

# The terrestrial herpetofauna of Martinique: Past, present, future

Michel Breuil

Département Systématique et Évolution, Taxonomie et Collections, UMS 602, Amphibiens-Reptiles, Muséum National d'Histoire Naturelle, 25 rue Cuvier, 75005 Paris, France  
e-mail: breuil.michel@gmail.com

---

## Abstract

I present an up-to-date annotated list of the herpetofauna of Martinique, and try to explain the causes responsible for the eradication of species such as *Leptodactylus fallax*, *Boa* sp. and *Leiocephalus herminieri*. *Mabuya mabouya* and *Liophis cursor* have not been seen for decades and may have been extirpated. It cannot be established that the mongoose was responsible; *Didelphis marsupialis*, of recent introduction, may have played an important role. Introduced and invasive species are numerous in Martinique: *Chaunus marinus*, *Scinax ruber*, *Eleutherodactylus johnstonei*, *Gymnophthalmus underwoodi*, *Iguana iguana*, *Gekko gekko*, *Hemidactylus mabouia*, without considering escaped pets and the dubious case of *Allobates chalcopis* as an endemic species. I also present the restoration plan for *Iguana delicatissima* in the French West Indies and the conservation work for this species in Martinique; increase of nesting areas, translocation, creation of numerous protected areas, and control of *I. iguana*. Of a total of 13 endemic and indigenous species from Martinique, three are definitely and a further two are probably eradicated. Including Guadeloupe, the French West Indies have the highest loss of herpetological biodiversity among all the islands in the West Indies.

© Koninklijke Brill NV, Leiden, 2009

## Key words

Amphibians, Chancel Islet, conservation, French West Indies, *Iguana delicatissima*, invasive species, Martinique, reptiles, restoration plan, threats.

## Introduction

The book of Schwartz and Henderson (1991) was the first attempt to realise, at the Caribbean level, an account of the distribution of all the species of amphibians and reptiles. Only a few islands have been worked in depth with thorough field work, to produce an atlas with precise distribution ranges for all the herpetofauna. The Guadeloupe islands with Saint-Barthélemy and Saint-Martin (Breuil, 2002) and now Martinique are the islands where the herpetofauna is the best known, but there are many species that must still be worked out in detail. If we have a good understanding of the distribution of the amphibians and reptiles in the French West Indies (FWI), I do not share the opinion of Lorvelec et al. (2007: 132) that we

have accurate distribution ranges for the majority of species at the island and islet levels. As an example, the precise altitudinal distribution is not known for most reptiles species. Moreover, the small French islets are poorly known as shown by the recent discovery of *Alsophis sanctonum sanctonum* on Ilet à Cabrit or *Hemidactylus mabouia* and *Thecadactylus rapicauda* on Ilet Kahouanne (Guadeloupe). This present paper brings the description of the situation on Martinique up to date, including all the recent changes that occurred since the last published works on species distribution.

I worked on Martinique since 1994 with field and historical approaches (Breuil, 2003), and also made field trips to Dominica, Saint Lucia and Antigua with colleagues from the Durrell Wildlife Conservation Trust (DWCT, Jersey) to compare the herpetofauna of islands that were less disrupted by human activities. Much of the resulting data are unpublished, and a companion volume to Breuil (2002) on Guadeloupe is planned for Martinique. At the time of writing, I have more than 3000 personal species-localities for Martinique, which have been given to offices such as PNRM or DIREN for distribution maps (full titles of local organizations are given in the Acknowledgements). With the help of old naturalists' data, museum collections, biogeographical and geological analysis, published literature and the results of more than 50 weeks in the field looking for amphibians and reptiles in Martinique, I present in this paper more details and newer information than in Breuil (2002, 2003, 2004) on the herpetological community of this island before European arrival (Past), its recent situation (Present) and current and likely changes (Future). I consider that we are now in this future period with respect to extinction and the arrival of invasive herpetofauna species.

I describe in this paper the herpetofauna of Martinique as it was probably at the beginning of European colonization; what I call the Past period. I might have chosen the date of arrival of the first Amerindians to define this first period, but as there are few reptile bones in the archaeological remains in Martinique, it is impossible to evaluate any impact for that first human colonization. This first period may conveniently end in the middle of the 19th century with the death of François-Joseph L'Herminier in 1866, who sent a lot of animals to the Paris museum (MNHN) at a time where there were not too many changes in the FWI (Breuil, 2002).

The second period is from that time to the beginning of the 1980s; this period is considered as the Present. This period is marked by an increase in the destruction of habitats and the importation and subsequent proliferation of mongoose and raccoon. Cats, dogs, rats, and pigs were present from the start of colonization (Du Tertre, 1667) and became more and more abundant during this period. For example, British soldiers had Manx cats with them when they were in Marie-Galante during the Napoleonic wars, and it is sometimes possible to see offspring of these tailless cats there. This period was also characterised by massive destruction of *Bothrops lanceolatus* (Pinchon, 1967).

The third period, the Future, has the same characteristics as the second period at the level of the FWI, but its origin is marked by the arrival of many amphibian

and reptile species from South America, North America, other Caribbean islands, and indeed from other parts of the world as escaped pets or waifs. Some of these animals may have great impact on the local fauna.

I analyse the status of each species that reproduces or was known to reproduce in Martinique, and some others, and divide the herpetofauna into eight groups according to their status and Antillean geographical ranges:

- Vanished species that are no longer present in Martinique even if there are close relatives on other Caribbean islands: *Leptodactylus fallax* (Leptodactylidae), *Boa* sp. (Boidae), *Leiocephalus herminieri* (Tropiduridae).
- Nearly-vanished species that may survive in some remote parts such as tiny islets: *Mabuya mabouya* (Scincidae), *Liophis cursor* (Colubridae).
- Endemic species, with respect to current taxonomic opinion, that are only present in Martinique: *Bothrops lanceolatus* (Viperidae), *Anolis roquet* (Polychrotidae), *Sphaerodactylus vincenti* (Gekkonidae).
- Indigenous Lesser Antilles species that are considered as endemic from the Caribbean region: *Eleutherodactylus martinicensis* (Brachycephalidae), *Gymnophthalmus pleii* (Gymnophthalmidae), *Iguana delicatissima* (Iguanidae), *Thecadactylus rapicauda* (Gekkonidae), *Leptotyphlops bilineatus* (Leptotyphlopidae).
- Deliberately-introduced species, that are definitely attributable to human transport: *Chaunus marinus* (Bufonidae), *Iguana iguana* (Iguanidae), *Gekko gecko* (Gekkonidae), *Chelonoidis carbonaria* (Testudinidae).
- Involuntarily-introduced invasive species, that were not known in the Past or are far away from their original geographical range: *Eleutherodactylus johnstonei* (Brachycephalidae), *Scinax ruber* (Hylidae), *Hemidactylus mabouia* (Gekkonidae), *Gymnophthalmus underwoodi* (Gymnophthalmidae).
- Species escaped from captivity and waifs that have not yet become established: various species.
- Species with dubious status or wrong geographical attribution: *Allobates chalcopis* (Aromobatidae), *Ameiva major* (Teiidae).

### Vanished species

#### Leptodactylus fallax

The presence of *Leptodactylus fallax* in Martinique is well documented by numerous old texts (Anonyme de Carpentras, 1620; Bouton, 1640; Du Tertre, 1654, 1667; Breton, 1666; Labat, 1724; Thibault de Chanvalon, 1756; Leblond, 1813; Moreau de Jonnès, 1818a, 1858; Plée, 1820). A specimen caught by Moreau de Jonnès has always been in the Paris collection (MNHN.4487) but the locality is simply men-

tioned as Antilles, so I cannot affirm that this was from Martinique. Du Tertre (1667) was the first to provide a description of the foam nest of this species. To Du Tertre this frog was 14 inches long, whereas it was one foot long for Labat (1724). *L. fallax* from Montserrat and Dominica seem to be smaller than the Martinique frogs, perhaps because they were heavily hunted by man for food (Daltry, 2002; McIntyre, 2003). To Plée, they seemed to be identical between Dominica and Martinique. Recently Hedges and Heinicke (2007) were surprised by the absence of divergence between the two extant populations of *L. fallax* in Montserrat and Dominica, and suggested that this situation arose by human introductions. If this is true, it is possible that the species was introduced by Amerindians in some islands and that the population in Martinique was the same. The genetic homogeneity of *Iguana delicatissima* is similarly interpreted in terms of recent introductions by Mallone and Davis (2004).

This frog was hunted by Europeans (Bouton, 1640; Labat, 1724; Thibault de Chanvalon, 1756; Leblond, 1813; Plée, 1820) and by Amerindians. Hunting by Amerindians should have been low because this species is still present in Dominica which they inhabited for a long time. The only precise old localities in Martinique are in Macouba (Labat, 1724), the vicinity of Saint-Pierre, Pitons du Carbet (Leblond, 1813), and Lamentin (Plée, 1820). The species is reported by the different authors to be very abundant. The last testimonies of the presence of *L. fallax* in Martinique are those of Plée (1820). In Martinique, there are enough pristine areas suitable for this species to exclude habitat destruction as the main cause of extinction. For example, Leblond (1813) hunted *L. fallax* between the Pitons du Carbet, that has always been a very wild place. Hunting by Europeans (Du Tertre, 1667) may be one of the major causes of the decline, as in Dominica where until recently between 18,000 and 36,000 mountain chickens were killed each year for human consumption (McIntyre, 2003). As the manicou (*Didelphis marsupialis*) is very abundant in Martinique (Breuil, pers. obs.), and as this species seems to have been introduced in the 18th century (Breuil, 2003), it is also possible that this nocturnal marsupial hunted *L. fallax* to extinction.

The manicou is fully protected in Martinique where it was until recently thought to be a local endemic. The manicou is reported to hunt along the banks of streams and rivers (Daltry, 2002), so as they frequent the same habitat it is easy for the manicou to feed on the frog. It is noteworthy that Daltry (2002) reported of *L. fallax* that their “naivety when approached is typical of an animal that has evolved in the absence of... large predators. Frog species from other tropical continental areas, on the other hand, tend to have... more advanced avoidance or defence behaviours”. This is one more argument to consider that the manicou is a recent comer to Martinique that has modified the original herpetofauna. The manicou (and the raccoon) were not considered as important predators in the FWI because, as they were described as endemic subspecies or species, it was believed that the indigenous fauna had adapted to their presence.

Classical introduced predators (cats, mongooses, rats, dogs) and feral pigs may have also contributed to the extinction of *L. fallax* in Martinique but there are no data to support this hypothesis for Martinique. Barbour (1930) and Westerman (1953) suggested the impact of the mongoose on *L. fallax*, but without precise arguments. The mongoose is strictly diurnal whereas *L. fallax* is strictly nocturnal. Other external causes may include the volcanic activity of Montagne Pelée, as for the activity of the Soufrière Hills in Montserrat that deposited acidic ash and decreased the area of suitable habitat. The causes of extinction of this frog are thus not established in Martinique, but the causes of the drastic decrease of the populations of Dominica and Montserrat are now known (Daltry, 2002; McIntyre, 2003). I work on a project with the DWCT to breed this species in Martinique (Breuil, 2007).

### *Leiocephalus herminieri*

*Leiocephalus herminieri* is known in France as holotrope de l'Herminier (Breuil, 2002). According to Duméril and Bibron (1837), the specimens were sent to the Paris museum from Martinique by Plée and Guyon, and from Ile de la Trinité (Trinidad) by L'Herminier. This kind of erroneous localization corresponds to the harbour from where the boat carrying the collections left the Lesser Antilles or South America (Breuil, 2002, 2003). Roger Bour (pers. comm., 2003) subsequently studied the herpetological collection of the Bordeaux Museum of Natural History, and found a *Leiocephalus herminieri* labelled Guadeloupe. So, we have three different origins for this species: Trinidad, Martinique and Guadeloupe, but as I have already demonstrated beyond any doubt (Breuil 2002, 2003), *L. herminieri* lived in Martinique.

The causes of extinction of this lizard are not established; it seems to have been abundant in the 18th century (Breuil, 2003), but its range could also have been very restricted. *L. herminieri* may have been a beach dweller, as are other species in the genus, and if so tsunami waves may have destroyed its last littoral habitats in Martinique. The 1843 earthquake in Guadeloupe produced waves that may have submerged its habitats, as a 1-2 m increase of sea level was detected hundreds of kilometres from the epicentre. Lorvelec et al. (2007) suggest that this species possesses morphological characteristics that make it vulnerable to the mongoose. As there is a gap of more than 50 years between the last sighting of this lizard and the introduction of the mongoose, this is an unlikely cause of extinction.

### *Boa sp.*

The first citation of *Boa* in Martinique is said by Lorvelec et al. (2007) to date back to Anonyme de Carpentras (1620), but it is impossible to affirm that this refers specially to Martinique. The presence in Martinique is first reliably reported by Labat (1724) when he described in 1699 in the vicinity of Macouba “une couleuvre qui poursuivait une grenouille, . . . l'animal paraissait avoir 10 pieds de long” (a snake

that ran after a frog, . . . the animal seemed to be 10 feet long). Labat wrote that this snake is non poisonous and that it is well known to eat frogs. Moreover, he said that this couleuvre is an enemy of *Bothrops* and as a consequence people do not kill it. This citation of Labat is the only text that refers to a huge snake in Martinique. Bonny (2007) placed the boas from Saint Lucia (*Boa orophias*) and Dominica (*Boa nebulosa*) into separate species. If this point of view is correct then the boa from Martinique may have belonged to another endemic species.

The extinction of the boa in Martinique seems to be quite ancient. Thibault de Chanvalon (1756), Plée (1820), and Moreau de Jonnés (1816, 1818a, 1818b, 1821, 1822, 1858) never mentioned this snake although these three naturalists were very often in the field collecting specimens for the Paris museum (Breuil, 2002, 2003). So, at the beginning of the 19th century this species was very rare to the point where it could not be found by naturalists. Saint Lucia is inhabited by the mongoose and the maniocou, yet *Boa orophias* is still present, so that these mammals are unlikely to have caused the extinction of the boa in Martinique. Perhaps it was killed because it was mistaken for a lancehead or because it killed poultry.

### Nearly-vanished species

#### Mabuya mabouya

*Mabuya mabouya* (see Breuil, 2002 and Miralles, 2005 for the taxonomic problems concerning this species) is the rarest lizard in the FWI. The type of this species (now lost) that was used by Lacepède was probably sent to Paris by Thibault de Chanvalon with other reptiles from Martinique (Breuil, 2002). Plée (1820) also collected some specimens in Martinique (Breuil, 2002) and Miralles (2005) chose one of these specimens, which have the same geographical origin as the type, as a neotype.

When the situation of this species in Dominica, Saint Lucia, Guadeloupe and Martinique is compared, it is easy to see that in all the islands with the mongoose, there is no *Mabuya* sp. In Guadeloupe, *M. mabouya* is only present in three mongoose-free islands (Petite Terre, Désirade, Ilet à Cochons; Breuil, 2002). This species may thus have been a victim of the mongoose, but there is no direct evidence of this, only correlation. When it is at low density, as in Petite Terre and la Désirade, it is not easy to spot this lizard. I did not see this species in Martinique, but optimism makes me hope that *M. mabouya* is still present in some remote islet.

#### Liophis cursor

*Liophis cursor* was well known in the 18th and 19th centuries (Moreau de Jonnés, 1818a). The Paris museum has 14 specimens of this species determined by Dixon (1981), but all except three are labelled with wrong or imprecise geographical origins (Brazil, Chile, India, French Guiana, undetermined); this shows once again that it is difficult to give credit to some historical labels. Toulouse Natural History Museum possesses two specimens (Dubois and Bour, 1992). To the best of

my knowledge there are no 20th century published observations of this species in Martinique main island, but Père Pinchon caught a specimen of this species in 1965 in the vicinity of Fort-de-France which was given at the beginning of the 1990s to a Kansas museum. There are several records of its presence in the 1970s. The latest published observations were made in Rocher du Diamant in 1962 by Lazell (1967) and two specimens were collected by Père Pinchon and Marcel Bon-Saint-Côme in 1964 and 1968 (these specimens are in the MPP), so the comment of Lorvelec et al. (2007: 138) concerning this species is inaccurate. With Mark Day, I searched the Rocher du Diamant in dry season 1997, but we did not observe this snake, although fishermen reported it basking on rocks.

As an elusive species, the Martinique racer could survive in some places, as was shown recently for *Alsophis antillensis* in Basse-Terre and Grande-Terre (Béatrice Ibéné, pers. comm., 2003) and on Ilet à Cabrit (new locality for Les Saintes as *Alsophis sanctonum sanctonum*) despite the presence of cats, mongooses, rats, and humans that kill all snakes. In Martinique, the confusion between the racer and the lancehead may be an important cause of the decline and perhaps eradication of this species, but other predators may also have played a part.

## Endemic species

### Bothrops lanceolatus

*Bothrops lanceolatus* is the most famous endemic species in Martinique, with Saint Lucia the only two oceanic islands in the West Indies to be inhabited by a lancehead. At the time of colonization, Martinique was infested by this snake (Du Tertre, 1654) which was said to be an obstacle to the settlement of the island. An old legend reported by Du Tertre (1667) tries to explain the origin of *Bothrops* in Saint Lucia and in Martinique as the result of biological warfare between Amerindian groups; Arawaks were supposed to have imported these snakes from South America to make war on Caribs. Wüster et al. (2002) performed a genetic analysis of the two insular *Bothrops* species with respect to their South-American relatives (*B. atrox* – *B. asper* complex). They found that the two species belong to the same clade that may have diverged from their parental continental species some 4.2–8.9 Mya. To them, the first step of the colonization was Saint Lucia, then by dispersion on floatsam to Martinique between 3.1–6.5 Mya. This analysis used only one specimen of *B. lanceolatus* and two for *B. caribbaeus*. Nevertheless, taking into account the supposed time of divergence, we should expect to find some genetic variation within each species. I provided R. Thorpe and W. Wüster more than 20 tissue samples of *B. lanceolatus* from northern Martinique, but they did not find any polymorphism for the gene studied (cytochrome c). As the anti-venom serum produced for *B. lanceolatus* some 40 years ago is not as efficient as before, local authorities decided in 2007 to produce a new one. This was the opportunity to catch *Bothrops* that will be also used to study their genetic and morphometric differentiation.

The native Caribbean name for Martinique is Ioüanacaera and for Saint Lucia it is Ioüanalao (Breton, 1666). The first name means the island with iguanas and the second the place (island) where iguanas are found. Breuil (2002, 2003) proposed a hypothesis to explain this denomination. Here, I propose another non-exclusive interpretation for these names. For the guyano-amazonian populations and for rural people in Martinique it is very dangerous to call the *Bothrops* by its real name, “serpent”. Numerous expressions are used in Martinique to name it: bête longue, cravate, ennemie, vipère. It is possible that Amerindians used the name Ioüana instead of snake (Ahoüa, Ioulia, Iouiliati, Iuanna) as a stratagem to name these islands without fearing the snake’s vengeance. This interpretation is supported by the fact that Ilet Chevallier (south Martinique) is also called Ilet à Lézards but was inhabited by *B. lanceolatus* (Rufz de Lavison, 1859).

Barbour (1930) supposed that the mongoose was responsible of the decline of *Bothrops* in Martinique and Saint Lucia, De Lalung (1934) thought that both man and mongoose were responsible, and Lorvelec et al. (2007) proposed that the decline of *Bothrops* may be related to human predation. The situation is not as simple as these suggestions. Pinchon (1967) reported the number of bounties paid for the destruction of the snake in the 1960s. These figures do not give the real number of lanceheads killed each year because people conserved the heads in salt or rum, waiting for the authorities to have the money to pay the bounty. Moreover, among the heads of snakes there are heads of toads and anoles which are in such poor condition that they were thought by the authorities to be parts of real snakes (Lescure, pers. comm., 1997)! Nevertheless, these figures give an approximate rate of 5-10 snakes killed per year per km<sup>2</sup>. Thus, we cannot consider that *Bothrops* was rare in the 1960s. Today, the lancehead’s main prey seems to be rodents and birds. In Martinique, a lot of pesticides (chlordecone) are used against pests in banana fields; these pesticides are ingested by rats and birds, and in turn are accumulated in the snakes. Dead rats are often found in rural places, and such poisoned prey may be lethal or physiologically damaging to snakes. The destruction and fragmentation of habitats, the use of more and more pesticides, the killing of the snake for bounty (about \$20 in 1992) are all factors that combined to cause the decline of this species. In summer 2007, a huge catching operation was organised to collect snakes with the help of firemen, local snake hunters, etc.; less than 20 lanceheads were caught alive in three weeks.

### *Anolis roquet*

*Anolis roquet* is the most common lizard in Martinique, present on all the mountains: Mont Conil, Morne Jacob, Montagne Pelée, Pitons du Carbet, Montagne du Vauclin. Its range is thus from sea level to the top of the island in undisturbed habitats (Breuil, unpubl. data). Its highest altitude is not 920 m as supposed by Schwartz and Henderson (1991) and Thorpe and Stenson (2003); I found it on Plateau du Palmiste (1200 m asl) and inside the caldeira of Montagne Pelée (1370 m asl),



where its presence is obviously a recent colonization event after the 1902 eruption. Lazell (1972) described six subspecies from colour patterns and scalation. For 10 years Roger Thorpe's team studied *A. roquet* in Martinique with genetic and morphometric analysis, and constructed its phylogeny in relation to the geological history of the island.

Martinique was formed by agglomeration of old volcanic islands (fig. 1), as described by Andreieff et al. (1976, 1988), Bouysse and Westercamp (1988) and Westercamp et al. (1989). The history of Martinique began with the emergence of the peninsulas of Caravelle (east) and Sainte-Anne (south). These two parts were independent islands since about 22 Mya (Oligocene), when dry vegetation grew on them. During the Miocene, the Vauclin-Pitault submarine chain (16-12 Mya) connected them and later emerged. Volcanic activity then began to construct the south-western peninsula (Presqu'île des Trois-Ilets; 12-9 Mya), and continued in the west to develop the Baie de Fort-de France (8-6.5 Mya) which is a graben, later filled by the sea. This depression was formed after the last volcanic event as shown by the sedimentary rocks on its bottom; the north of this graben was also an old island. Morne Jacob volcano developed (5.5-4 Mya as submarine activity, then 2.7-2.25 Mya as aerial activity) as an independent island that progressively connected itself with the older parts to the south. From 2-0.8 Mya, Pitons du Carbet formed on its west flank. Earlier (3.5-2.5 Mya), an independent island formed at the extremity of the south-west peninsula (Presqu'île des Trois Ilets) that progressively connected itself with the older parts of Martinique. Mont Conil, a new island, formed north of Morne Jacob 0.5 Mya, connected to Morne Jacob and Pitons du Carbet by the birth of Montagne Pelée 0.2 Mya. Lastly, eustatic variation and sedimentation were responsible for the recent coastline and the presence of offshore islets. From this geological sketch, it is easy to see that there were numerous proto-islands that were entry points for the flora and the fauna.

Thorpe and Stenson (2003) did not use these geological data. A calibration of the molecular clock with local geological history might be useful for the sake of comparison, assuming that colonization of proto-islands is a rapid event after their formation. I agree with Thorpe and Stenson (2003) that for this kind of study it is insufficient to sample populations according to recognized subspecies and it is necessary to sample along transects. But to me, it is also necessary to sample in all areas according to the supposed geological history. Their genetic data lead to the assumption that one of the proto-islands (Péninsule de Sainte-Anne) was not colonized by anoles for some 12-15 My. Palaeontological data show that there is dry forest with *Gayacum*, *Tabebuia* and *Aiphanes* on this old island (Pons, 1987 in Westercamp et al., 1989). This forest was destroyed by ash from volcanic eruptions that date back to 22-20 Mya. Since that time, the south of Martinique emerged and there was no volcanic eruption after 18 Mya. So Sainte-Anne and Caravelle, that have the same age, are the two old islands that were stepping stones for colonization. It seems difficult to believe that these two islands were not colonized by anoles for some 15 My.

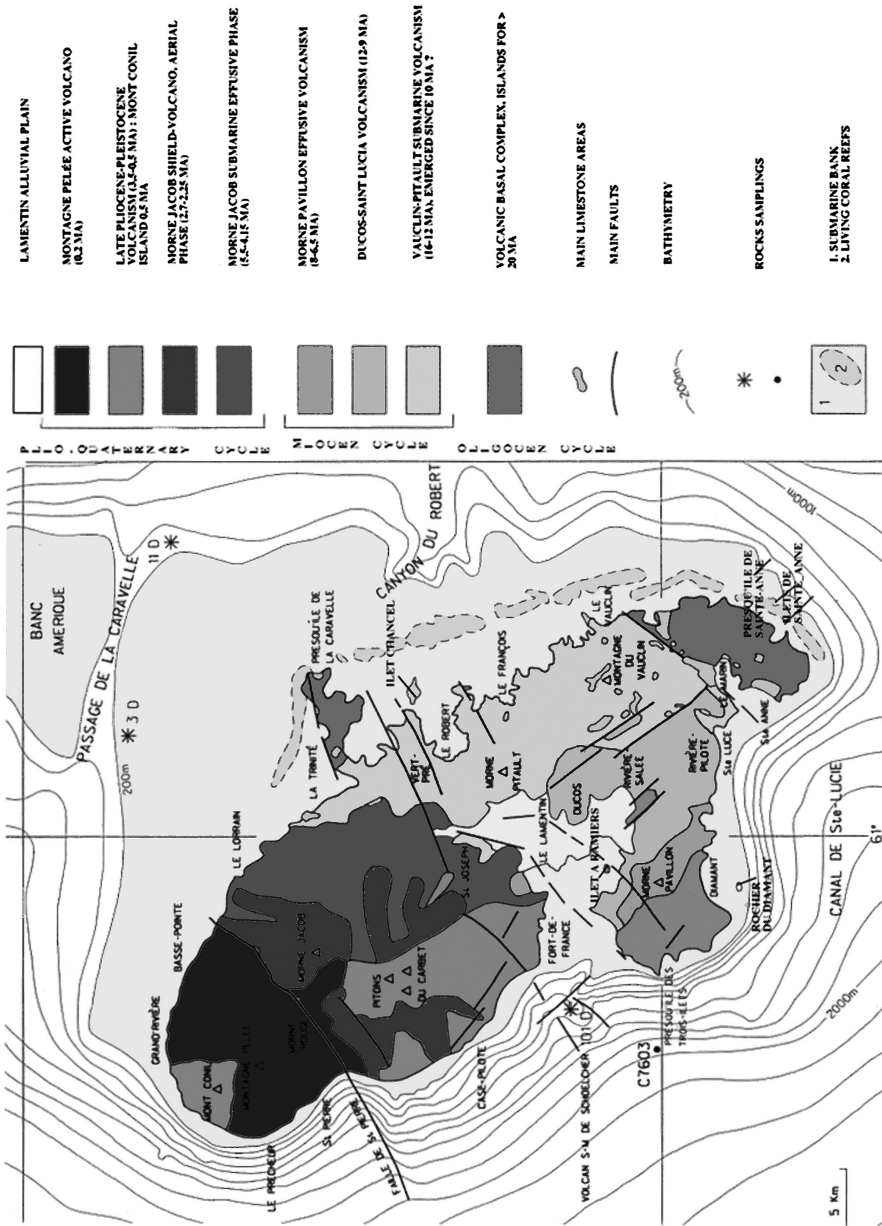
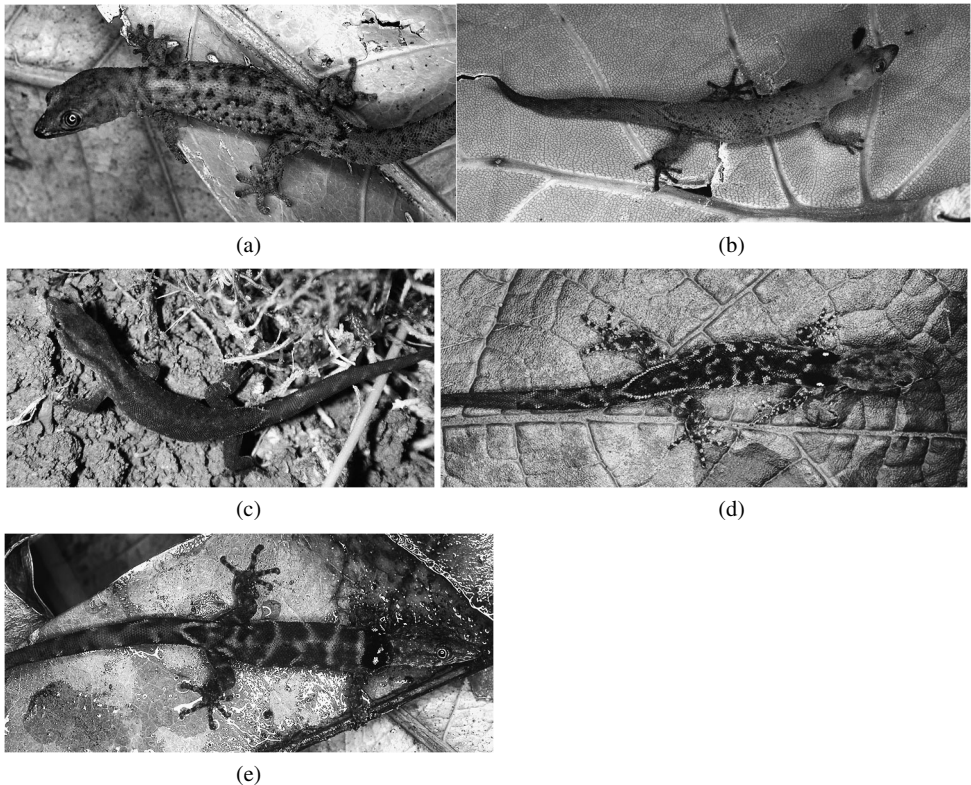


Figure 1. Geological map of Martinique (modified from Westercamp et al., 1989). (Colour original — see [www.ahatley.f9.co.uk/appliedherpetology/cartherp.htm](http://www.ahatley.f9.co.uk/appliedherpetology/cartherp.htm).)

*Sphaerodactylus vincenti*

Due to its biology, *Sphaerodactylus vincenti* seems to be a more interesting phylogeographical model than *Anolis*. I discovered more than 250 localities where this species is present, compared with the 15 localities mentioned by Schwartz and Henderson (1991). This species is quite abundant, sometimes at very high density (one per m<sup>2</sup> in the litter of dry forest) to very low density at high altitude on the Plateau du Palmiste (1200 m asl) on Montagne Pelée or on the summit of Morne Jacob and Montagne du Vauclin. In these moist forests, numerous individuals are found in bromeliads *Glomeropitcairnia penduliflora* at 1–3 m above soil level. As this species is more selective in its habitats, and moves less than *Anolis*, its differentiation is probably more representative of the geological history of Martinique.

Schwartz (1965) described six *S. vincenti* subspecies. My researches show that the situation is more complex, with probably two clades present in Martinique (fig. 2). One clade is in the south, where the *Sphaerodactylus* are small with no ocelli on the back, the other is in the north, containing subspecies that are bigger and have ocelli on the back. A comparison of morphology of northern and south-



**Figure 2.** *Sphaerodactylus vincenti* from (a) Rocher de Diamant; (b) South Peninsula (Sainte-Anne); (c) Montagne Pelée; (d) Ajoupa Bouillon; (e) Mont Conil. (Colour originals — see [www.ahailey.f9.co.uk/appliedherpetology/cariherp.htm](http://www.ahailey.f9.co.uk/appliedherpetology/cariherp.htm).)

ern populations shows so many differences that it would be easy to place them in two separate lineages, one that originates in the Sainte-Anne Peninsula, the other in Caravelle (figs 1 and 2).

The morphological characteristics of the *Sphaerodactylus* populations fit well with the history of Martinique as proposed by Westercamp et al. (1989). Each part of Martinique that was an independent island has its own type of *Sphaerodactylus* (Sainte-Anne, Caravelle, Péninsule des Trois-Ilets, Rocher du Diamant, Pitons du Carbet, Morne Jacob, Mont Conil, Montagne du Vauclin), but in some places there are intermediate phenotypes. The destruction of dry forest and its replacement by pastures, canefields and banana fields, and the use of many pesticides, are the main causes of the decline of *Sphaerodactylus* in the lowlands. The last hurricane (Dean, that impacted Martinique on 17 August 2007) nearly destroyed the south coastal populations of this species (as well as *Gymnophthalmus underwoodi*) by blowing away the leaf litter.

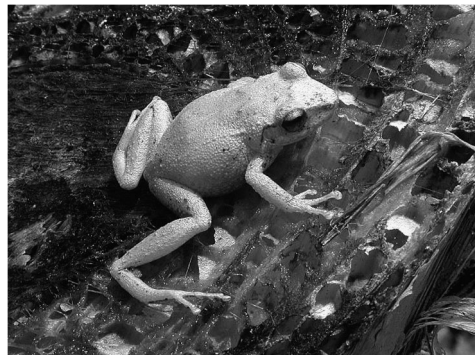
### Indigenous lesser Antilles species

#### *Eleutherodactylus martinicensis*

The only indigenous species of whistling frog in Martinique is *Eleutherodactylus martinicensis* (more than 280 localities). Plée first collected this species, probably on Pitons du Carbet. The type series in the MNHN contains females from Martinique and a male probably from Saint-Barth that could belong to an extinct *Eleutherodactylus* species endemic to that bank (Breuil, 2002). *E. martinicensis* is mainly present north of a line from Fort-de-France to Robert (fig. 3). Some populations remain in the moistest parts of the south such as Montagne du Vauclin (504 m asl) or in Rivière Pilote. It is probable that this patchy distribution is the consequence of the extension of *E. johnstonei* (more than 660 localities); *E. martinicensis* becomes rare.



(a)



(b)

**Figure 3.** *Eleutherodactylus martinicensis* from (a) Saint-Joseph (centre of Martinique) and (b) from north-east Martinique. (Colour originals — see [www.ahailey.f9.co.uk/appliedherpetology/cariherp.htm](http://www.ahailey.f9.co.uk/appliedherpetology/cariherp.htm).)

### *Gymnophthalmus pleii*

*Gymnophthalmus pleii* is widespread in Martinique; it is found mainly in littoral dry forests but also at greater altitude (400 m asl) along roadsides (more than 100 localities). For a long time it was considered to be the only *Gymnophthalmus* in Martinique (Schwartz and Henderson, 1991). For example, Pascal et al. (2004) saw a *Gymnophthalmus* sp. on Hardy islet in Sainte-Anne (south Martinique) and thought that this species was *G. pleii*. I made a herpetological inventory of these islets before them in 2001 and identified *G. pleii*, but *G. underwoodi* was also present on the nearby shore. Barbour (1930) considered that *G. pleii* was extinct in Martinique and Saint Lucia, and suspected that the mongoose was the cause. Nevertheless, it is easy to see that the two *Gymnophthalmus* species are very abundant even in mongoose-infested islands. *G. pleii* is so abundant in Martinique that it is obvious that the mongoose is not a problem for this species; even poultry does not seem to affect it, as seen in Chancel.

A comparison of *G. pleii* from Saint Lucia, Martinique and Dominica shows some differences in the coloration of each island population. It is possible that there is genetic differentiation that may warrant a specific status for these populations. There are about ten localities in Martinique where the two *Gymnophthalmus* species are present together. *G. pleii* decreased with respect to *G. underwoodi* in one of them that I followed since 1997 (Breuil, unpubl. data). These preliminary observations suggest that *G. underwoodi* becomes more widely distributed and abundant in Martinique and that *G. pleii* could be threatened as a result.

### *Thecadactylus rapicauda* and *Leptotyphlops bilineatus*

*Thecadactylus rapicauda* and *Leptotyphlops bilineatus* are the two least known species in Martinique; their distribution range is poorly known because of their secretive habits. *Thecadactylus* is found in dry and moist forest from sea level to more than 700 m asl (Rocher du Diamant, Mont Conil, Montagne du Vauclin, Ilet Chancel). Kronauer et al. (2005) and Bergmann and Russell (2007) recognized a cryptic species, *Thecadactylus solimoensis*, in South America that is different from the Lesser Antillean *T. rapicauda*.

*Leptotyphlops bilineatus* is also very widespread but not easy to find. It occurs in dry forest, gardens, fields and moist forest from south to north. It is also present on Ilet Chancel but now very rare there. A study of the systematics of this latter species is needed.

### *Iguana delicatissima*

The study of *Iguana delicatissima* and *I. iguana* began in the FWI in 1992 (Breuil et al., 1994), the first time that the opinion of Lazell (1973) concerning the relationships between the two iguanas species was challenged. Day and Thorpe (1996) confirmed the hybridization hypothesis between the two species and Breuil (2000c,

2001, 2002; Breuil et al., 2007) published some pictures of the hybrids. Day et al. (1999) wrote the action plan for *I. delicatissima*, and a synthesis of all the works devoted to is in Breuil (2002, 2003) and Pasachnik et al. (2006).

*Iguana delicatissima* is now very localized in Martinique. There are some individuals in the moist forest around Montagne Pelée (Pinchon, 1967; Lazell, 1973; pers. obs., fig. 4a). We know nearly nothing about these populations which are very difficult to study. A small population lives in the vicinity of Anse Coulevre (north) with iguanas nesting on the black sand beaches (Jean-François Maillard, ONCFS and SEPANMAR, pers. comm., 2005, 2007). The most important *I. delicatissima* population in Martinique lives on Ilet Chancel (Baie du Robert, Atlantic Coast, fig. 4b). I studied this population since 1993, with the collaboration of ONF, DIREN, ONCFS, AOMA, the municipality of Le Robert and the owners of the island (Breuil, 2000a, 2000b, 2001, 2002, 2003; Ourly, 2006; Legouez, 2007; Maillard and Breuil, 2007).

A comparison of the population of Chancel with that of Petite Terre (Guadeloupe) shows two important differences; the iguanas are at lower density and have smaller body size in Chancel (Breuil, 2002). From 1993 to 2005, I tagged iguanas with a metallic tag on the dewlap, and since 2006 they are tagged with PIT (Ourly, 2006; Legouez, 2007). Capture-recapture methods (Hayes and Carter, 1999) allow study of the growth and movements of the animals and estimation of the size of the population. Up to now more than 320 iguanas were ‘pitted’ in addition to 140 tagged on the dewlap. Chancel covers 70 ha and Petite Terre 129 ha; the density difference between the two populations is ten-fold although the habitats are similar (dry forest and patches of mangrove). The soil is, however, different; limestone and sand in Petite Terre, and difficult-to-dig volcanic rocks and clay in Chancel. One reason for the small population in Chancel is a nesting limitation, as females migrate to a few colonial nesting sites. A comparison of the iguanas in Chancel from 1997 to 2006 reveals some increase of length (Breuil, 2002; Ourly, 2006; Legouez, 2007), but in ten years the growth was not very high. The small size produces another effect; as the number of eggs laid by a female is related to body size, the small size of the females makes them lay fewer eggs than their counterparts on Petite Terre.

### **Deliberately-introduced species**

#### **Chaunus marinus**

*Bufo marinus*, now *Chaunus marinus* (Frost et al., 2006) was introduced to fight the sugar cane beetle hence its name of cane toad (review in Breuil, 2002). This toad was introduced in Martinique early in the 19th century, and is now present everywhere at low and medium altitude (more than 340 localities). It is also present in some islets with temporary ponds where it breeds: Chancel, Lavigne. It is more abundant in cultivated areas (mainly in banana fields), but it is also present in littoral dry forests. It is absent on the volcano summits of Montagne Pelée, Pitons du Carbet, and Morne Jacob, but it can be found along the roadsides between these



(a)



(b)



(c)

**Figure 4.** (a) *Iguana delicatissima*, Anse Céron, Martinique; (b) Ilet Chancel, Baie du Robert, Martinique; (c) Ilet à Ramiers, Baie de Fort-de-France, Martinique. (b), (c): photo DIREN Martinique. (Colour originals — see [www.ahailey.f9.co.uk/appliedherpetology/cariherp.htm](http://www.ahailey.f9.co.uk/appliedherpetology/cariherp.htm).)

mountains at an altitude of more than 470 m asl. It is unlikely that the cane toad contributed to the extinction of the mountain chicken since the introduction of *C. marinus* was more than 60 years after the last recorded observation of *L. fallax*.

There are also differences in diet (Lescure, 1979) and breeding site between these two large anurans, and *C. marinus* is absent from some areas where *L. fallax* was known to occur (Pitons du Carbet).

### Gekko gecko

The tokay (*Gekko gecko*) was introduced in Martinique in the 1970s from Indochina (Henderson et al., 1993). This species was reported to live in the lower parts of Martinique between Lamentin and Le Robert-Trinité where it is very abundant (10 localities) and easy to locate at night from its barking call. With its sticky eggs (Breuil, 2004) it is easily carried from place to place and now it is found at Sainte Luce, Le François (south) and Sainte Marie (north east). I have no data on the impact of this species on the local fauna. Nevertheless as a big predator (I saw it eating bats *Molossus molossus* and *Tadarida brasiliensis*, and other nocturnal lizards) its impact in a house is of the same type as the presence of a cat.

### Iguana iguana

*Iguana iguana* is not indigenous in Martinique. The green or common iguanas that are now present were introduced from Les Saintes by Père Pinchon (Breuil, 2003) in the middle of the 1960s. Some may also have been brought to this island by the sailors of the warship Jeanne d'Arc. Since the end of the 1960s they were freed in Fort Saint-Louis and they proliferate in this quiet place which has many trees to hide, food from the army kitchen, and nesting sites. From less than ten individuals in the 1960s the population increased and I estimated its size in 1994 at about 500 adults and subadults (Breuil, 2000a). The number dropped ten-fold at the beginning of the 21st century, as policy towards the iguanas changed (no food supplies; cutting of the trees; cats and dogs running free) and they began to move outside the fort. Iguanas now walk in the public garden close to the fort and people carry them to other places in Martinique. Since the end of the 1990s, there are each year new records of iguanas in different parts of Martinique (Trinité, Le Robert, Saint-François, Le Vauclin, Le Diamant, Trois-Ilets, Schoelcher, Terreville, Le Gallion; the last three places are in the suburbs of Fort-de-France), but there is no proof of the reproduction of this species away from Fort Saint-Louis. *I. iguana* is now in the vicinity of Chancel and there is the danger that somebody will translocate them there or that they will swim to the islet. In Martinique, ONCFS, DIREN and ONF consider that *I. iguana* is an invasive species that must be eliminated to prevent the loss of *I. delicatissima*.

### Chelonoidis carbonaria

*Chelonoidis carbonaria* is found in Martinique in gardens, where it reproduces. I have no information on the presence of *C. denticulata* in Martinique, although there is a carapace with no data in the MPP, whereas I have proof of the existence



of this species in Guadeloupe but with an unknown status (Breuil, 2002). I already discussed the origin of *C. carbonaria* in Guadeloupe and the same hypothesis holds for Martinique. Although some waif *C. carbonaria* are sometimes found in the wild, I do not think that there are feral populations in Martinique.

### **Involuntarily-introduced invasive species**

#### *Scinax ruber*

I found the first *Scinax ruber* in 1997 in a house in the town of Le Robert. Since then, I discovered more than 25 populations in Martinique, south of a line Fort-de-France to Le Robert, but this is an underestimation of its true abundance (Breuil and Ibéné, 2008). This species was found in the extreme north of Martinique in March 2007 (Catzefis, pers. comm.). It inhabits pastures, orchards, banana fields and gardens, and can also be found in buildings in Fort-de-France (Francis Deknuydt, pers. comm., July 2005), and reproduces in tanks, barrels, and ponds. It is more abundant in the south because there are many ponds in the fields for cattle. At night, it hunts on walls and trees; in the day it hides in bricks, pipes, and other construction materials so that it is easily transported from place to place. During the wet season, this species is also able to rapidly colonize new areas on its own. Saint Lucia is the only other Lesser Antillean island where this species is known, but it is not common (Matthew Morton, pers. comm., 2005 and pers. obs.). It is possible that *S. ruber* arrived in Martinique from Saint Lucia, but its low abundance there makes this less probable than a direct arrival from French Guiana (Breuil and Ibéné, 2008).

#### *Eleutherodactylus johnstonei*

*Eleutherodactylus johnstonei* is the most widespread *Eleutherodactylus* in the FWI. It is very abundant in Martinique everywhere from dry forest to the top of the volcanoes (Pitons du Carbet) where it is often found in bromeliads. It replaces *E. martinicensis* in the south of Martinique. In the moist forest of the north, *E. johnstonei* is abundant on the ground whereas *E. martinicensis* is mainly in trees.

#### *Hemidactylus mabouia*

*Hemidactylus mabouia* is very widespread in Martinique from sea level to the electric transformer of Aileron (880 m asl) on Montagne Pelée (more than 180 localities). This species is also abundant on very small islets off south Martinique (Aigrette, Hardy, Percé); *Hemidactylus* hides in and under rocks in such places with nearly no trees. The presence of this gecko is explained by its ability to stick eggs on fishing boats, as I observed many times. This species was probably introduced with the slave trade at the beginning of colonization (Breuil, 2002) and was not dispersed by rafting from Africa as suggested by Kluge (1969). The genetic analyses of amphisbaena by Vidal et al. (2008) and of geckos by Weiss and Hedges

(2007) show that transatlantic colonization of the Americas from Africa did occur in the past. But there is nearly no genetic variation in Greater Antilles populations of *H. haitianus* and *H. brooki*, and these species clustered with one population of *H. angulatus* from Equatorial Guinea. So according to Weiss and Hedges (2007) these two species must be referred to *H. angulatus* and are the descendants of historically introduced individuals. In this context, *H. mabouia* is also a good candidate for human transportation during the slave trade; genetic analysis is necessary to test this hypothesis. It is worth remembering that, at the beginning of colonization, only one gecko species was known by Du Tertre (1654, 1667); presumably *T. rapicauda* (Breuil, 2002).

### Gymnophthalmus underwoodi

Breuil (2002) presented the problems concerning the distribution of the two *Gymnophthalmus* species and how the first *G. underwoodi* found in Martinique were determined as *G. pleii*. I now know more than 25 places where this species is present, and among them 10 are also inhabited by *G. pleii*. *G. underwoodi* is a newcomer in Martinique; it probably arrived at the beginning of the 1990s. Replacement of *G. pleii* by *G. underwoodi* is already known in some places in Martinique. The question is whether this parthenogenetic species arrived in the West Indies once from South America and then colonized other islands from this unknown stepping point, or if it was introduced several times. Genetic analysis must be performed to study the modality of colonization of this invasive species.

### Species escaped from captivity

The oldest waif I discovered is an agamid found alive (1968) on the boat Le Mont Blanc from Marseille that stopped in Fort-de-France. This lizard (probably *Laudakia stellio*) lives in Greece and is now in the MPP. In Martinique, since the beginning of the 21st century, the following species have been found in the wild as waifs or escaped pets: *Graptemys pseudogeographica*, *Terrapene carolina*, *Trachemys scripta elegans*, *Geochelone sulcata*, *Pantherophis guttatus*, *Natrix natrix*, *Epicrates cenchria*, *Boa constrictor*, *Python regius* and an undetermined caiman from Guiana some 25 years ago.

The first *Trachemys scripta elegans* found in the FWI was discovered by Père Pinchon in Guadeloupe (Breuil, 2002). These historical specimens are in the collection of the MPP in Martinique. *Trachemys scripta elegans* is now found in artificial ponds but also in rivers and swamps all over Martinique. As the males are very rare because the sex is determined by the incubation temperature, and professional breeders produce only females, it is possible that this species does not reproduce in Martinique. Some specimens of *Pantherophis guttatus* have been found in the field in Martinique (PNRM, ONCFS, pers. comm., 2005, 2006). Moreover, in June 2007, two *Natrix natrix* were found as road kills in the harbour in Martinique by Jean-François Maillard (ONCFS), probably coming in with European cars.

## Species of dubious status or wrong geographical attribution

### *Allobates chalcopis*

*Colostethus chalcopis* was described as an endemic taxon from Martinique by Kaiser et al. (1994). At the time of its description, *C. chalcopis* was considered to be a dendrobatid, but the supposed presence of such a family on an oceanic island was quite strange. Grant et al. (2006) placed this species in another family (Aromobatidae), in a new subfamily (Allobatinae), and in the genus *Allobates*. As with the Dendrobatinae, the sub-family Allobatinae does not have any other representative on oceanic islands.

The lack of naturally-occurring anurans with totally aquatic development in the Lesser Antilles, even in the southern oceanic islands of the West Indies, suggests that frogs (i.e. metamorphosed anurans) are unable to survive for days on a raft in the sea (Breuil and Ibéné, 2008). The only indigenous Lesser Antillean anurans are Leptodactylidae (*Leptodactylus*) and Brachycephalidae (*Eleutherodactylus*) that may have arrived as eggs or in foam nests that can be considered as more resistant stages for survival on a raft. If anurans were able to colonize the Lesser Antilles as frogs, it is curious why there are no indigenous representatives of Hylidae, Centrolenidae, Dendrobatidae and Bufonidae in these islands. I know cases where frogs from Venezuela were carried to Martinique with plants for a botanical garden (Jardin de Balata), and plants from this place have been used in a garden within the distribution area of *A. chalcopis*. To me, its endemism is dubious but as I have no stronger arguments, it must at present be considered as a local endemic that should be protected.

### *Ameiva major*

Since the work of Baskin and Williams (1966), *Ameiva major* was considered to be a lost *Ameiva* from Martinique. Nevertheless, I showed beyond any doubt that this species lived in Petite Terre in the Guadeloupean Archipelago (Breuil, 2002). My biogeographical analysis (Breuil, 2003) suggested that the probability of the existence of an *Ameiva* species in Martinique in historical times was low. There are neither texts nor fossil remains that suggest the presence of an *Ameiva* species in Martinique. Ineich et al. (2005) mentioned the presence of a specimen of *Ameiva major*, labelled Martinique, in the Museum of Natural History of Lyon. This is probably one of the specimens used by Duméril and Bibron (1839) for the description of the taxon and labelled Martinique with reference to the MNHN specimens. Such specimens were thereafter given to local and foreign museums (Breuil, 2002). This citation therefore does not modify my conclusions on the localization of *Ameiva major*. It is probable that Martinique did not have an *Ameiva* species in historical times.

## Conservation measures

The indigenous species of amphibian and reptile are fully protected in Martinique since 1989. The official list contains many mistakes, including three species that do not live in Martinique. The following species are fully protected by this text: *Gymnophthalmus pleii*, *Anolis roquet*, *Iguana delicatissima*, *Sphaerodactylus vincenti*, *Thecadactylus rapicauda*, *Liophis cursor*, *Leptotyphlops bilineatus*, *Eleutherodactylus johnstonei* and *E. martinicensis*. *Mabuya mabouya* is not protected because it was thought that it had vanished. An updated list of protected species is in preparation for Guadeloupe and Martinique.

### *Conservation of Iguana delicatissima*

*Iguana iguana* is protected only in Guadeloupe where it was thought, on the basis of Lazell's (1973) work, that it is naturally present; this species is now eliminating *I. delicatissima* by competition and hybridization. Breuil (2002) gave many arguments that show that *I. iguana* is a newcomer in Guadeloupe, and its recent expansion there dates back to the 1980s. It is worth noting that in the newspaper France-Antilles (14 June 2008), a man tells of bringing iguanas from Les Saintes to Basse-Terre at the end of the 1950s. Since 1993, I informed local administrations of the situation but it became worse and worse and nothing was done in Guadeloupe to limit the extension of this invasive species (Breuil, 2003). Field work conducted in summer 2007 showed that all the known *I. delicatissima* populations in Basse-Terre and Grande-Terre are now invaded by *I. iguana* with the production of many hybrids (Breuil et al., 2007). This dramatic situation in Guadeloupe was understood in Martinique and local authorities tried to prevent such a situation occurring there. Lorvelec et al. (2004, 2007) now consider that *I. iguana* is a species which causes great threats to *I. delicatissima* in Guadeloupe, although this threat was not recognised earlier (Lorvelec and Pavis, 1999). It is hoped that a consensus will be found in the FWI and that the local administrations and the Ministry of Ecology and Sustainable Development will take the decision to consider *I. iguana* as an invasive species in the FWI and withdraw it from the list of protected species in Guadeloupe. In Martinique, since 2005 an official text authorizes agents from ONCFS to kill *I. iguana* to prevent its extension in the island.

The Ministry of Ecology and Sustainable Development in April 2005 requested a restoration plan for *I. delicatissima* for the FWI. This plan is nearly ready for Martinique (Legouez, 2007) but it is not the case in Guadeloupe where the situation is more complex (Breuil et al., 2007). *Iguana iguana* is now found in Marie-Galante, probably coming from Les Saintes (Fortuné Guiougou, pers. comm., April 2008). Worse, *I. iguana* is seen regularly in Saint-Barth since 2007 and hybrids were discovered that suggest an *I. iguana* arrival already some years ago. These *I. iguana* are from St Maarten and are waifs or escaped pets (Karl Questel, Franciane Le Quellec, Michel Magras, in litt., April 2008).

The causes of the small size of the *I. delicatissima* population on Chancel are known (Breuil, 2000a, 2000b, 2001c). In 2000 one of the two known colonial nesting sites there was improved to prevent excavation of eggs by females, to increase the population size which is low with respect to the island's carrying capacity (Breuil, 2000a, 2000b, 2001c). This programme was necessary to balance the negative impact of thousands of tourists that walk on the nesting site, destroying eggs. This island is a tourist hot spot with 50-200 daily visitors all year round; visits to the ruins (old factory, lime kiln) and the sighting of iguanas have a great economic value for the town of Le Robert. This improvement of the nesting site was a success and there were an increase of the adult population and a decrease of egg loss in the following years (Ourly, 2006; Legouez, 2007). The vegetation of Ilet Chancel has changed since the 1950s, as shown by aerial photographs; there was a small landing place for light aircraft on the top of the hill that may have been a nesting site some decades ago, but which is now covered with trees. With the population's increase in the last two years, new nesting sites were dug by iguanas in places without trees.

As a result of the increase of the Chancel population, the ONCFS, DIREN and the MNHN proposed in 2006 to the French Ministry of Ecology and Sustainable Development to translocate some iguanas to Ilet à Ramiers (Baie of Fort de France, fig. 4c). This action was necessary because there is the chance that *I. iguana* will invade Chancel. This project was accepted because it was documented along Biological Conservation Rules. In 2005, an Arrêté de Protection de Biotope (Local Habitat Protection Law) was published for Ilet Chancel and Ilet à Ramiers; the latter is owned by Marine Nationale and nobody is allowed to get there without permission. The translocation followed the protocol of Knapp and Hudson (2004) for *Cyclura*, and occurred in July 2006 (Ourly, 2006). Some of the iguanas were equipped with radiotransmitters and all of them were PIT tagged. I went to Ilet à Ramiers in April 2008 with ONCFS. We discovered a 2007 nest at the place we recognized before the translocation as a suitable nesting site and where in summer 2007 we saw signs of nesting activity. We dug the nest and collected 14 eggs, among which 12 hatched. Other islets are currently under study for the PNRM to evaluate their capacity to support an *I. delicatissima* population.

#### *Other species of terrestrial herpetofauna*

The Rocher du Diamant, supposed to be the last place where *Liophis cursor* lives, now has full protection status (Arrêté de Protection de Biotope, 2005). It was fitted with videocameras to observe the birds and I hope that we will soon get pictures of *L. cursor*. It is amazing that this very small place that was inhabited by the English, the French and rats during the Napoleonic wars could still perhaps possess this snake. The persistence of a small population of a racer on a tiny islet calls to mind the survival of other racer species on Maria Islands (Saint Lucia), on Great Bird Island (Antigua), or in Les Saintes.

An important (2300 ha) Reserve Biologique Intégrale, a status recognized by IUCN, was also created in 2007 around Montagne Pelée after years of study, and another is in preparation around Pitons du Carbet (4000 ha) by ONF. Another area, west of the reserve of Montagne Pelée, also has special protection status to preserve the important biodiversity in that sector. These reserves protect the habitat of the last *I. delicatissima* in moist forest, *B. lanceolatus* and other herpetofauna, and a beautiful endemic spider, *Avicularia versicolor*. There are also two nature reserves in Martinique. The older one is the east part of Péninsule de la Caravelle that protects mangrove and dry littoral forest inhabited by *Anolis roquet caracoli*, *Sphaerodactylus vincenti ronaldi*, *Thecadactylus rapicauda*, *Gymnophthalmus pleii*, *Leptotyphlops bilineatus*, and *Eleutherodactylus martinicensis*. The second, La Réserve Naturelle des Ilets de Sainte-Anne, is devoted to birds. Among these islets Hardy is inhabited by *G. pleii*, *Anolis roquet salinei* and *H. mabouia*. The presence of *G. pleii* in Hardy as well as on other offshore islets (Gros Ilet, Chancel, etc.) is of interest with the colonization of Martinique by *G. underwoodi*.

The FWI possess the worst situation in the Lesser Antilles with respect to the preservation of the original herpetofauna. These islands lost the highest number of amphibian and reptile species and they gained the highest number of introduced and invasive herpetofauna that begin to spread to other islands (Breuil, 2002, 2003; Breuil and Ibéné, 2008). The situation is more problematic in Guadeloupe, Saint-Martin and Saint-Barthélemy than in Martinique. As I wrote (Breuil, 2003) there is always something new to discover in the FWI. Since then, Guadeloupe has the additional reproducing species: *Ramphotyphlops braminus* (Basse-Terre, Grande-Terre), *Scinax* cf. *x-signatus* (Basse-Terre, Grande-Terre, Marie-Galante, La Désirade), *G. gecko* (Grande-Terre), *G. underwoodi* (Saint-Martin), *I. iguana* (Marie-Galante, Saint-Barthélemy) (Breuil, 2004; Fortuné Guiougou, Béatrice Ibéné, Karl Questel, Franciane Le Quellec, Maxime Louis, Michel Magras, Fred Martail, Éric Dubois-Millot, pers. comm.). Moreover, *Scinax ruber*, *G. gecko*, *G. underwoodi* and *I. iguana* are expanding in Martinique. The exchanges of introduced species within the FWI, as already shown by *G. gecko*, will soon occur on an even greater scale with the increase of commercial links between Guadeloupe and Martinique. L'ASFA recently edited a leaflet on the problem of invasive frogs, and a poster on endemic vertebrate species. Other posters and leaflets were also produced by DIREN Martinique on the terrestrial herpetofauna, on iguanas, and marine turtles, to promote knowledge and protection. A stamp picturing *I. delicatissima* was issued by the French Post Office in 2007, but unfortunately also one picturing the raccoon!

#### Acknowledgements

I would like to acknowledge the administrations of Martinique and their personnel for their help in the study of the herpetofauna of Martinique: Office National des Forêts (ONF), Office National de la Chasse et de la Faune Sauvage (ONCFS), Direction Régionale de l'Environnement (DIREN), Parc Naturel Régional (PNRM), Conseil Régional, Musée Père Pinchon (MPP, Fort-de-France), and local associations such as Association Ornithologique Martiniquaise (AOMA), Société pour l'Étude, la Protection et l'Aménagement de la Nature en Martinique (SEPANMAR), Le Gaiac (Iguana group of Guadeloupe) and l'Association pour la Sauvegarde et la Réhabilitation de la Faune des Antilles (L'ASFA). Thanks also to Dr Béatrice Ibéné

(L'ASFA) and the members of this association for her information concerning the recent herpetological data for Guadeloupe and to the naturalists that send me pictures for identification. I would like also to thank Adrian Hailey and three anonymous referees that made pertinent remarks and improved the text.

## References

- Andreieff, P., Bellon, H., Westercamp, D. (1976): Chronométrie et stratigraphie comparée des édifices volcaniques et formations sédimentaires de la Martinique (Antilles françaises). *Bull. BRGM* (2), **IV**, 4: 335-346.
- Andreieff, P., Baubron, J.-C., Westercamp, D. (1988): Histoire géologique de la Martinique, (Petites Antilles): biostratigraphie (foraminifères), radiochronologie (potassium-argon), évolution volcano-structurale. *Géologie de la France* **2/3**: 39-70.
- Anonyme de Carpentras (1620): Un Flibustier Français dans la Mer des Antilles (1618-1620). Paris, Payot & Rivages, presented by Moreau, J.-P., 2002.
- Barbour, T. (1930): Some faunistic changes in the Lesser Antilles. *Proc. New England Zoöl. Club*. **11**: 73-85.
- Baskin, J.N., Williams, E.E. (1966): The Lesser Antillean *Ameiva* (Sauria, Teiidae). Re-evaluation, zoogeography, and the effects of predation. *Stud. Fauna Curaçao Carib. Is.* **23**: 144-176.
- Bergmann, P.J., Russell, A.P. (2007): Systematics and biogeography of the widespread Neotropical gekkonid genus *Thecadactylus* (Squamata), with the description of a new cryptic species. *Zoological Journal of the Linnean Society* **149**: 339-370.
- Bonny, K. (2007): Die Gattung *Boa*. Taxonomie und Fortpflanzung. Kus-Verlag, Rheinstetten, Germany.
- Bouysse, P., Westercamp, D. (1988): Effets de la subduction de rides océaniques sur l'évolution d'un arc insulaire : l'exemple des Petites Antilles. *Géologie de la France* **2/3**: 2-38.
- Bouton J. (1640): Relation de l'Etablissement des Français depuis l'an 1635 en l'Isle de la Martinique, l'une des Antilles de l'Amérique, des moeurs des Sauvages de la situation et des autres singularités de l'Isle. Paris, Sébastien Cramoisy.
- Breton, R. (1666): Dictionnaire caraïbe françois-Dictionnaire françois caraïbe meslé de quantité de remarques historiques pour l'éclaircissement de la langue. Grammaire caraïbe. Gilles Bouquet, Auxerre.
- Breuil, M. (2000a): Taxon Reports: Lesser Antilles *Iguana delicatissima* and *Iguana iguana*. *West Indian Iguana Specialist Group Newsletter* **3**(1): 4-5.
- Breuil, M. (2000b): Taxon Reports: Lesser Antilles *Iguana delicatissima* and *Iguana iguana*. *West Indian Iguana Specialist Group Newsletter* **3**(2): 11-13.
- Breuil, M. (2000c): Taxon Reports: Hybridization in the Guadeloupean Archipelago. *West Indian Iguana Specialist Group Newsletter* **4**(2): 13-15.
- Breuil, M. (2001): Taxon Reports: Lesser Antilles *Iguana delicatissima* and *Iguana iguana*. *West Indian Iguana Specialist Group Newsletter* **4**(2): 9-11.
- Breuil, M. (2002): Histoire Naturelle des Amphibiens et Reptiles Terrestres de l'Archipel Guadeloupéen. Guadeloupe, Saint-Martin, Saint-Barthélemy. Paris, MNHN, Institut d'Écologie et de Gestion de la Biodiversité, Service du Patrimoine Naturel, Patrimoines naturels No 54.
- Breuil, M. (2003): In the footsteps of French naturalists, a "battle" of iguanas, and "improvements" in biodiversity. In: *Islands and the Sea. Essays on Herpetological Exploration in the West Indies*, p. 255-270. Henderson, R.W., Powell, R., Eds, Ithaca, New York, Society for the Study of Amphibians and Reptiles.

- Breuil, M. (2004): À la Découverte des Amphibiens & Reptiles des Antilles. Le Gosier, Guadeloupe, PLB (Thierry Petit Le Brun) Éditions.
- Breuil, M. (2007): Projet de réintroduction à la Martinique du crapaud de la Dominique *Leptodactylus fallax*. Report ONCFS-DIREN Martinique.
- Breuil, M., Day, M., Thiébot, B. (1994): L'iguane antillais (*Iguana delicatissima*), une espèce en voie de regression. Le Courrier de la Nature, **143**: 16-17.
- Breuil, M., Guiouguou, F., Ibéné, B. (2007): Lesser Antillean Iguana (*Iguana delicatissima*). West Indian Iguana Specialist Group Newsletter **10**(2): 15-17.
- Breuil, M., Ibéné, B. (2008): Les Hylidés envahissants dans les Antilles françaises et le peuplement batrachologique naturel. Bull. Soc. Herp. Fr. **125**: 41-67.
- Daltry, J.C. (2002): Mountain Chicken Monitoring Manual. First Draft. Fauna & Flora International, Cambridge, and the Forestry and Wildlife Division, Dominica.
- Day, M.L., Thorpe, R.S. (1996): Population differentiation of *Iguana delicatissima* and *I. iguana* in the Lesser Antilles. In: Contributions to the West Indian Herpetology. A Tribute to Albert Schwartz, p. 436-437, abstract. Powell, R., Henderson, R.W., Eds, Ithaca, New York, Society for the Study of the Amphibians and Reptiles, Contributions to Herpetology, Vol. 12.
- Day, M.L., Breuil, M., Reichling, S. (1999): Lesser Antillean iguana. *Iguana delicatissima*. In: West Indian Iguanas: Status Survey and Conservation Action Plan, p. 62-67. Alberts, A., Ed., Gland, Switzerland, IUCN, Species Survival Commission, West Indian Iguana Specialist Group.
- De Lalung, H. (1934): Le Serpent de la Martinique. Sa légende, ses mœurs, ses ennemis. Comment les Caraïbes et les Nègres soignaient ses piqûres. Essai de médecine rétrospective. Laboratoire Corbières, Paris.
- Dixon, J.R. (1981): The Neotropical Snake genus *Liophis*: The Eastern Caribbean complex. *Copeia* **1981**: 296-304.
- Dubois, A., Bour, R. (1992): Inventaire des collections herpétologiques (Amphibiens et reptiles) du Muséum d'Histoire naturelle de Toulouse. Report. Laboratoire des Reptiles et Amphibiens, MNHN.
- Duméril, A.M.C., Bibron, G. (1837): Erpétologie Générale ou Histoire Naturelle Complète des Reptiles. Vol. 4. Paris, Librairie Encyclopédique de Roret.
- Duméril, A.M.C., Bibron, G. (1839): Erpétologie Générale ou Histoire Naturelle Complète des Reptiles. Vol. 5. Paris, Librairie Encyclopédique de Roret.
- Du Tertre, J.-B. (1654): Histoire générale des isles de Saint-Christophe, de la Guadeloupe, de la Martinique et autres de l'Amérique où l'on verra l'établissement des colonies françaises dans ces isles, leurs guerres civiles et étrangères et tout ce qui se passe dans le voyage et retour des Indes. Paris, J. et E. Langlois.
- Du Tertre, J.-B. (1667): Histoire générale des Antilles habitées par les François. T.1 contenant tout ce qui s'est passé dans l'établissement des colonies françaises. T. 2 contenant l'histoire naturelle. Paris, Thomas Jolly.
- Frost, D.R., Grant, T., Faivovich, J., Bain, R.H., Haas, A., Haddad, C.F.B., De Sá, R.O., Channing, A., Wilkinson, M., Donnellan, S.C., Raxworthy, C.J., Campbell, J.A., Blotto, B.L., Moler, P., Drewes, R.C., Nussbaum, R.A., Lynch, J.D., Green, D.M., Ward, C., Wheeler, W.C. (2006): The amphibian tree of life. *Bull. Amer. Mus. Nat. Hist.* **297**: 1-370.
- Grant, T., Frost, D.R., Caldwell, J.P., Gagliardo, R., Haddad, C.F.B., Kok, P.J.R., Means, D.B., Noonan, B.P., Schargel, W.E., Wheeler, W.C. (2006): Phylogenetic systematics of dart-poison frogs and their relatives (Amphibi: Athesphatanura, Dendrobatidae). *Bull. Amer. Mus. Nat. Hist.* **299**: 1-262.



- Hayes, W., Carter, R. (1999): Population monitoring. In: West Indian Iguanas: Status Survey and Conservation Action Plan, p. 79-85. Alberts, A., Ed., Gland, Switzerland, IUCN, Species Survival Commission, West Indian Iguana Specialist Group.
- Hedges, S.B., Heinicke, M.P. (2007): Molecular phylogeny and biogeography of West Indian frogs of the genus *Leptodactylus* (Anura, Leptodactylidae). *Molecular Phylogenetics and Evolution*. **44**: 308-314.
- Henderson, R.W., Delatte, A., McCarthy, T.J. (1993): *Gekko gekko* (Sauria: Gekkonidae) established on Martinique, French West Indies. *Carib. J. Sc.* **29**: 128-129.
- Ineich, I., Martelli, J.-L., Clary, J. (2005): Catalogue des collections de reptiles du Muséum d'Histoire naturelle de Lyon, sixième note: Sauriens (deuxième partie) et Rhynchocéphales. *Cahiers scientifiques Mus. Hist. Nat. Lyon*. **8**: 33-66.
- Kaiser, H., Coloma, L.A., Gray, H.M. (1994): A new species of *Colostethus* (Anura Dendrobatidae) from Martinique, French Antilles. *Herpetologica* **50**: 23-32.
- Kluge, A.G. (1969): The evolution and geographical origin of the New World *Hemidactylus mabouia-brookii* complex (Gekkonidae, Sauria). *Misc. Publ. Mus. Zool., Univ. Michigan*. **138**: 1-78.
- Knapp, C.R., Hudson, R.D. (2004): Translocations strategies as a conservation tool for West Indian iguanas: Evaluations and Recommendations. In: *Iguanas Biology and Conservation*, p. 199-219. Alberts, A., Carter, R., Hayes, W., Martins, E., Eds, *Iguanas Biology and Conservation*. Univ. California. Press.
- Kronauer, D.J.C., Bergmann, P.J., Mercer, J.M., Russell, A.P. (2005): A phylogeographically distinct and deep divergence in the widespread Neotropical turnip-tailed gecko, *Thecadactylus rapicauda*. *Mol. Phylogenet. Evol.* **34**: 431-437.
- Labat, J.-B. (1724): Voyage du Père Labat, aux isles de l'Amérique contenant: une exacte description de toutes ces isles; des arbres, plantes, fleurs et fruits qu'elles produisent; des animaux, oiseaux, reptiles et poissons qu'on y trouve; des habitants, de leurs mœurs et coutûmes, des manufactures et du commerce qu'on y fait etc. La Haye, P. Lussou et al. (éd. en 2 volumes de l'édition de 1722 en 6 volumes).
- Lazell, J.D., Jr. (1967): Wiederentdeckung von zwei angeblich ausgestorbenen Schlangenarten der westindischen Inseln. *Salamandra* **3**: 91-97.
- Lazell, J.D. (1972): The anoles (Sauria, Iguanidae) of the Lesser Antilles. *Bull. Mus. Comp. Zool.* **143**: 1-115.
- Lazell, J.D. (1973): The Lizard Genus *Iguana* in the Lesser Antilles. *Bull. Mus. Comp. Zool.* **145**: 1-28.
- Leblond, J.-B. (1813): Voyage aux Antilles. D'île en île, de la Martinique à Trinidad (1767-1773). Karthala, (2000) Paris.
- Legouez, C. (2007): Les iguanes des Petites Antilles: étude de la population de l'îlet Chancel (Martinique) et élaboration du plan de restauration. Master II, Ecologie, Gestion de la Biodiversité. Toulouse.
- Lescure, J. (1979): Étude taxinomique et éco-éthologique d'un Amphibien des Petites Antilles: *Leptodactylus fallax* Müller, 1926 (Leptodactylidae). *Bull. Mus. Nat. Hist. Nat. Paris* 4<sup>e</sup> sér., 1. Sect. A, no 3: 757-774.
- Lorvelec, O., Pavis, C. (1999): L'iguane des Petites Antilles. Poster DIREN-AEVA.
- Lorvelec, O., Levesque, A., Barré, N., Feldmann, P., Leblond, G., Jaffard, M.-É., Pascal, M., Pavis, C. (2004): Évolution de la densité de population de l'iguane des Petites Antilles (*Iguana delicatissima*) dans la réserve naturelle des îles de la Petite Terre (Guadeloupe) entre 1995 et 2002. *Rev. Écol. (Terre Vie)*. **59**: 331-344.

- Lorvelec, O., Pascal, M., Pavis, C., Feldmann, P. (2007): Amphibians and reptiles of the French West Indies: Inventories, Threats and Conservation. *Applied Herpetology* **4**: 131-161.
- Maillard, J.-F., Breuil, M. (2007): The conservation of iguana *delicatissima* in Martinique and a Future Action Plan for the French West Indies. West Indian Iguana Specialist Group Newsletter. **10**(1): 15.
- Mallone, C., Davis, S.K. (2004): Genetic contributions to caribbean iguana conservation. In: *Iguanas Biology and Conservation*, p. 45-57. Alberts, A., Carter, R., Hayes, W., Martins, E., Eds, *Iguanas Biology and Conservation*. Univ. California. Press.
- McIntyre, S. (2003): The Current Status of the Mountain Chicken *Leptodactylus fallax* on Dominica, Eastern Caribbean; an Amphibian in Decline. Masters dissertation, University East Anglia.
- Miralles, A. (2005): The identity of *Lacertus mabouya* Lacepède, 1788, with description of a neotype: an approach toward the taxonomy of new world *Mabuya*. *Herpetologica* **61**: 46-53.
- Moreau de Jonnès, A. (1816): Monographie du trigonocéphale des Antilles ou grande vipère Fer-de-Lance de la Martinique. *Jour. Méd.* **36**: 324-365.
- Moreau de Jonnès, A. (1818a): Monographie de la Couleuvre couresse des Antilles *Coluber cursor* de Lacépède. *Journal de Physique* **87**: 193-200.
- Moreau de Jonnès, A. (1818b): Monographie du Mabouia des murailles, ou Gecko mabouia des Antilles. *Bull. Sci. Soc. philom. Paris, sér.* **3**: 138-139.
- Moreau de Jonnès, A. (1821): Monographie du Gecko mabouia des Antilles. *Journal de Physique* **20**: 1-16.
- Moreau de Jonnès, A. (1822): Histoire physique des Antilles françaises; savoir: la Martinique et les îles de la Guadeloupe. Migneret, Paris, 1-560.
- Moreau de Jonnès, A. (1858): Aventures de guerre au temps de la République et du Consulat. Tome second. Pagnerre, Paris.
- Ourlly, L. (2006): Conservation de l'iguane des Petites Antilles (*Iguana delicatissima*) en Martinique. Suivi des populations de l'îlet Chancel et réintroduction sur l'îlet à ramiers. Report Université Paul Sabatier-Office National de la Chasse et de la Faune Sauvage.
- Pasachnik, S.A., Breuil, M., Powell, R. (2006): *Iguana delicatissima*. *Cat. Amer. Amphib. Rept.* **811**: 1-14.
- Pascal, M., Brithmer, R., Lorvelec, O., Vénumière, N. (2004): Conséquences sur l'avifaune nicheuse de la réserve naturelle des îlets de Sainte-Anne (Martinique) de la récente invasion du rat noir (*Rattus rattus*), établies à l'issue d'une tentative d'éradication. *Rev. Écol. (Terre Vie)*. **59**: 309-318.
- Pinchon, R. (1967): Quelques Aspects de la Nature aux Antilles. Fort-de-France, Martinique, Caen, France, Imprimerie Ozanne et Cie.
- Plée, A. (1820): MS 71. Catalogue des divers objets qui composent mon premier envoi au Muséum d'Histoire naturelle (Fort Royal, île de Martinique) avec un supplément, BMNH.
- Rufz de Lavison, D. (1859): Enquête sur le serpent de la Martinique. Germer Baillière, Paris.
- Schwartz, A. (1965): A review of *Sphaerodactylus vincenti* on the southern Windward Islands. *Carib. J. Sci.* **4**: 391-409.
- Schwartz, A., Henderson, R.W. (1991): Amphibians and Reptiles of the West Indies. Descriptions, Distributions and Natural History. Gainesville, University of Florida Press.
- Thibault de Chanvalon, J.-B.M. (1756): Voyage à la Martinique contenant diverses observations sur la physique, l'histoire naturelle, l'agriculture, les mœurs et les usages de cette île. Manuscript MS 690 MNHN edited by Karthala, Paris (2004).
- Thorpe, R.S., Stenson, A.G. (2003): Phylogeny, paraphyly and ecological adaptation of the colour and pattern in the *Anolis roquet* complex on Martinique. *Molecular Ecology* **12**: 117-132.
- Underwood, G. (1959): Reptiles of the Eastern Caribbean. *Caribbean Affaires, NS* **1**: 1-192.

- Vidal, N., Azvolinsky, A., Cruaud, C., Hedges, S.B. (2008): Origin of tropical American burrowing reptiles by transatlantic rafting. *Biol. Letters* **4**: 115-118.
- Weiss, A.J., Hedges, S.B. (2007): Molecular phylogeny and biogeography of the Antillean geckos *Phyllodactylus wirshingi*, *Tarentola americana* and *Hemidactylus haitianus*. *Mol. Phyl. Evol.* **45**: 409-416.
- Westermann, J.H. (1953): Nature Preservation in the Caribbean. Foundation for Scientific Research in Surinam and the Netherlands Antilles, Utrecht **9**: 1-106.
- Westercamp, D., Andreieff, P., Bouysse, P., Cottez, S., Battistini, R. (1989): Carte géologique de la France (1: 50 000), feuille Martinique. Notice explicative. Bureau de Recherches Géologiques et Minières, Orléans.
- Wüster, W., Thorpe, R.S., Salamao, M.G., Thomas, L., Puerto, G., Theakson, R.D.G., Warell, D.A. (2002): Origin and phylogenetic position of the Lesser Antillean species of *Bothrops* (Serpentes: Viperidae): biogeographical and medical implications. *Bull. Nat. Hist. Mus. (Zoology)*, Lond. **68**: 101-106.

*Accepted: 2 June 2008 (AH).*