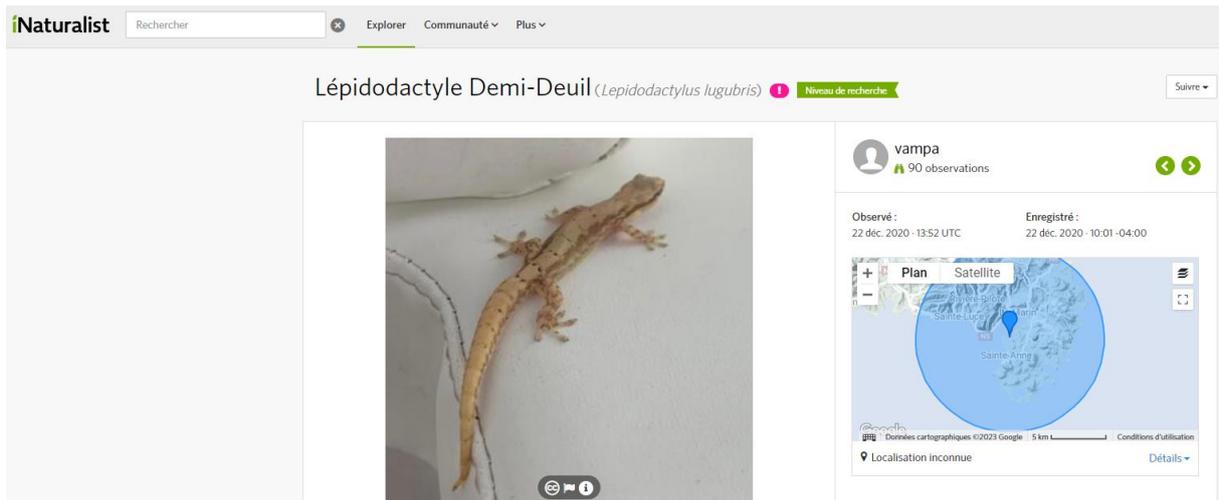
The Mourning Gecko (*Lepidodactylus lugubris*), an Asian dwarf gecko, is one of the most prolific geckonid species in the world ; due to its capacity for parthenogenesis (Cuellar and Kluge 1972; Borroto-Páez 2018). Like the hemidactyl Mabouya, these geckos produce eggs that are resistant to exposure to salt water and desiccation (Bosch and Páez 2017 ; Lorvelec et al. 2017) because their hard-shelled eggs contain the water necessary for their survival. development (Andrews 2012).

Also in addition to the passive anthropochoric introductions of the Mourning Gecko, their presence in the exotic pet trade (EAC), constitutes growing facts of intentional introductions; thus *L. lugubris* has amplified the opportunities for introductions beyond its natural distribution (Lorvelec et al. 2017).

Originally from the coastal areas of Southeast Asia and the Indo-Pacific region (Behm et al. 2018), Mourning geckos have spread to several Pacific islands, North America, and more recently in the Caribbean (Nania et al. 2020). The first report of the presence of the species in the Caribbean is from 1976 on Big Corn Island in Nicaragua (Henderson et al. 1976).

They have since been reported in Guadeloupe in 2010 (Lorvelec et al. 2011; Gomès and Ibéné 2013; Borroto-Páez 2018) and in other Caribbean countries such as Cuba and Bonaire (Alonso Bosch and Borroto-Páez 2017; Van Buurt and Smulders 2022).

The very first record indicating the presence of the species in Martinique dates from December 2020, by an observer member of iNaturalist (<https://www.inaturalist.org/observations/66918518>) who posted a location in the southeastern part of Martinique on the territory of the city of Sainte-Anne, visibly observed on a ship at anchor near Pointe Marin.



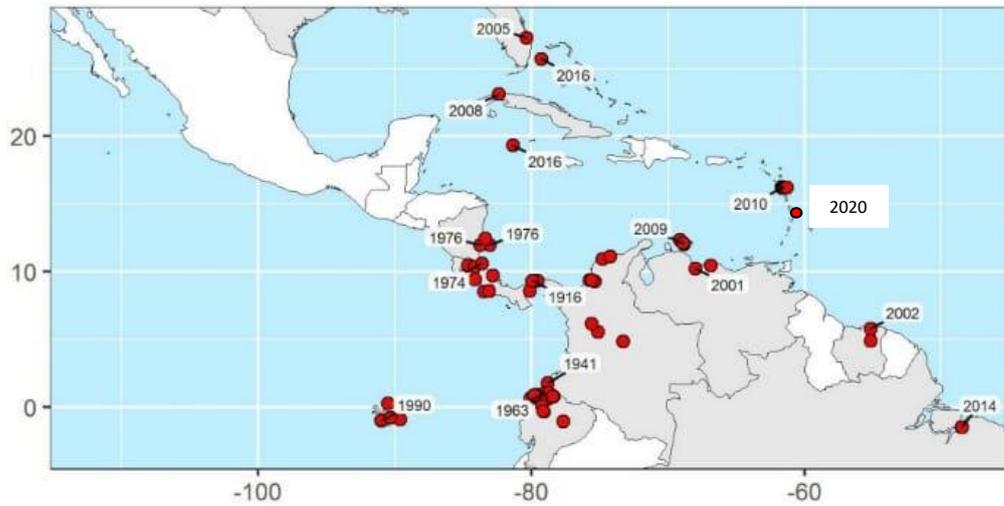
A second report of the presence of *Lepidodactylus lugubris* dated July 2022 observed on the banks of the Lézarde canal in Lamentin Martinique, was recorded by a publication in May 2023, by Alice Armand and Benjamin Ferlay of the Bivouac Naturaliste association on journal: Reptiles & Amphibians (ku.edu)

And a third report by the author of this publication, dated the end of December 2022, of the presence of *Lepidodactylus lugubris* around the Marina marina ; identification of the species confirmed by Dr Ivan INEICH expert in herpetology of the MNHN of Paris.

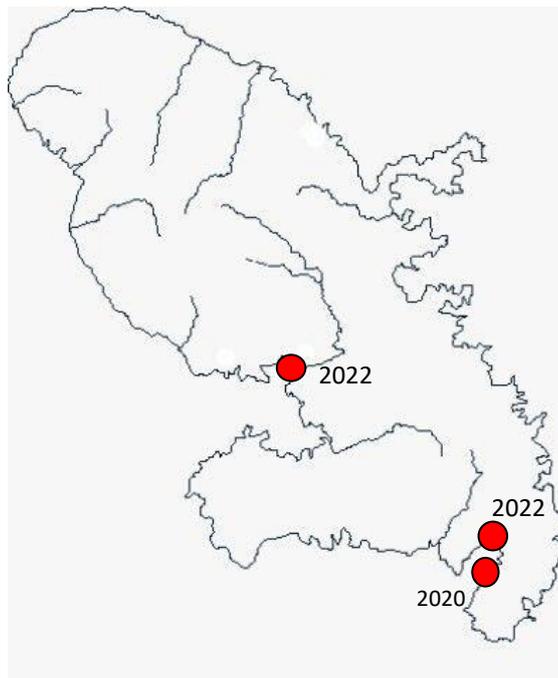


Specimens of Dwarf Gecko, Demi-Deuil *Lepidodactylus lugubris* observed at Marina du Marin

Lepidodactylus lugubris



Distribution of *Lepidodactylus lugubris* in the Caribbean and Central and South America (June 2023). The presence of the Mourning Dwarf Gecko, *L. lugubris* is now attested in Martinique. This second Asian species present in Martinique was clearly introduced in a passive and anthropochoric mode by propagules most likely coming from Guadeloupe.



In red, the first three sites of observation of introductions of the Asian species of Dwarf Mourning Gecko *Lepidodactylus lugubris* in Martinique.

Presumed impacts on biodiversity of introductions of Asian geckos in Martinique.

For the time being in Martinique only the harmful and destructive impact of biodiversity due to the introduction of the *Gekko gekko* can be observed and analyzed.

The rule and logic among lizards is that the larger consumes the smaller; and that within a species there is cannibalism, with adults consuming their own offspring. The Tokay Gecko by its larger size comes to Martinique to supplant the endemic Gros Mabouya of the Caribbean, the *Thecadactylus rapicauda*. Occupying the same ecological niche, the *G. gekko* becomes, at this size scale, the supreme predator of the herpetofauna in Martinique. Hunter of the night, arboreal, it consumes *Anolis*, *Dactyloa roquet* with diurnal habits ; But it also descends from trees to hunt on the ground, thus it attacks all other Mabouyas that are also night owls (*Ti Mabouya*, *Sphaerodactylus festus*, ..., *Hemidactyls*, ...), amphibians, as well as insects within its reach. It even attacks birds, eggs and small chicks in their nests.



Juvenile *Thecadactylus rapicauda*, endemic Mabouya photographed in Sainte-Anne Martinique

(a)



(b)



Above: two juvenile specimens of *Hemidactylus mabouia* of the same age and size; one on the left, (a) native to the natural environment of the Limestone hills of the Sainte-Anne peninsula, (South East Martinique); And the one on the right, (b) from a dwelling in Batelière Case Navire, (Centre West) not far from Pointe des Nègres (historic landing site for slave ships in Martinique).



Juvenile *Gekko gekko*

Asian Tokay Gecko

Invasive alien species introduced since 1970

Intentional introduction / Order on EEE list 2013



Juvenile *Lepidodactylus lugubris*

Asian Dwarf Mourning Gecko

Exotic species recently introduced in Martinique (report 2020)

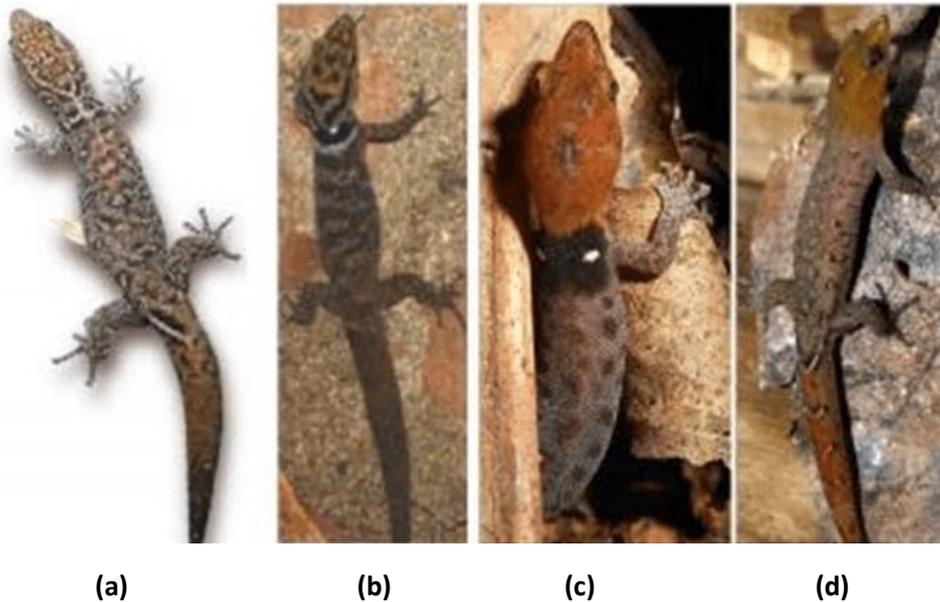
Passive introduction on the Sainte-Anne peninsula and shore of the Lézarde Lamentin

The new Asian dwarf gecko, Mourning *Lepidodactylus lugubris*, also arboreal but still frequenting the ground, rocks and litter, will come to occupy the ecological niche of the endemic and native lizards of Martinique. Considering its size, it will probably be eaten by larger geckos than it, but also by Anolis. On the other hand, the Asian dwarf gecko could easily consume Ti Mabouya *Sphaerodactyles* at night.

But we must not neglect the certain advantage of the Asian dwarf gecko Mourning over other native species whose ecological niches it will occupy to the point that these endemic species disappear there (substitution process); that of its parthenogenetic mode of reproduction giving it an exceptional potential for propagation.

Note that there are now only two species of exotic lizards introduced in Martinique whose mode of reproduction is parthenogenetic:

- The *Lepidodactylus lugubris*, Asian dwarf gecko probably constituting a threat for the endemic dwarf geckos of Martinique which are the *Sphaerodactyles*.
- The *Gymnophthalmus underwoodi* Grant, 1958, originating from the South American continent, very prolific which threatens to replace the endemic species of Saint Lucia and Martinique, the *Gymnophthalmus pleii* Bocourt, 1879.



- (a) Ti Mabouya of the Mornes Limestones of Sainte-Anne Martinique, Dwarf Gecko *Sphaerodactylus* sp.
- (b) Ti Mabouya of Saint-Lucia, Dwarf Gecko, *Sphaerodactylus microlepis* Reinhardt & Lütken 1862
- (c) Ti Mabouya of Martinique, Dwarf Gecko, *Sphaerodactylus festus* Barbour, 1915
- (d) Ti Mabouya of Martinique, Dwarf Gecko, *Sphaerodactylus vincenti* Boulenger, 1891

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