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HISTORY OF THE ENDEMIC TURTLES OF THE CARIBBEAN

Testudinidae present in Martinique

Chelinoïd Land Turtles and Trachemy Marsh Turtles

Fundamental geological context of a Caribbean made up of continental American islands and logical distributions of these Testudines as a result of allopatric speciation processes.

by Marcel BOURGADE



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Introduction

Fundamentally, this history of the endemic Testudines of the Caribbean, with regard to their distributions, tracing their origins and dispersals, reconstructed on the basis of data from the paleobiology and paleogeology of Caribbean biodiversity, contributes to a questioning of the hitherto accepted, somewhat fixed vision, underestimating tectonic geological history, presenting an eastern Caribbean that would be made up of an archipelago of "oceanic islands that would have emerged one after the other due to volcanic activity." For this, the very existence of terrestrial fauna (insects, mollusks, vertebrates: Testudines, mammals, reptiles and amphibians, in particular) that would come from elsewhere and then have become endemic there, would be explained, according to the current dominant discourse, hypothetically by dubious scenarios of multiple "rafting" (unimaginable for the Testudines), that is to say, of dispersals of these animal species from the shores of northern South America, crossing marine expanses, drifting on rafts of plants, and are thought to have been stranded by the currents on islands, as far away as the Bahamas.

Supported by fossils dating back several million years, the very existence of Testudines endemic to the Caribbean, in addition to the endemism rate of the central islands of the Eastern Caribbean, and particularly Martinique, and the latest advances and research results in paleogeology tend to invalidate such scenarios of settlements of these central islands of Saint Lucia, Martinique, and Dominica by successive rafting trips. The endemic flora and fauna species of the central islands of the Eastern Caribbean did not cross the sea, nor even cross marine expanses by air, to find themselves isolated on these islands; These species became progressively isolated starting an average of 35 million years ago, due to the detachment of a northern orogenic portion of the South American continental crust, which was tectonically thrust, forming an isthmus and then a large island, which fragmented to form several islands, which slid along the Caribbean Arc subduction zone, until collisions with submarine volcanoes located below the latitude of the Dominica Channel, before partially disintegrating and being submerged. These islands in the eastern Caribbean (from Aruba to Sombrero) are part of the orogenic geological province detached from the north of the South American continent.

Fundamental research for scientific knowledge in paleogeology and paleobiology is crucial for the management and conservation of biodiversity and therefore the fight against invasive alien species in the Caribbean islands.

We therefore propose a reconstructed history of the Caribbean Testudines; a history necessarily determined by the geological tectonic history of this geographical region; This history is aligned with phylogenetic data and the current distribution of these endemic land and freshwater turtles. This historical scenario thus leads to the current distributions of many faunal species on the Caribbean islands, and is particularly explanatory of the known endemism in Saint Lucia and Martinique, concerning animal species of mammals, amphibians, reptiles, and sedentary birds, mollusks, and insects.

Keywords: history, Testudines, Caribbean, Chicxulub, GAARlandia, GrANoLA, Matina, KaruWétu, geosciences, paleogeology, paleobiology, Colombia, Aruba, Curaçao, Martinique, Saint Lucia, Saint Vincent, Grenada, Barbados, Guadeloupe, Antigua, Barbuda, Anguilla, Sombrero, Saba, Virgins, Puerto Rico, Mona, Haiti, Jaragua, Jamaica, Cuba, Bahamas, herpetology, biodiversity, speciation, allopatric, orogenic, geological, province.

DISTRIBUTION STATEMENT

Testudines Species Present in Martinique

- **Five (5) taxa of marsh and freshwater turtles are present in Martinique:**

Three (3) species of turtles are native to continental North America from the USA:

Graptemys pseudogeographica (Gray, 1831)

Trachemys scripta elegans (Wied, 1839)

Trachemys scripta scripta (Schoepff, 1792)

One (1) species of turtle is native to West and Central Africa:

Pelusios castaneus (Schweigger, 1812)

One species of island turtle native to the Caribbean, presumed to be from Puerto Rico:

Trachemys stejnegeri stejnegeri (Schmidt, 1928) (?)

The distribution of the presumed *Trachemys stejnegeri* ssp. in the Eastern Caribbean, its presence in Guadeloupe, Basse Terre and Grande Terre, in Les Saintes, Terre de Bas and Terre de Haut, in Marie Galante, in Dominica where it is the only marsh turtle, and in Martinique and not further south, its non-existence in the islands of the Eastern Caribbean north of Guadeloupe, leaves us perplexed and in a question as to its supposed introduction from Puerto Rico. Knowing that species of turtles of the genus *Trachemys*, including *T. stejnegeri*, are also native to South America.



Young male *Trachemys* sp. observed at Pelletier Lamentin, central Martinique

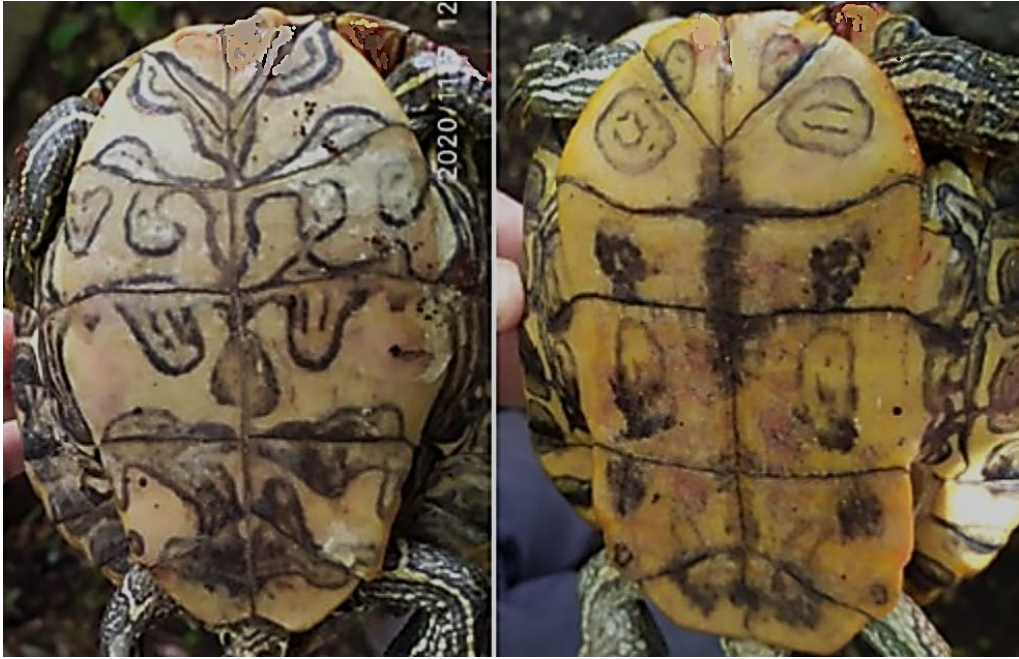
Photographic data by David Belfan



Plastron of an adult female *Trachemys sp.* turtle observed in Rivière-Pilote, south-east of Martinique



Plastron of an adult female *Trachemys sp.* turtle observed in Desnel, Gros-Morne, central Martinique



Breastplates of young males *Trachemys sp.* observed on the peninsula of southeastern Martinique



Trachemys stejnegeri - Photo (BY-NC-SA 3.0) President and Fellows of Harvard College

Plastron pattern of a young male *Trachemys stejnegeri* in the Dominican Republic

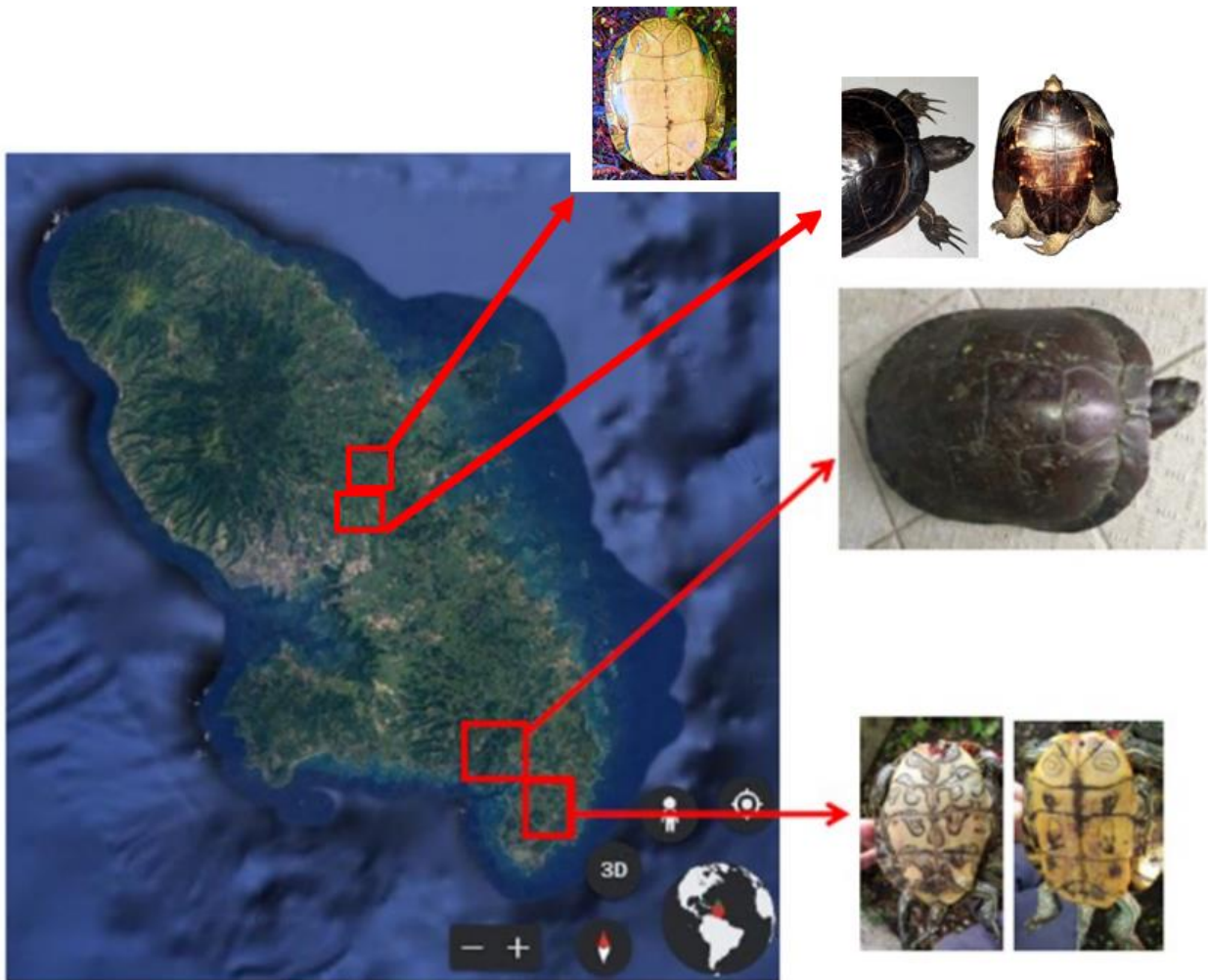
Sources: <https://idfg.idaho.gov/species/taxa/17843>

Similarities between the plastron patterns of *Trachemys medemi* in Colombia (South America) and those of *Trachemys sp.* and/or *Trachemys stejnegeri ssp. (?)* in Martinique

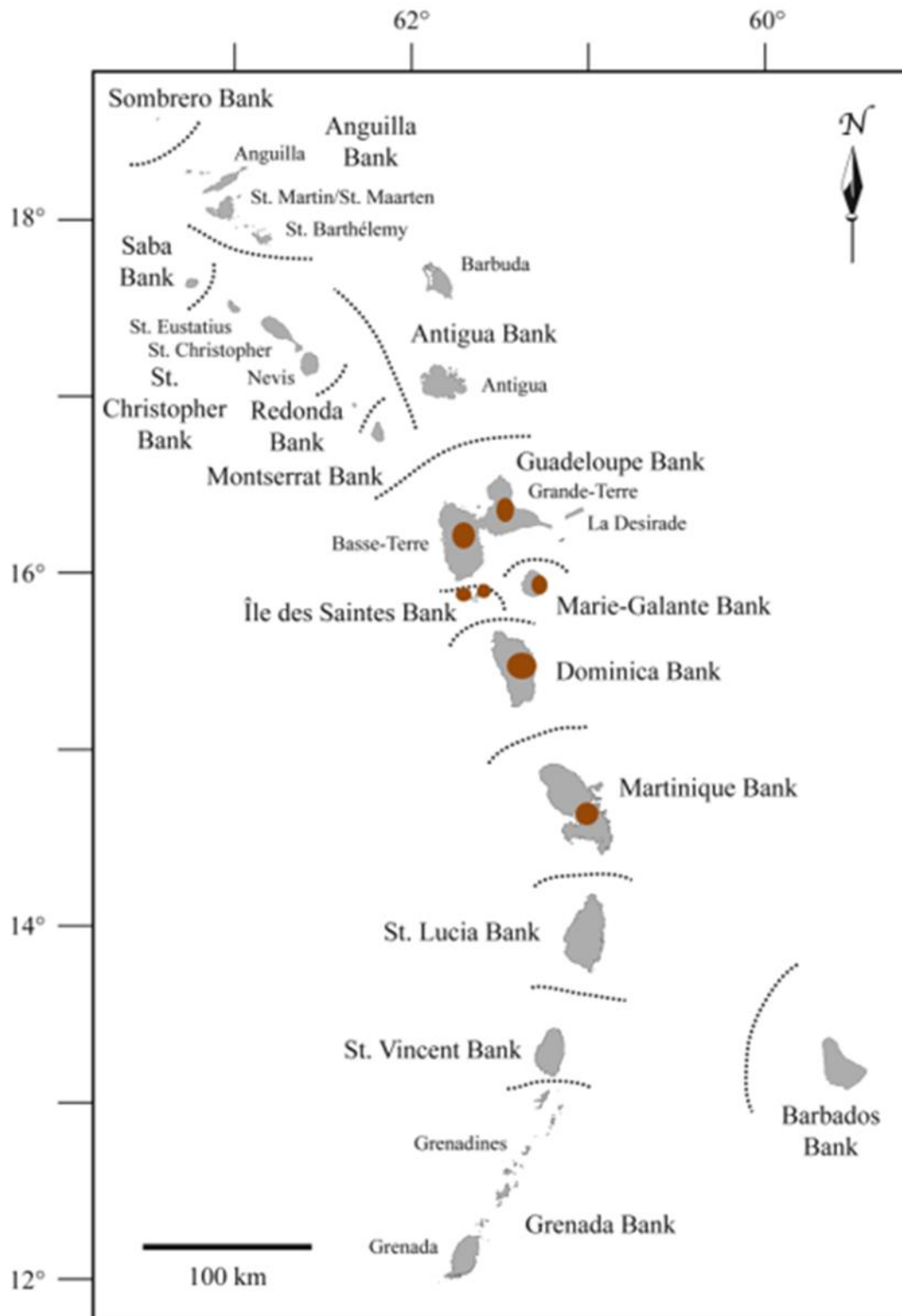


Trachemys medemi, adult female, Ciénaga de Marriaga, Unguía, Chocó, Colombia. Carlos del Valle in Vargas-Ramírez et al. (2017).

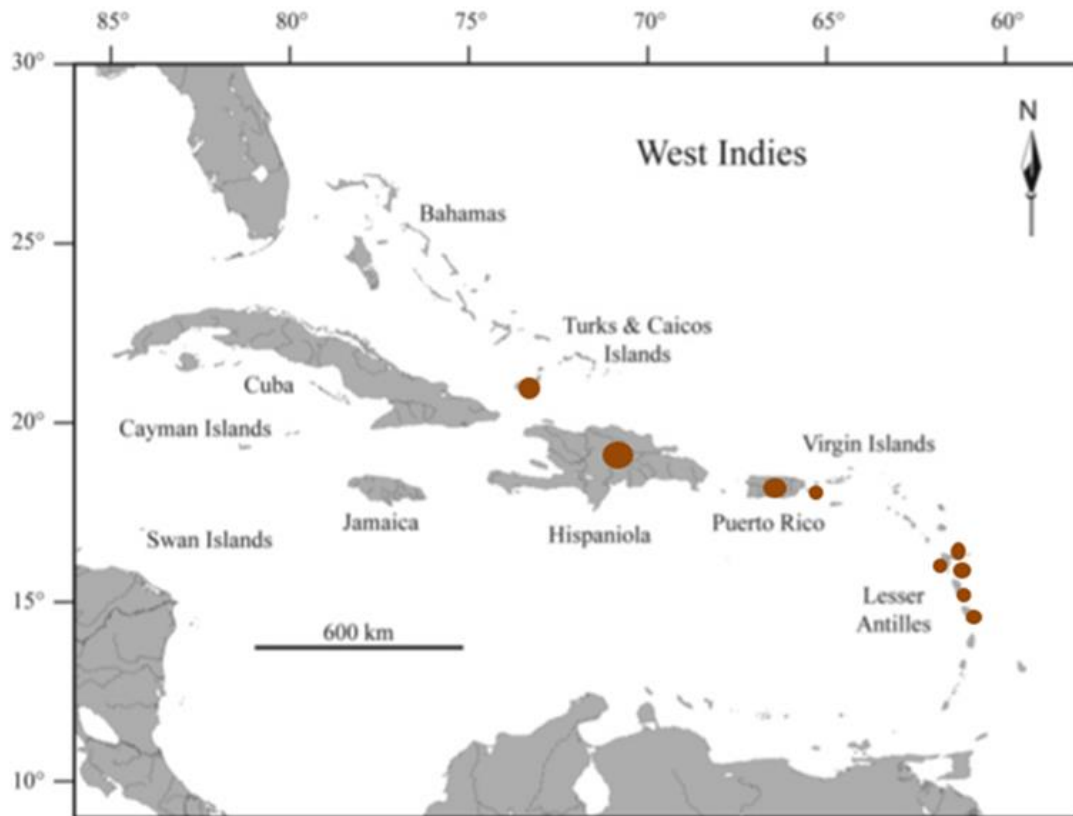
[Sciency Thoughts: Trachemys medemi: A new species of Slider Turtle from northwestern Colombia.](#)



Locations of observations of *Trachemys* marsh turtles showing similarities with *T. stejnegeri* in Martinique



Eastern Caribbean distribution of *Trachemys*, presumed to be of the species *T. stejnegeri*



Caribbean distribution of Trachemys of the species *T. stejnegeri*

• Three (3) taxa of tortoises are present in Martinique:

One (1) tortoise species is native to north-central Africa:

Centrochelys sulcata (Miller, 1779)

Giant African spurred tortoise (*Mbonnatu suuf mi*) in the Wolof language

Africa extending from the Atlantic coast to the Red Sea coast. It is known with certainty from Benin, Togo, Burkina Faso, Mali, Mauritania, Niger, Nigeria, Senegal, Cameroon, the Central African Republic, Chad, Sudan, Eritrea, and Ethiopia.

One (1) tortoise species is native to Central and North America, Mexico, and the USA:

Terrapene carolina (Linnaeus, 1758)

Terrapene carolina is a species of turtle in the Emydidae family. It is sometimes called the box turtle or eastern box turtle.

This species is found:

Terrapene carolina bauri is found in the United States in Florida;

Terrapene carolina carolina is found in the United States and possibly in Canada in Ontario;

Terrapene carolina major is found in the United States in Alabama, Florida, Georgia, Louisiana, Mississippi, and Texas;

Terrapene carolina mexicana is found in Mexico in the states of San Luis Potosí, Tamaulipas, and Veracruz;

Terrapene carolina triunguis is found in the United States in Alabama, Arkansas, Illinois, Kansas, Louisiana, Mississippi, Missouri, Oklahoma, and Texas;

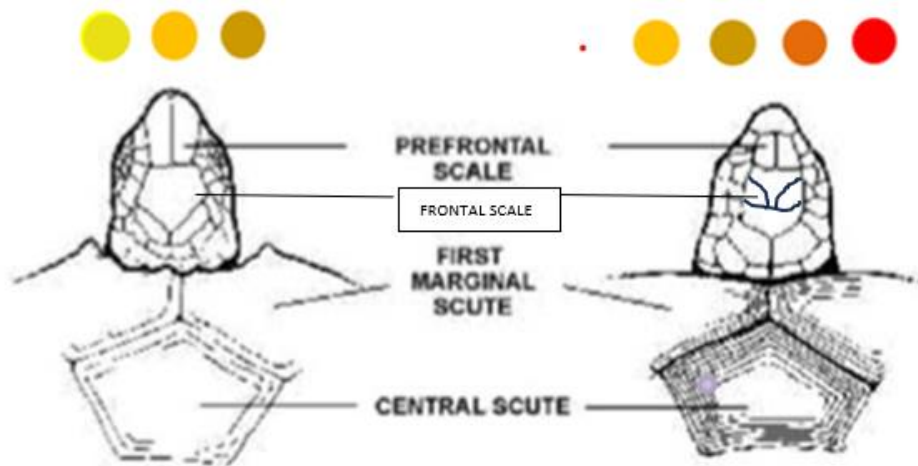
Terrapene carolina yucatana is found in Mexico in the states of Campeche, Quintana Roo and Yucatán.

One (1) species of turtle is native to South America, *Chelonoidis carbonaria* (?), called Mòlòkòy, which, based on current knowledge, is "probably introduced" to Martinique and the Eastern Caribbean.

The turtle *Chelonoidis carbonaria* (Spix, 1824) inhabits northern South America, from Colombia to the Guiana Plateau, and is more likely to be found in arid environments.

M. C. Duméril and M. Aug. Duméril, in their methodical catalog of the reptile collection of the Museum of Natural History in Paris, reported the existence of the land turtle *Chelonoidis carbonaria* in Martinique as early as 1851. This is the earliest date for mentioning the existence of *Chelonoidis carbonaria* in one of the eastern Caribbean islands where land turtles of the genus *Chelonoidis* exist. Mòlòkòy land turtles still live in the wild in Martinique. On the southeastern peninsula of Martinique, in the territory of the commune of Sainte-Anne near the banks of the river at the foot of the Crève-Cœur peak, we noted the presence in 2021 of a newborn (of a size proportional to that of its egg) wandering in the wild; also in this same area of Crève-Cœur a few years earlier, but also more recently in 2023, in Baréto in the back of the mangrove, observations of two mòlòkòy remains, *Chelonoidis* (pers. comm.). Many individuals traditionally have Mòlòkòy in their gardens whose origin they do not know. And this, despite the ravages on biodiversity, caused by the introduction of rats: *Rattus rattus* (Linnaeus, 1758) and *Rattus norvegicus* (Berkenhout, 1769); but also of the mongoose *Urva auropunctata* (Hodgson, 1836) in 1887 (after 1851), invasive exotic species that prey on turtle eggs. Lineages of Mòlòkòy turtles have likely been decimated in Martinique and elsewhere in other Caribbean islands due to these predator introductions, which have obviously also caused and are still causing the decline and eventual extinction of species endemic to Martinique, birds (1), reptiles and an amphibian (2) and mammals (3) that have disappeared from Martinique:

- (1) Gwakamayo Parrot or Martinique Macaw, *Ara martinica* (W. Rothschild, 1905); Kano or Koukou Tè, *Speotyto cunicularia* (Molina, 1782). (See attached documents)
- (2) Martinique Skink, *Capitellum metallicum* (Plée, 1820); Martinique Great Skink, *Mabuya mabouya* (Bonnaterre, 1789); Herminier's Holotropide, *Leiocephalus herminieri* (Dumeril & Bibron, 1837); Martinique Snake, *Erythrolamprus cursor* (Bonnaterre, 1790); Martinique Boa, *Boa* sp. (Moreau de Jonès, 1818); Large Frog, *Leptodactylus fallax* (Müller, 1926). (See attached documents)
- (3) Pillory Rat or Muskrat, *Megalomys desmarestii* (J. Fischer, 1829); Agouti, *Dasyprocta antillensis* (Carl Von Linné, 1758). Nine-banded Armadillo, *Dasypus novemcinctus* (still present in Grenada, mentioned and drawn by Du Tertre as being present in Martinique). (See attached documents)



Chelonoidis denticulata

Chelonoidis carbonaria

Identification key supplemented by color variations of the scales of the forelegs



Chelonoidis sp. Mòlòkòy present in Martinique

Featuring five frontal scales arranged differently from the four frontal scales of *C. carbonaria*.

With a carapace whose scutes tend to resemble those of *C. denticulata*.





Mòlòkòy in Martinique, young female *Chelodoinis carbonaria* (photos: Christine NAIME)



Mòlòkòy in Martinique, adult female *Chelonoidis carbonaria* (photos: Pascal VATBLE)



Mòlòkòy in Martinique, adult male *Chelonoidis sp.* (?) (Photos: Pascal VATBLE)

Specimen whose carapace scutes tend to resemble those of *C. denticulata* (Linnaeus, 1766)

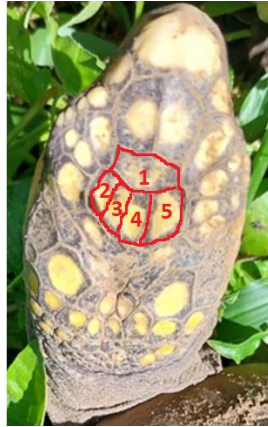
Authors including Censky (1988) cite four non-exclusive hypotheses to explain the existence of land turtles in the Caribbean:

- These turtles may have arrived on the islands by rafting and traveled from island to island. (?) This hypothesis is supported by Hedges (1996) and Le Gratiot (1997).
- These turtles may have been transported by the first peoples to arrive from South America. (?) Lescure (1983) suggested this hypothesis, but this view is contested by Williams (1989).
- These turtles were apparently introduced at the beginning of the colonization of the Caribbean by Europeans. (?)
- According to Censky, these could still be turtles that were owned by individuals as pets and that escaped or were released. (?) Since the existence of transport in the recent past (before the 1970s) and still today (despite the Washington Convention) of coal turtles from French Guiana to Martinique, Guadeloupe, and also between the islands of the Guadeloupe archipelago cannot be denied.

The last three hypotheses, which attempt to explain the distribution of tortoises in the Caribbean by human activity, are untenable and cannot be sustained once the existence of fossils of species all originating from South America, of extinct tortoises of the genus *Chelonoidis* in many islands of the Caribbean (western and eastern), the Turks and Caicos Islands, and the Bahamas, are seriously considered. For these fossils discovered in the eastern Caribbean, Ernst and Leuteritz (1999) considered them to be millions of years old and to be coal-headed tortoises. There is therefore scientific certainty that tortoises of the Mòlòkòy type, *Chelonoidis sp.* extinct turtles have inhabited islands in the Caribbean (eastern and western), including from northern Cuba to the Bahamas and the Turks and Caicos Islands, for millions of years, with evidence provided by molecular biology (Christian Kehlmaier et al., 2021); Sombrero Island, the northernmost island in the Eastern Caribbean, where a fossil species described under the taxon *Chelonoidis sombreroensis* was discovered as early as the 19th century (Pregill et al., 1994), attests to this fact, as do the fossils from Barbados, which also provided the habitat of a land turtle related to the taxon *Chelonoidis* (Pregill et al., 1994). *Chelonoidis* turtle fossils have also been discovered in Barbuda (Pregill et al., 1994); and in Anguilla (Lazell, 1993).

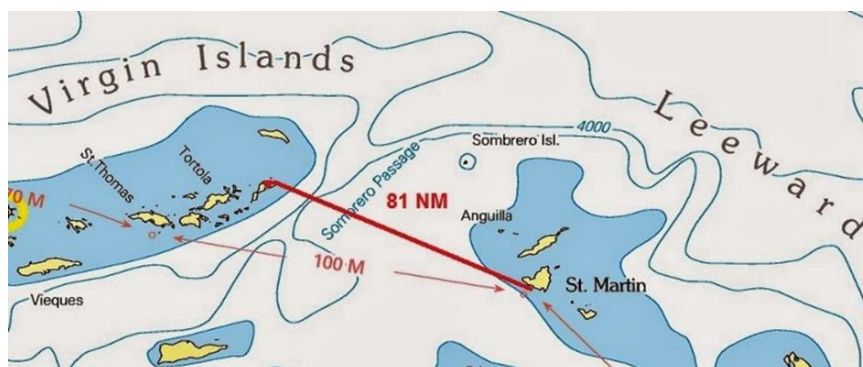
It should be noted that the current existence of species of *Chelonoidis sp.* unidentified as *C. carbonaria*, currently recognized as being present in Barbados, Saint Lucia and Saint Vincent; but also in Curaçao (recently extinct species), also invalidates these last three hypotheses of Censky.

A species of *Chelonoidis sp.* not identified as *C. carbonaria*, is also attested by this publication as existing in Martinique.

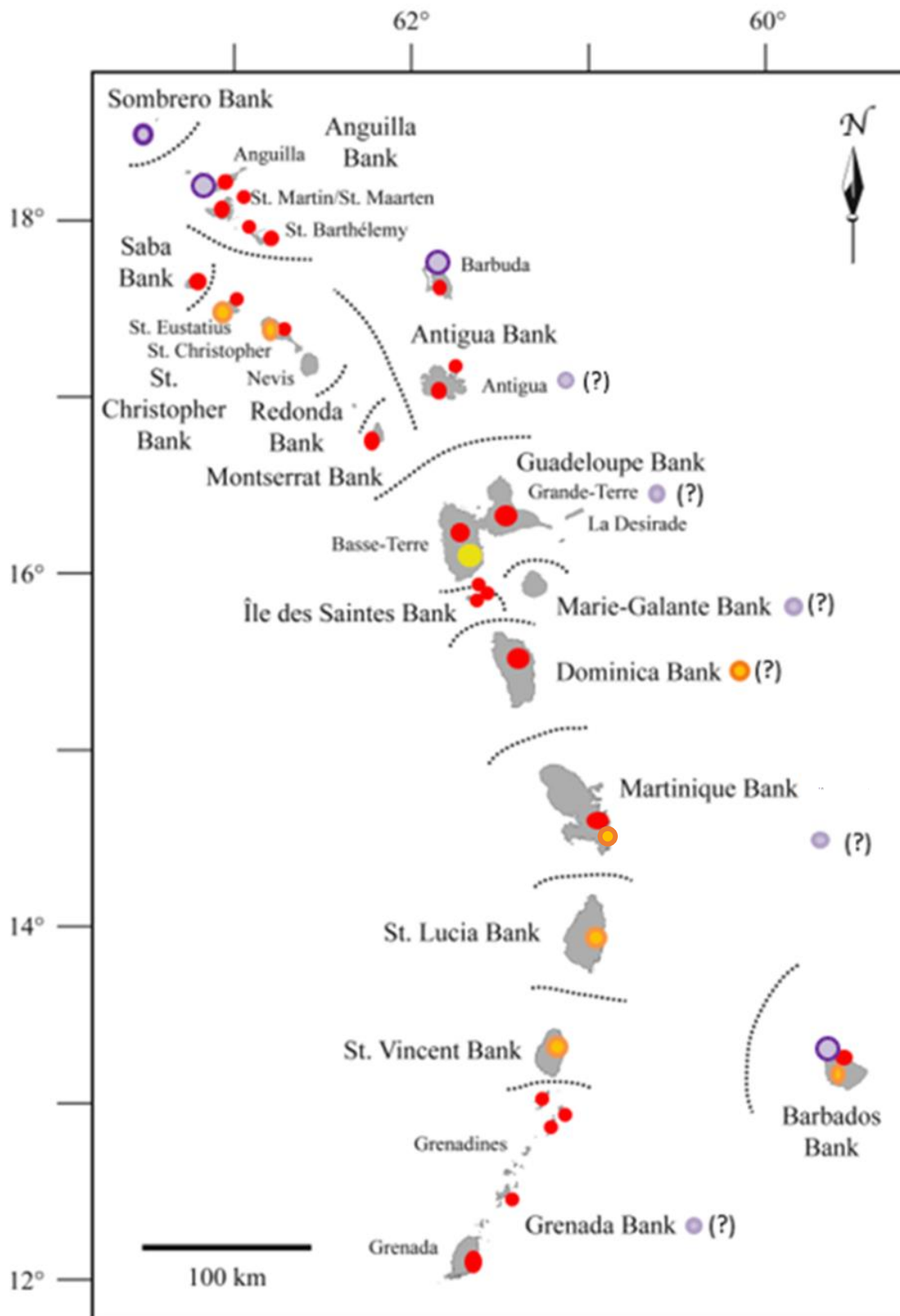


5 frontal scales for this specimen of Mòlòkòy *Chelodoinis* sp. in Martinique

Censky's first hypothesis certainly has the merit of not attributing the existence of land turtles in the Caribbean to human actions and implicitly admits that extinct species of island Chelonoidis could have existed, but according to its authors by a process of speciation which would be peripatric from the north of South America; but in truth, because this first hypothesis claims to explain the presence of land turtles on islands by an improbable multitude of repeated events of rafting from island to island, from the coasts of northern South America, to the Bahamas north of Cuba, it is clearly truly unrealistic and therefore not credible. In addition to the fact that it is almost impossible for these land turtles to cope with the marine elements, and therefore to survive the movements of the swell and waves, even on a calm sea and in a context of mild weather that would last several days, it is very difficult to imagine that these Mòlòkòy turtles, given their morphology, could really remain on rafts of plants during perilous crossings of straits; this first hypothesis of Censky, very imaginative, is fundamentally part of a fixist vision of the Caribbean, which does not integrate its geological tectonic evolution, by considering these islands of the eastern Caribbean as so-called "oceanic" islands which would have emerged from the Atlantic Ocean due to volcanic activity which is certainly undeniable, but as we will see, is not fundamentally at the origin of the emerged lands of the Caribbean.

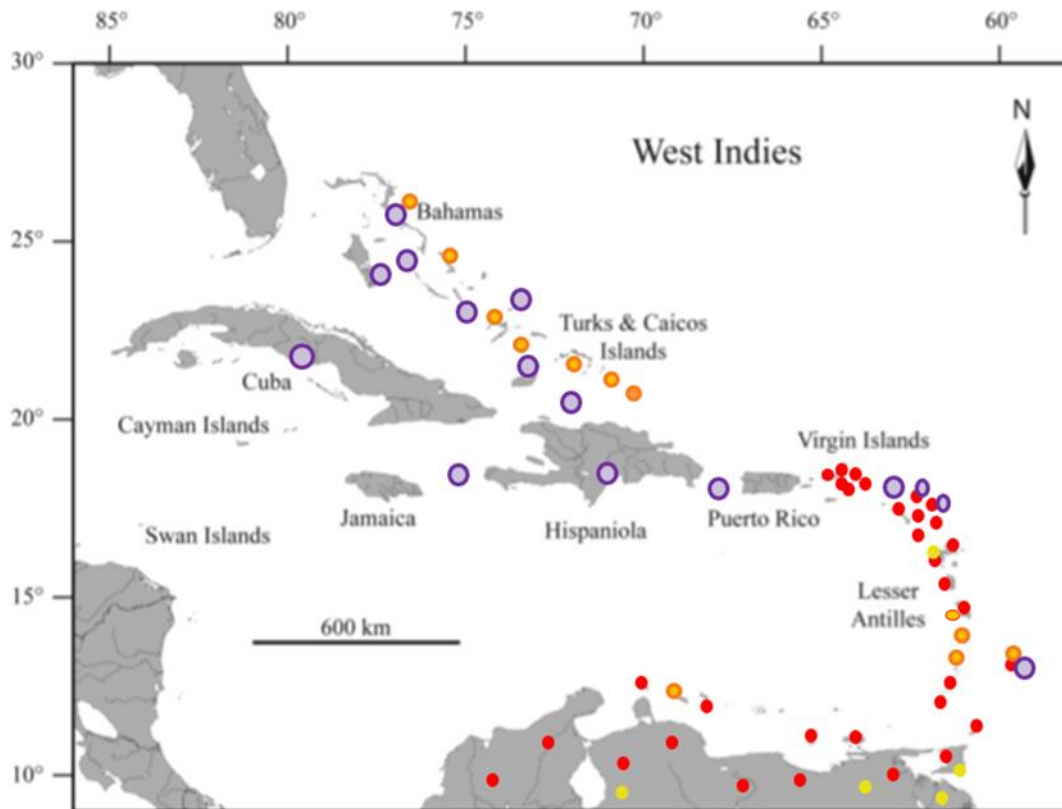


It is clearly impossible for the Testudines to undertake an unimaginable sea voyage on a plant raft to cross straits.



Distribution of Mòlòkòy tortoise species of the genus *Chelonoidis* in the Eastern Caribbean

● Fossiles
 ● *Chelonoidis sp. (?)*
 ● *Chelonoidis carbonaria*
 ● *Chelonoidis denticulata*



Distribution of Mòlòkòy tortoise species of the genus *Chelodoinis* in the Caribbean

○ Fossiles
 ○ *Chelonoidis sp. (?)*
 ● *Chelonoidis carbonaria*
 ● *Chelonoidis denticulata*

This summary map of the distribution of *Chelodoinis* tortoise species across the Caribbean indicates the existence of very ancient extinct fossil species; for the western Caribbean, Cuba, Navas (Haiti), Dominican Republic, Mona (Puerto Rico); and north of Cuba, the Turks and Caicos Islands, and the Bahamas. Also for these islands north of Cuba, there are coal-eating tortoises *Chelodoinis sp.* not identified as being of the species *C. carbonaria* (Spix, 1824).

For the eastern Caribbean, Sombrero (the northernmost islet, approximately half the size of Chancel Islet located south of the Caravelle Peninsula, east of Martinique), suggests that these Mòlòkòy-type tortoises evolved over a much larger area of land at the time of their existence; which supports the explicit vision of geologists who highlighted GrANOla, Philippon, M. et al. (2020). The same reasoning applies to the fossil species of Anguilla, Barbuda and Barbados. It is therefore entirely possible to consider the very probable existence of fossil *Chelodoinis* species in Marie-Galante, Grande Terre Guadeloupe, on the Caravelle peninsulas, in the southeast and southwest of Martinique, and also in Saint Lucia and on other islands further south. Note the current existence of species of *Chelonoidis sp.* not identified as *C. carbonaria*, currently recognized as being present in Barbados, Saint Lucia and Saint Vincent; but also in Curaçao (recently extinct species). In-depth studies of *Chelonoidis* populations in Martinique could reveal, as in Barbados, the cohabitation of two species, one being *C. carbonaria*, and the other unidentified as such, *Chelonoidis sp.* . It should also be noted that the authors Robert POWELL and Robert W. HENDERSON express serious doubts about alleged "introductions" of turtles identified as being of the species *C. carbonaria* in the Virgin Islands. It should be noted that the coal turtle *Chelonoidis denticulata* (Linnaeus, 1766) exists in the Caribbean, only present in the wild on the island of Basse-Terre in Guadeloupe.

To establish the previous distribution maps of land and marsh turtles, we identified the testudine taxa found in the Eastern Caribbean, referring to the publication by Robert Powell and Robert W. Henderson entitled: ISLAND LISTS OF WEST INDIAN AMPHIBIANS AND REPTILES, published in 2012.

Approximately 120 species of amphibians and reptiles were documented on 139 islands of the Eastern Caribbean in this publication. The references are:

For the Guadeloupe archipelago (Breuil, 2002), Anguilla (Hodge et al., 2003), and the Dutch Windward Islands (Powell et al., 2005), Anguilla (Hodge et al. 2011), Guadeloupe, Saint Martin, Saint Barthelemy, Martinique (Lorvelec et al. 2011), Antigua, Barbuda and Redonda (Daltry 2011), Sint Maarten (Powell 2011), Dominica (Malhotra et al. 2011), Guadeloupe and Martinique (Breuil 2011), Saint Vincent (Powell and Henderson, 2011), the Grenadines (Daudin & de Silva 2011), Grenada (Henderson and Berg, 2011), and Barbados (Fields and Horrocks 2011).

EXTRACTS with additional data in red relating to the existence of fossils:

SOMBRERO BANK

Sombrero (18.36°/-63.03°) (0.37 km²) (**Altitude : 6m**)

Chelonoidis sombrerensis (**F**) = (**Fossile**)

ANGUILLA BANK

Anguilla (18.23°/-63.03°) (90.7 km²)

Chelonoidis carbonaria

Chelonoidis sp. (**Fossile**)

Saint-Barthélemy

(= St. Barts) (17.89°/-62.83°) (22 km²)

Chelonoidis carbonaria

Trachemys scripta elegans

Saint-Martin/Sint Maarten

(18.06°/-63.05°) (85 km²)

Chelonoidis carbonaria

Trachemys scripta elegans

Îlet Pinel (pas d'habitant)

(18.11°/-63.01°) (0.05 km²)

Chelonoidis carbonaria

Tintamarre (pas d'habitant)

(18.12°/-62.98°) (0.50 km²)

Chelonoidis carbonaria

SABA BANK

Saba (17.63°/-63.23°) (13 km²)

Chelonoidis carbonaria

ST. CHRISTOPHER BANK

St. Christopher (= St. Kitts) (17.36°/-62.78°) (170 km²)

Chelonoidis carbonaria

Chelonoidis sp.

St. Eustatius

(17.49°/-62.98°) (20 km²)

Chelonoidis carbonaria

Chelonoidis sp.

Trachemys scripta elegans

ANTIGUA BANK

Antigua (17.08°/-61.80°) (280 km²)

Chelonoidis carbonaria

Barbuda

(17.65°/-61.81°) (160 km²)

Chelonoidis carbonaria

Chelonoidis sp. (Fossile)

Green Island

(17.07°/-61.67°) (0.43 km²)

Chelonoidis carbonaria

MONTSERRAT BANK

Montserrat (16.74°/-62.19°) (100 km²)

Chelonoidis carbonaria

GUADELOUPE BANK

Guadeloupe (Basse-Terre) (16.18°/-61.68°) (848 km²)

Chelonoidis carbonaria

Chelonoidis denticulata

Kinixys erosa

Kinixys homeana

Pelusios castaneus

Trachemys scripta elegans

Trachemys stejnegeri stejnegeri

Guadeloupe (Grande-Terre) (16.33°/-61.46°) (590 km²)

Chelonoidis carbonaria

Pelusios castaneus

Trachemys scripta elegans

Trachemys stejnegeri stejnegeri

Îles de la Petite Terre

Terre de Bas (16.17°/-61.12)

Chelonoidis carbonaria

ÎLE DES SAINTES BANK

Terre-de-Bas (15.86°/-61.68°) (9.5 km²)

Chelonoidis carbonaria

Trachemys scripta elegans

Trachemys stejnegeri stejnegeri

Terre-de-Haut (15.87°/-61.58°) (4.5 km²)

Chelonoidis carbonaria

Trachemys stejnegeri stejnegeri

Grande Îlet (= Mare Basse) (15.84°/-61.59°) (0.7 km²) (pas d'habitant)

Chelonoidis carbonaria

Pelusios castaneus

MARIE GALANTE BANK

Marie Galante (15.94°/-61.26°) (160 km²)

Trachemys scripta elegans

Trachemys stejnegeri stejnegeri

DOMINICA BANK

Dominica (15.43°/-61.35°) (751 km²)

Chelonoidis carbonaria

Trachemys stejnegeri stejnegeri

MARTINIQUE BANK

Martinique (14.68°/-61.01°) (1,100 km²)

Centrochelys sulcata

Chelonoidis carbonaria

Graptemys pseudogeographica

Pelusios castaneus

Terrapene carolina

Trachemys scripta elegans

Trachemys stejnegeri stejnegeri

ST. LUCIA BANK

St. Lucia (13.92°/-60.96°) (616 km²)

Chelonoidis sp.

BARBADOS BANK

Barbados (13.14°/-59.56°) (430 km²)

Chelonoidis carbonaria

Chelonoidis sp.

Chelonoidis sp. (Fossile)

Trachemys scripta elegans

ST. VINCENT BANK

St. Vincent (13.26°/-61.19°) (350 km²)

Chelonoidis sp.

GRENADA BANK

Grenada (12.12°/-61.68°) (311 km²)

Chelonoidis carbonaria

Bequia (13.02°/-61.23) (18.0 km²)

Chelonoidis carbonaria

Canouan (12.71°/-61.32°) (7.4 km²)

Chelonoidis carbonaria

Carriacou (12.48°/-61.45°) (32.0 km²)

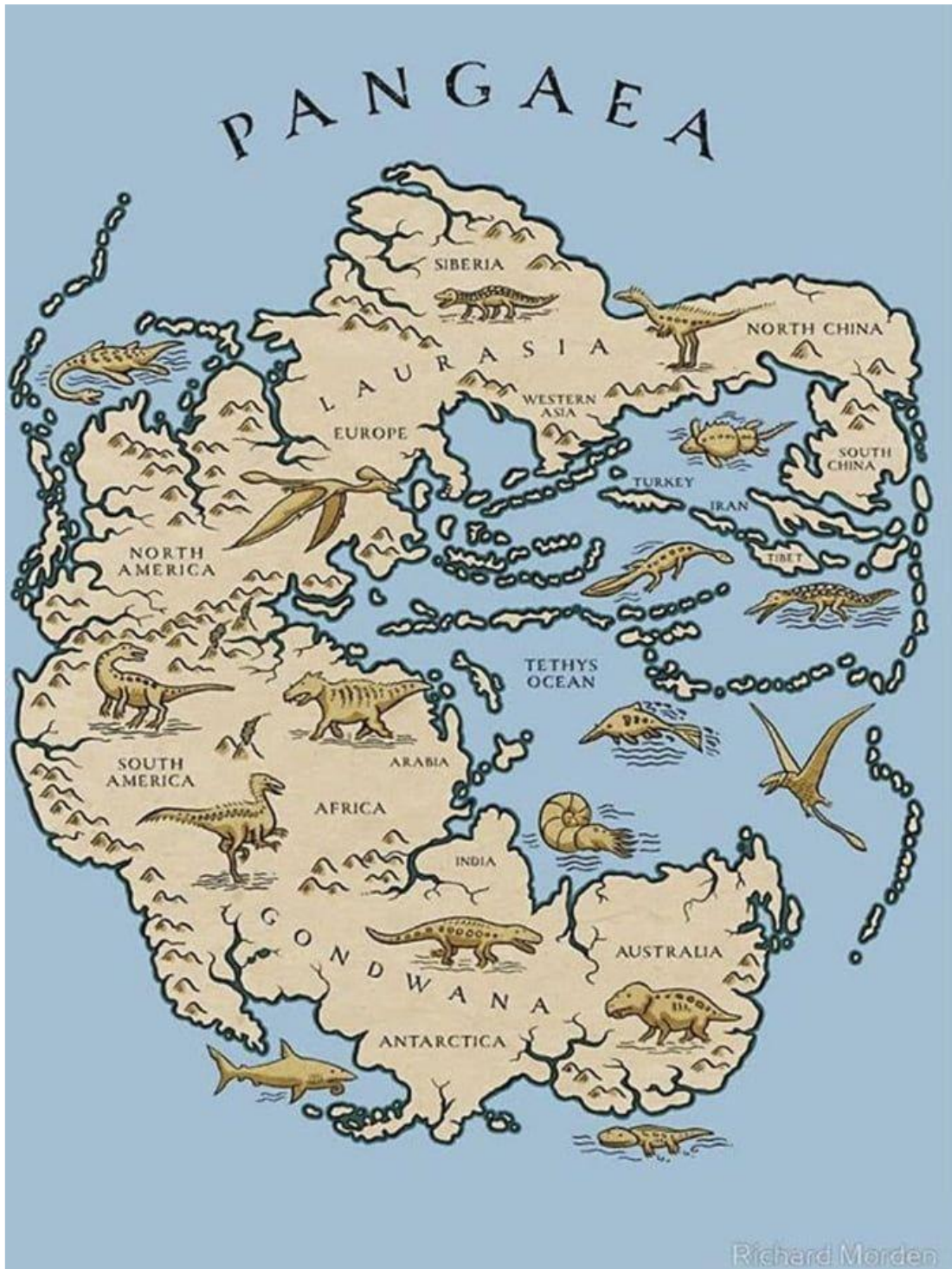
Chelonoidis carbonaria

Union (12.60°/-61.44°) (8.1 km²)

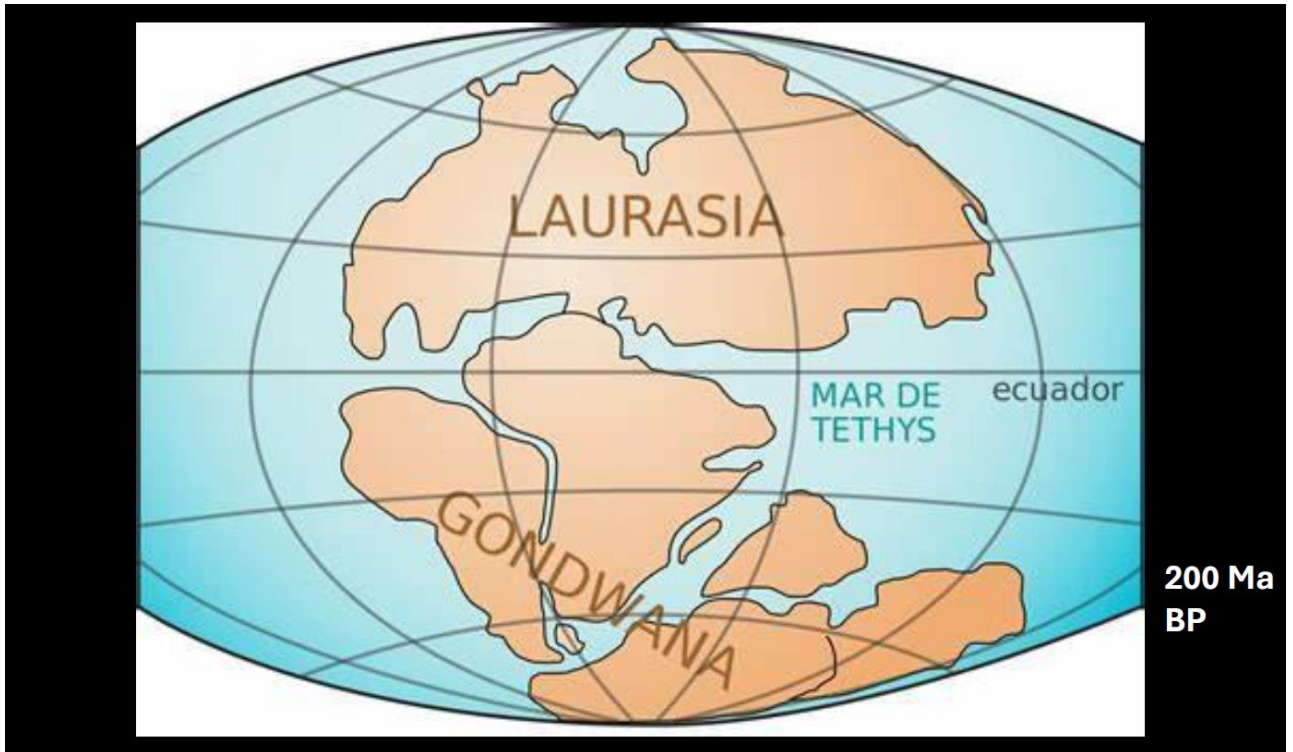
Chelonoidis carbonaria

CHRONOLOGICAL REVIEWS OF GEOLOGICAL CONTEXTS

STARTING 300 MILLION YEARS BP (Before Present):



300 Ma BP (Before Present)



A **craton** (from the Greek κράτος, kratos: strength), also called continental area, is a vast stable portion of the continental domain as opposed to deformed unstable zones (**orogens**). It forms an element of continental lithosphere with a geological identity, notably in terms of the nature of the rocks and the structuring of the geological units that compose it. A craton is composed of a crustal part of a continental nature, also called cratonic crust, and a so-called lithospheric part, of a mantle nature.

Chicxulub

Located in Mexico, the Chicxulub crater is one of the largest known impact craters on planet Earth. It was formed some 66 million years ago by the impact of a large asteroid, causing a cataclysm that is reputed to have most likely caused the extinction of the dinosaurs.

Approximately 200 impact craters are currently known on Earth. These depressions were formed following the impact of objects of varying sizes on the surface of our planet. This is the case with the Chicxulub crater; with its diameter of approximately 170 km, it is among the five largest impact craters known to date.

The Chicxulub crater is located in the Yucatán Peninsula in southeastern Mexico; it is not clearly visible, which explains why it was discovered only recently. It was in 1978 that geophysicists Glen Penfield and Antonio Camargo, working for an oil company, identified an anomaly north of the peninsula in the Gulf of Mexico. Geophysical data revealed a large underground arc 70 km in diameter. In fact, this was not the first time such a structure had been detected in the area. Ten years earlier, in 1968, another specialist had made a similar discovery but was prohibited from publishing it. Upon resuming his work, Glen Penfield discovered that there was a second arc, forming a circle about 180 km in diameter with the first, centered near the town of Chicxulub. The Chicxulub crater was then identified, but it wasn't until the 1990s that its existence was confirmed by another study in 1996. (Smit et al., 1996)

Determining the exact size of the Chicxulub crater is not easy, as knowledge is based solely on geophysical data. These data indicate that the formation extends over at least 180 kilometers in diameter and 20 km in depth, covering an area of at least 25,000 square kilometers. These measurements must have been much larger when the crater formed some 66 million years ago. This gives an idea of the size of the object that created it and the cataclysm it represented.

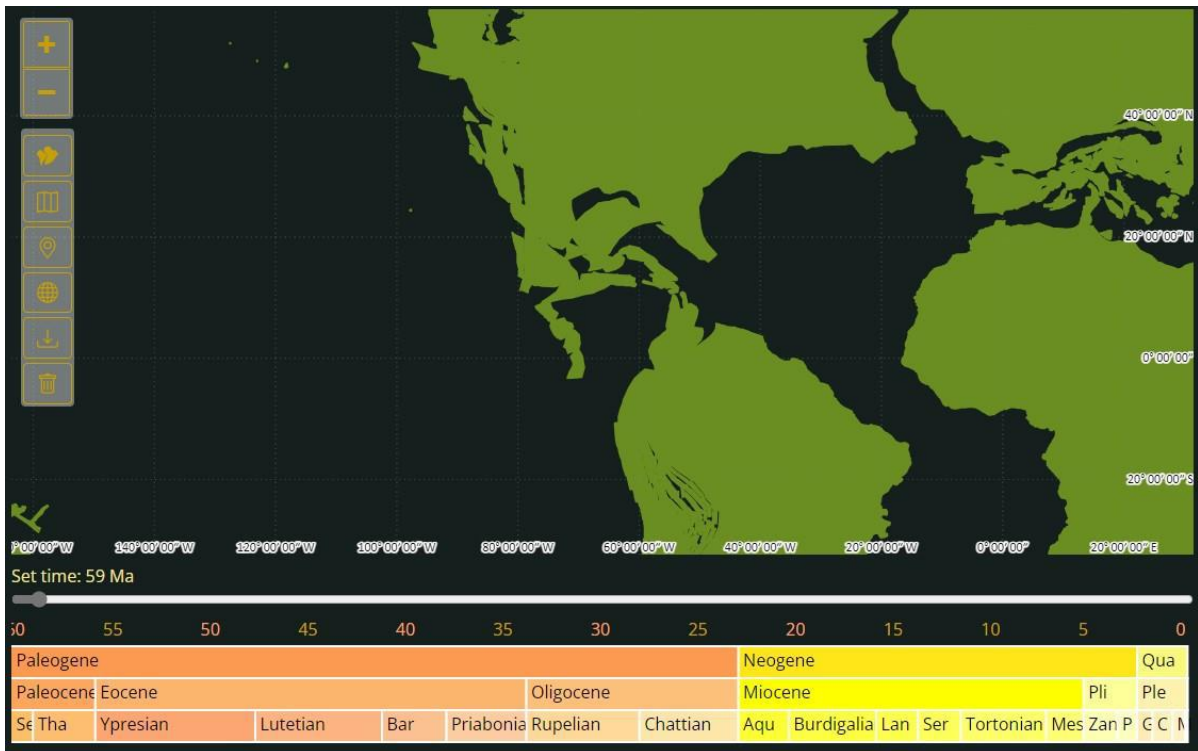
Various studies have therefore been conducted to identify the origin of the impact: comet or asteroid? Based on the rocks present in particular, these studies concluded and confirmed that the formation came from a collision between a large cosmic object and the surface of planet Earth, which occurred approximately 66 million years ago. Comet or asteroid, both possibilities have been considered by scientists, who are now leaning more towards the latter. One of the latest studies on the subject was published in February 2021 in the journal *Science Advances*. Conducted on samples collected in the crater, it revealed high levels of several elements, including iridium, associated with asteroids. Based on the dimensions of the depression, the researchers estimate that the object (whose exact origin remains undetermined) measured at least 10 km in diameter and that its fall caused a veritable cataclysm. A cataclysm that, according to a study published in 2010, released an estimated 100,000 gigatons of TNT, several billion times that of the atomic bomb dropped on Hiroshima in 1945. Scientists are still trying to piece together what really happened during this period. In May 2022, a British paleontologist, Robert DePalma, announced in a documentary that he had found a new avenue of investigation at a site located in North Dakota, United States, some 3,000 kilometers from the Chicxulub crater. The paleontologist reportedly found a tiny fragment of the "Chicxulub asteroid" trapped in amber.

According to the reconstructions, the asteroid's impact would have dug a cavity several dozen kilometers deep that would have collapsed on itself, forming a crater with a ring in its center. At the same time, phenomenal quantities of dust and other elements would have been projected into the air, completely covering the surface of planet Earth, blocking the sun's rays, and disrupting the climate and food chain for several years. Various scenarios also suggest gigantic fires, acid rain, and even devastating waves. All of these phenomena would have

made life on our planet very difficult. **Today, the impact of this asteroid is one of the main causes cited to explain the mass extinction that occurred at the end of the Cretaceous period, some 66 million years ago, and led to the disappearance of 75% of species, both animal and plant, including non-avian dinosaurs.** The testudines, or land, marsh and freshwater turtles, the hylod amphibians, like reptiles such as iguanas of the species present in the Caribbean (western and eastern), originally from South America, are like all living beings on the planet survivors of the cataclysm generated by the impact of the Chicxulub asteroid, whose epicentre is located north of the Yucatan Peninsula (present-day Mexico).



**North American landmass context 77 million years BP
prior to the Chicxulub asteroid impact 66 million years ago**



Maps of land surface evolution (Set time: 59 Ma BP) generated by the Terra Antiqua software developed on QGIS by geologist Guillaume Dupont Nivet. QGIS is an open-source geographic information system that allows you to visualize, modify, and analyze geospatial data.

[Terra Antiqua Tutorial video 1/4 - Introduction](#)

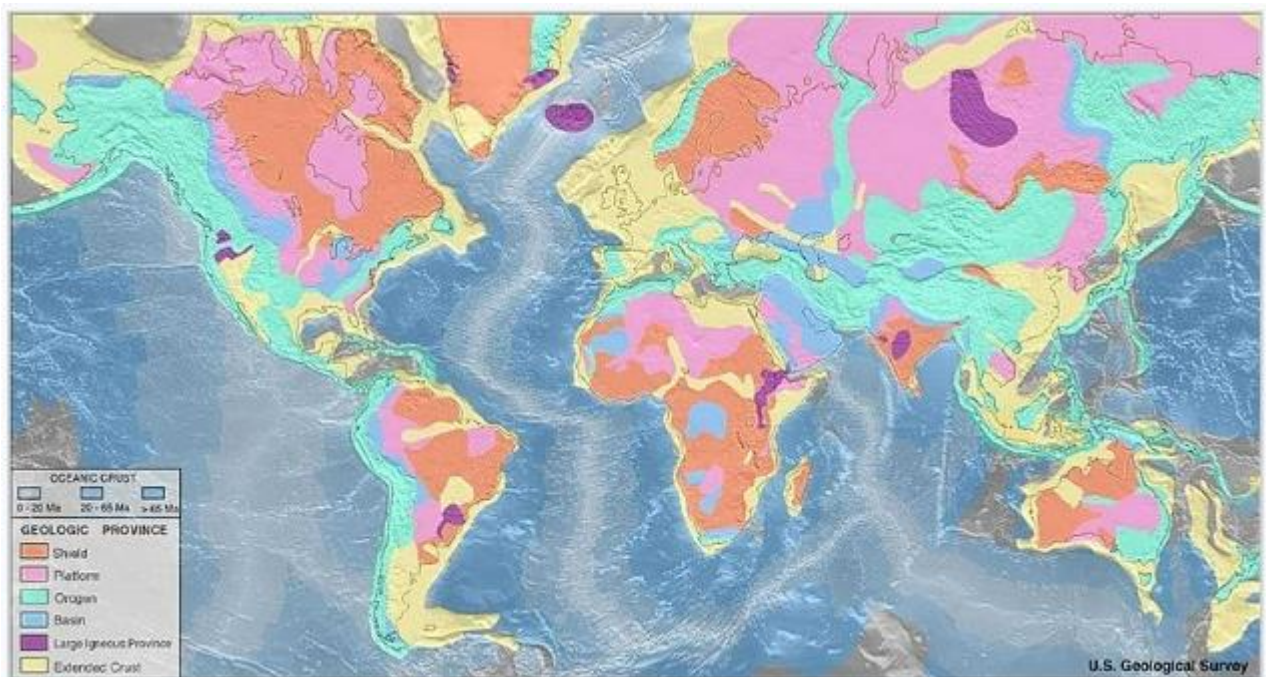


Dispersals of Testudines, land turtles (Chelodoinis), marsh turtles, and freshwater turtles (Trachemys), from northwestern South America to the proto-eastern Caribbean (proto-Granola peninsula -KaruWétu) and to the proto-GAARlandia peninsula (Saba), proto-Puerto Rico, proto-Hispaniola, proto-Cuba, proto-Turks and Caicos, and proto-Bahamas.

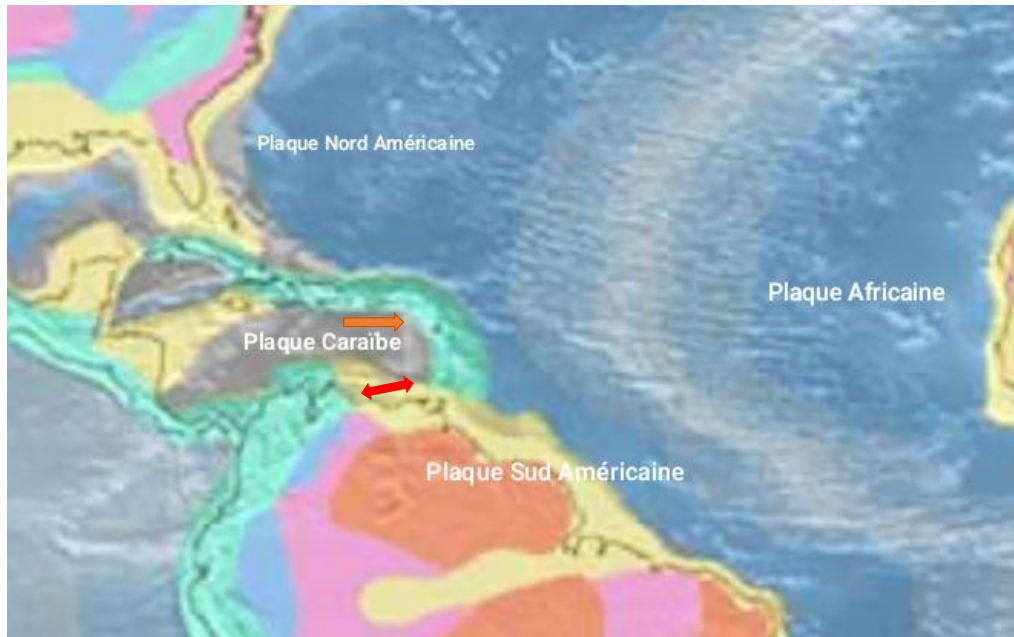
Peripatric speciation process, initiated 59 million years ago, by land for Testudines (living and fossil).



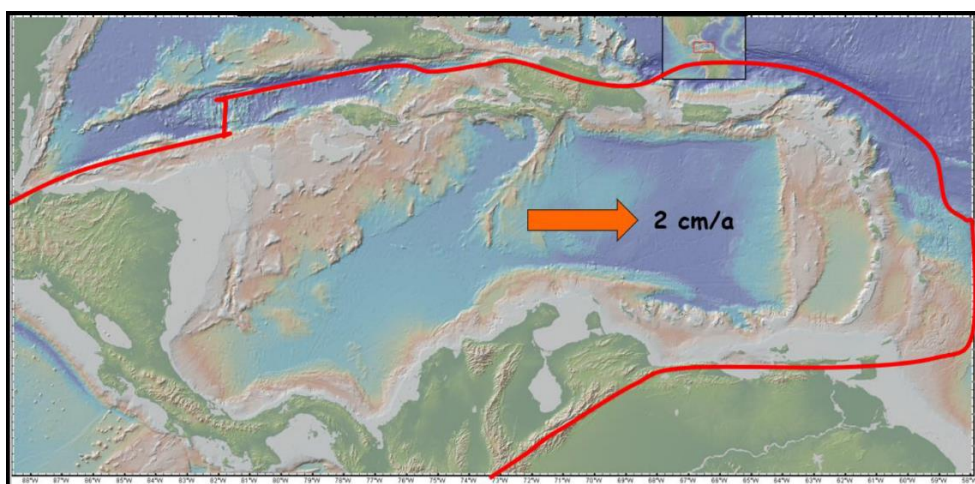
Location of the future islands located 59Ma BP on part of the orogenic province, like a belt on the edge of the American plates on the Pacific side, which will dislocate from the north of the South American continental crust, by the relative movement of the Caribbean plate, causing a stretching in a southwest to northeast direction.



Geological provinces of the Earth according to data from the U.S. Geological Survey



The relative movement of the Caribbean plate causes a stretching of the orogenic province, a belt along the coastline of the north of the South American continent, forming the Eastern Caribbean arc, from Aruba to Saba and Sombrero. The same phenomenon occurs in the stretching of the orogenic province to the south of the North American continental crust, a belt extending from the Yucatan, from Cuba to Puerto Rico, as far as the Virgin Islands.



An **orogen** is a system of continental or oceanic mountains resulting from orogeny. Orogeny is limited to convergent plate interactions. The long regions of deformed rock created by orogenies are called orogenic belts of the Earth's crust or **orogens** (unstable zones).

New paleogeological data consistent with those of molecular biology (phylogeny)

Molecular biology generally reveals that the genetic divergence of many species of flora and fauna constituting the biodiversity of the Eastern Caribbean with their closest continental South American congeners is much older than the previously accepted presumed dating of 24 million years of emergence for the proto-Martinique. For example, for the hylodes, this genetic divergence between the Caribbean and South American ones, that is to say the dating of the beginning of the speciation process of the hylodes of the Eleutherodactylus group of the Caribbean, is established between 50 and 45 million years ago. Another example is the lizards of the Dactyloa group, whose different species are currently believed to be distributed across the islands off the Venezuelan coast (Bonaire, Blanquilla, etc.) as far as the latitude of Martinique in the eastern Caribbean, and diverged from the continental South American Anolis 37 million years ago. North of Martinique, with the Dominica Channel constituting a geographical barrier for Anolis species, we have another group of Anolis, the Ctenonotus, from Dominica to the latitudes of the large islands of the western Caribbean (Guadeloupe, Antigua, Anguilla, Virgin Islands, Puerto Rico, Hispaniola, etc.), which genetically diverged from the continental South American Anolis about 55 million years ago. Initial results of geological studies carried out by Professor Mélodie PHILIPPON and her team from the Universities of the Antilles and Montpellier have already revealed a scenario of geological tectonic evolution of the Caribbean plate that took place between 50 and 25 million years ago, which would coherently explain the modes of dispersal and speciation processes, and the distributions observed today of the endemic flora and fauna species constituting the biodiversity of the current Caribbean islands; including the distributions of extinct or disappeared species from these islands. Let us note that this presumed geological scenario of the formation of the islands of the Eastern Caribbean, originally describing a fragmentation of the emerged surface of the north of the South American continent and a detachment of the upper crust, forming a peninsula then a large island (which we, M. BOURGADE, named "Matina" for study), which tectonically slid in a northeast direction, along the subduction zone of volcanoes of the cordillera constituting the arc of the Eastern Caribbean; then scenario of collisions or accretions of fragments of this large island that was Matina, with the south of an archipelago of two other large islands, the one highlighted by Professor PHILIPPON called GrANoLA located further north, and the second island south of GrANoLA constituting proto Guadeloupe, Marie-Galante, and Dominica (which we, M. BOURGADE, have named "KaruWétu" for study), that such a scenario was mentioned by Dr. Roger MAUVOIS who, during a UNESCO Workshop organized by the PNRM in October 2015, explained the formation of the Pitons massifs of Saint Lucia and Martinique by this same phenomenon of upper crust migrations or "thrust sheet" phenomenon (described since 1936 by the German mathematician, physicist and geologist STILLE Wilhem Hans). These large islands of Matina, KaruWétu, and GrANoLA, which existed 35 million years ago, disintegrated and were almost completely submerged 24 million years ago, except for the island banks of the proto-Martinique, Saint Lucia, and the island bank east of Puerto Rico, but also around Marie-Galante and Grande Terre (Guadeloupe).

Also, the presumed isthmus disintegrated to form the islands, "Matina," then "Matigwana," at the top of a mountain range (volcanic arc), located on the southeastern edge of the said Caribbean plate, at the junction of the three lithospheric films (or plates), Caribbean, North America, and South America, south of GrANoLA, and which would have formed a bridge (second after that of the Aves: GAARlandia) between the Orinoco basin and the western Caribbean; The presumed isthmus highlighted by Marcel Bourgade in his publication, Matina then Matigwana, two large islands that have formed over time geologically emerged parts of the southern arc of the eastern Caribbean (November 2020), published on the site <https://hal.science/hal-02994952> was confirmed by a first mapping below, reconstructing the geological context of 35 Ma ago, presented in January 2024 in Guadeloupe by Leny Montheil.

Proto – GAARlandia and GAARlandia

Proto-GAARlandia is a presumed precedent to GAARlandia. In the Late Cretaceous and Early Paleocene, there was clearly a land bridge between North and South America, given the arrival of mammals belonging to the Theria in the latter continent during this period. Proto-GAARlandia is this inter-American land bridge that made possible the first American biotic exchange (referring to the later Great American Biotic Exchange). This proto-GAARlandia may have been formed by volcanic activity, unlike GAARlandia. This land bridge would have been uplifted in response to the tectonic displacement of the South American plate to the southwest. GAARlandia is the ancient land bridge, which connected the present-day large islands of the western Caribbean to South America during the Paleogene. The term was constructed from the English acronym GAAR, for Greater Antilles-Aves Ridge. The geographical position of this GAARlandia bridge corresponds to the north-south oriented shoals located between the north of what is now the eastern Caribbean (east of Puerto Rico) and northern Venezuela, passing through the Isla de Aves. It is believed to have formed during the transition from the Eocene to the Oligocene, 35 to 33 million years ago, due to a combination of the region's tectonic uplift and the global drop in sea level. (Philippon et al., 2020)

The biological connection with northern South America allowed flora and fauna to spread to the large islands of the western Caribbean. Fossils of mammals, ground sloths, Caribbean monkeys, porcupines, hutias and capybaras, among others, have been found in the large islands of the western Caribbean and have a certain South American origin (Philippon et al., 2020). This is also the case regarding the origin of many groups of animals, including of course that of reptiles and amphibians; iguanas of the *Cyclura* species, *Ctenonotus anolis*, Eleutherodactyls, are precisely living witnesses in these large islands of the western Caribbean of this terrestrial connectivity via the GAARlandia bridge with South America, where their ancestors were able to survive the Chicxulub cataclysm.

Proto-GrANoLA (peninsula) and GrANoLA, then KaruWétu

The Proto-GrANoLA peninsula, 59 Ma ago, was located in northern South America, positioned almost parallel to the east of Proto-GAARlandia, following a south-to-north direction. Thus, this peninsula gradually detached from northern South America between 50 Ma and 40 Ma, to form the large island of GrANoLA (French-English acronym: GrAN for "Greater Antilles" - and oLA for "of Lesser Antilles du Nord").

This large island of GrANoLA, comparable in size to those of the current large islands of the Western Caribbean, clearly existed around 35 Ma ago and allowed terrestrial biological connectivity between the Eastern and Western Caribbean.

According to the map developed by Lenny Montheil et al., 35 Ma ago the island of GrANoLA split in two; And it is this section south of GrANoLA that we have named KaruWétu.

KaruWétu, to phonetically identify the large island that existed 35 million years ago, south of GrANoLA, positioned at the base of the current islands of the Guadeloupe archipelago (Basse Terre, Grande Terre, Désirade, Les Saintes, Marie Galante) and Dominica. Acronym composed of Karu, a prefix of Karukéra corresponding to Guadeloupe, and Wétu, a prefix of Wétukubuli to name Dominica.

Proto-Matīna (peninsula) and Matīna

Matīna, to identify the large island (extending almost from Grenada to Martinique), continental fragment, sedimentary mass, which will dislocate from the peninsula connected to the South American continent (the proto-Matīna), to slide in a tectonic context along the South American plate; by a phenomenon of thrusting on the Caribbean plate, in a northeast direction, during a period ranging from 35 to 25 million years, until collusion with the island of KaruWétu. Matīna or Matīnina is phonetically the oldest Taíno toponym known to name Martinique.

The Eastern Caribbean Arc (orogenic province of the South American continent): archipelagos of continental islands, remnants of Matīna, KaruWétu, and GrANoLA

The islands of Martinique, Saint Lucia, Saint Vincent, the Grenadines, and Grenada are the remnants of the large island of Matīna, which was submerged. The islands off the coast of Venezuela—Aruba, Curaçao, Bonaire, Tortuga, Blanquilla, Testigas, and Margarita—are also remnants of the proto-Matīna.

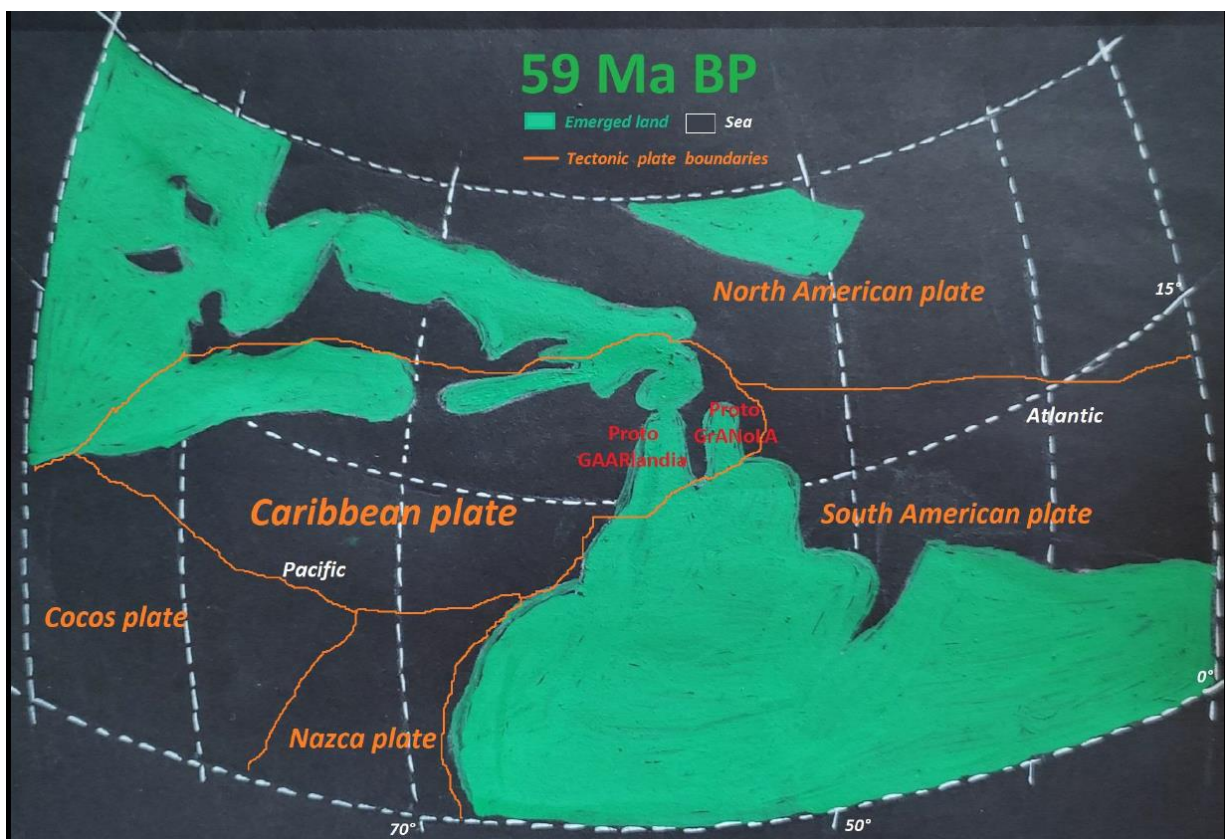
The islands of Dominica, Marie-Galante, Les Saintes, Petite-Terre, La Désirade, Grande-Terre, and Basse-Terre of Guadeloupe are remnants of the large island of Karu-Wétu.

The northern islands of Guadeloupe, Montserrat, Saint Kitts and Nevis, Antigua and Barbuda, St. Martin, St. Barth, Anguilla, and Sombrero are remnants of the large island of GrANoLA.

The island of Saba is a remnant of GAARlandia.

The Western Caribbean (orogenic province of the North American continent):

Large continental islands and related island groups that were once connected to the Yucatan, Nicaragua, and Florida peninsulas; Cuba, Bahamas, Turks and Caicos, Jamaica, Cayman, Jaragua, Hispaniola, Mona, Puerto Rico, Virgin Islands.



Map drawn by the author, based on that generated by the Terra Antiqua software developed on QGIS by the geologist Guillaume Dupont Nivet..

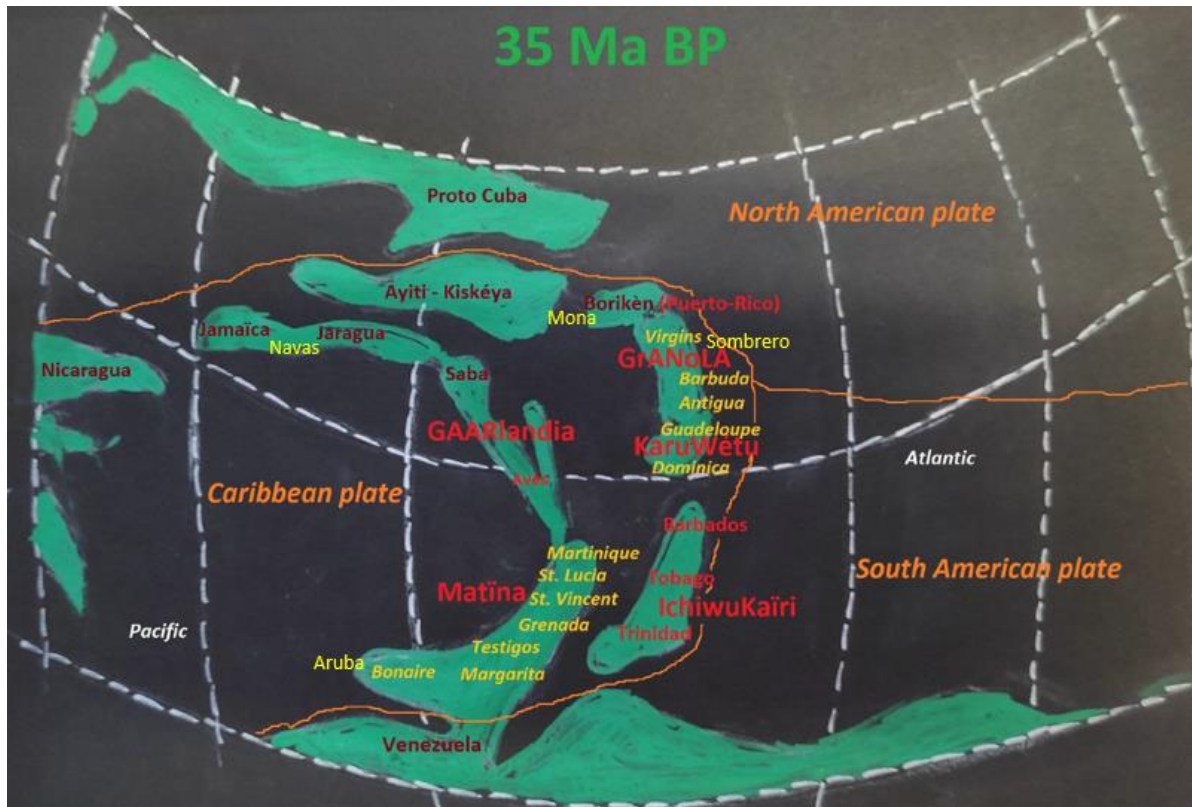
As soon as possible after surviving the cataclysm caused by the Chicxulub asteroid impact 66 Ma ago, the ancestors of Testudines, Chelodoinis and Trachemys surviving from the Amazonian craton dispersed from South America to the peninsula that we have named proto-GrANoLA. These ancestors of Testudines separated from the ancestors of the Testudines at this time, around 50 Ma BP, who also originated from the same dispersal center in South America and moved towards the peninsula further west, that of GAARlandia, in collusion with a large island of the time gathering proto-Puerto Rico, Mona, proto-Hispaniola (Jaragua), proto-Jamaica, proto-Cayman, proto-Cuba, Bahamas ... It is this dispersal by GAARlandia which generated, through a process of peripatric speciation by land, the existence of fossil species of Chelonoidis inventoried on islands of the Bahamas, Turks and Caicos, Cuba, Navas, Mona. Once detached from the Proto-GrANoLA peninsula in northern South America, Testudine ancestors found themselves isolated on the island of GrANoLA, which would fragment into several islands, including KaruWétu. From about 40 Ma BP, Testudines evolved separately from those that remained on the South American continent and those that dispersed via GAARlandia to Puerto Rico, Mona, Hispaniola, Jaragua, Jamaica, Cuba, the Bahamas, etc.

From 25 Ma BP, as GrANoLA and KaruWétu gradually submerged, Testudines survived by finding refuge on remnant islets of GrANoLA and KaruWétu, which remained above water and constituted proto-Anguilla, proto-Saint Martin, proto-Saint Barth, proto-Antigua and Barbuda, proto-Guadeloupe archipelago, proto-Dominica and proto-Martinique (North of Matina). Hence the fossil species of Chelonoidis discovered so far on the islands of Sombrero, Anguilla, and Barbuda.

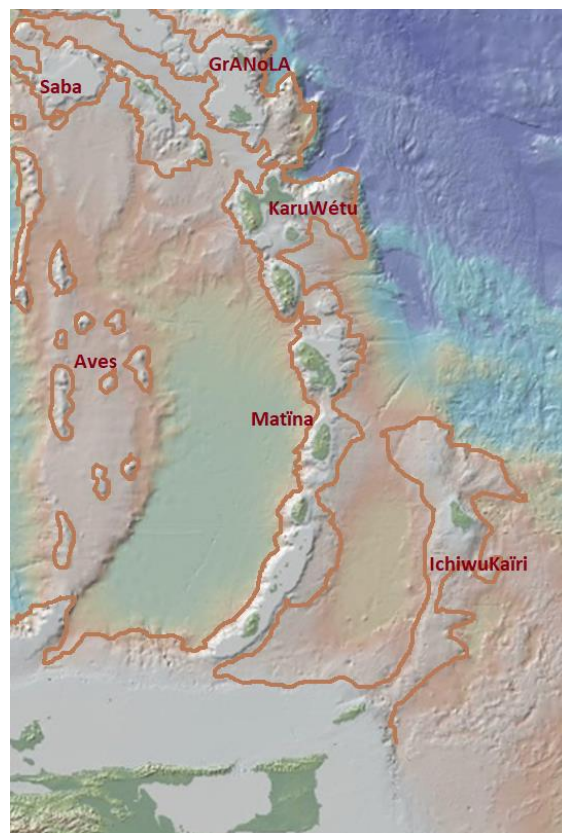
But also Mòlòkòy, already naturally existing on the land masses of Matina for more than 35 Ma, evolved over geological time, finding themselves isolated as a result of an allopatric process in Grenada, Saint Vincent, Saint Lucia, and Martinique.

The same is true in Barbados and Trinidad, Tobago, where Mòlòkòy were isolated for more than 35 Ma from other Testudines on the continent, for a time on the large island we named IchiwuKairi for study; hence the existence in Barbados of three species of Chelodoinis: one a fossil species and therefore extinct, a second unidentified as *C. carbonaria*, and the third being so.

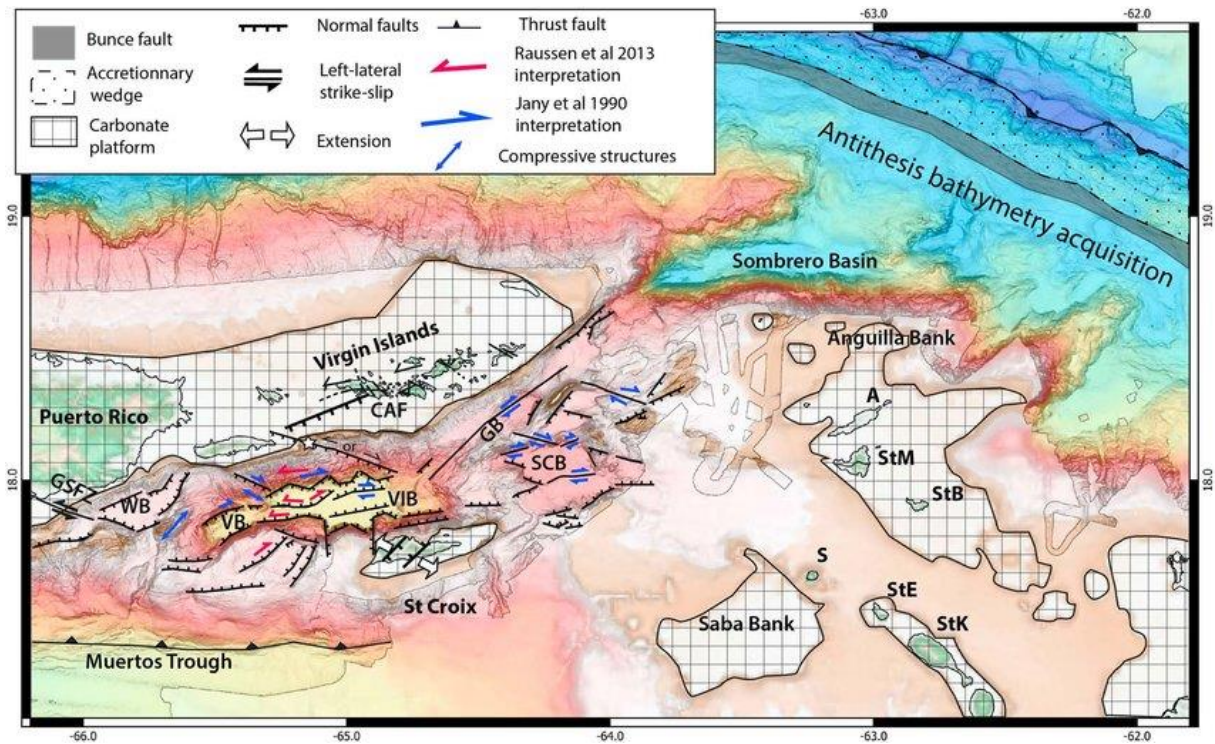
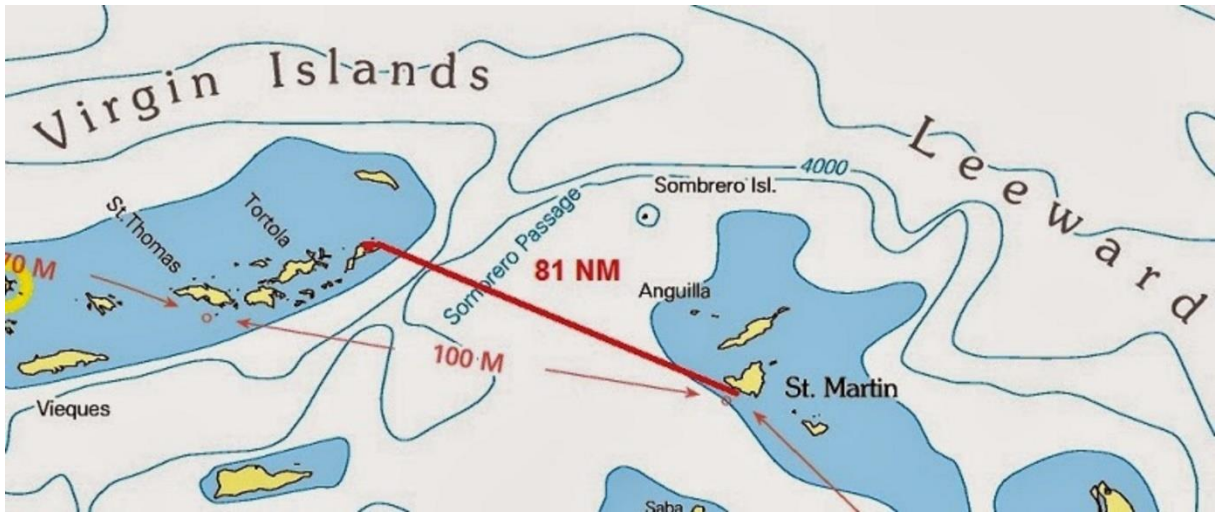
Concerning the palustrine and freshwater Testudines of the genus Trachemys present on almost all the islands of the Guadeloupe archipelago, in Dominica and Martinique, unlike the Chelodoinis more or less adapted to arid zones, these were unable to survive and prosper on the islands north of Guadeloupe, from Sombrero to Antigua, which were too dry and arid; Lineages of Trachemys certainly existed on GrANoLA, but were unable to survive as it submerged, on islands that became too arid. The same reasoning applies to the islands south of Martinique, where biotopes favorable to the existence of palustrine and freshwater turtles became rare, and completely disappeared over the geological time of the submersion of Matina between 35 Ma and 24 Ma BP.



Map produced by the author, based on the work of Lenny Montheil (2024) showing details of the land masses of the Caribbean 35 million years ago.

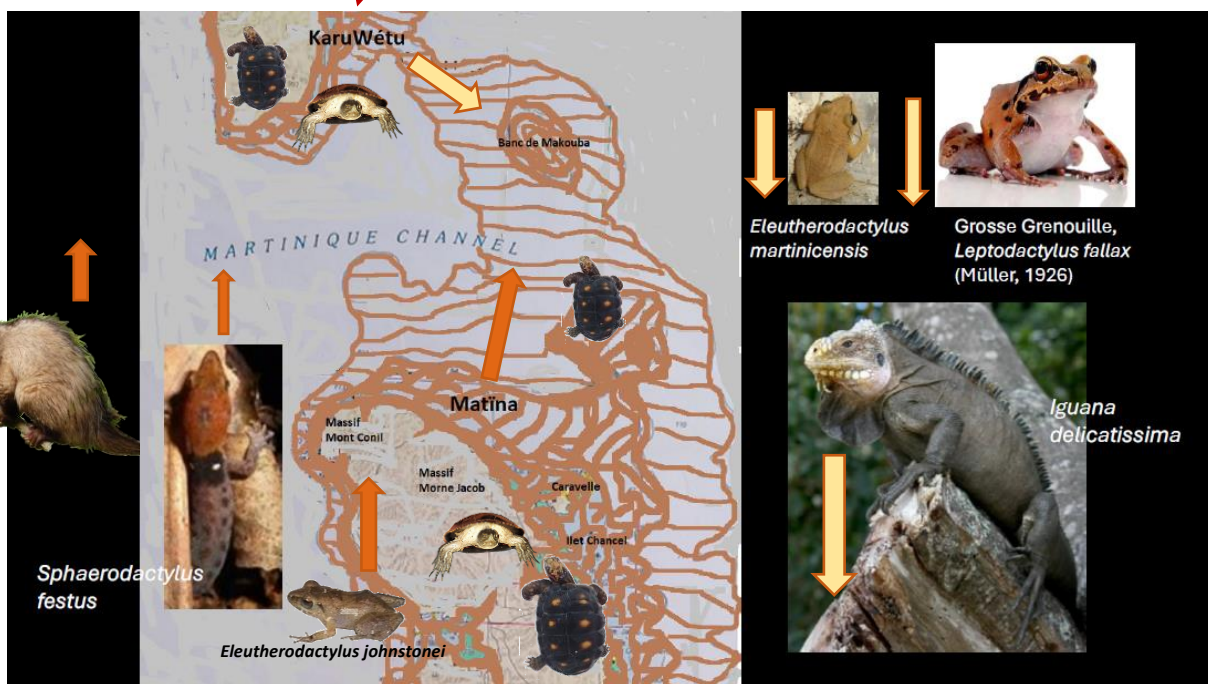
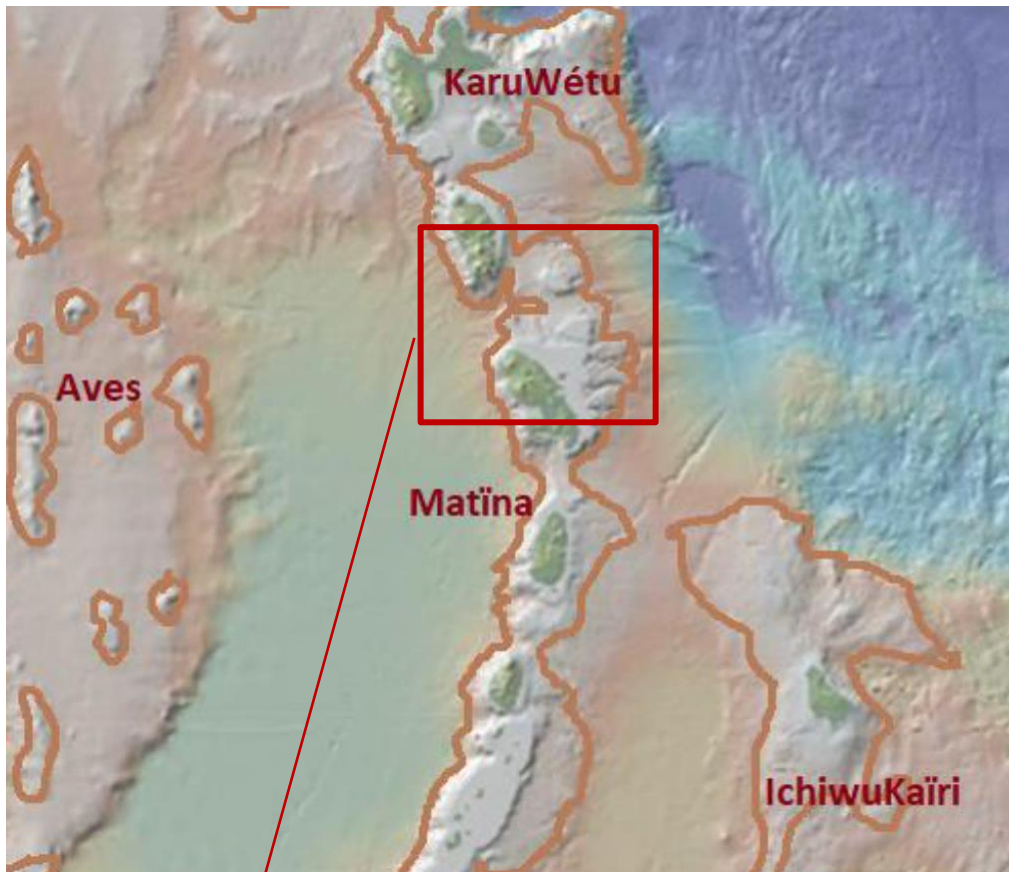


Eastern Caribbean landmass context over a time period estimated to be between 35 Ma and 27 Ma BP



Sombrero: collision or accretion zone between the North American orogenic belt and the South American orogenic belt

It is easy to understand that Sombrero Island, which today has its highest point at 6 meters above sea level, once constituted a plateau at a much higher altitude, inland from the large island of GrANoLA.



Like Sombrero, the Macouba Bank, a current strait between Martinique and Dominica: collision or accretion zone between the northern end of Matina and the south of KaruWétu..

It is easy to understand that the Macouba bank, now submerged, once constituted a plateau at a given altitude, within emerged lands allowing terrestrial bioconnectivity between Matina and KaruWétu.

Conclusion

The evidence of the proto-Matīna (35 Ma BP) and of Matīna clearly emerged until about 27 Ma BP, of GrANoLA and KaruWétu, in addition to that of proto-GAARlandia, should remove the uncertainties expressed by researchers regarding the origin of the presence of Testudines throughout the Caribbean, for millions of years, from the Bahamas to Aruba.

If we abandon the false premise, which asserts that the so-called "Lesser Antilles would be made up of oceanic islands (implied Atlantic), which would have emerged from the sea one after the other starting 24 million years ago for Martinique, due to volcanic activity"; If we then understand that, in truth, fundamentally and tectonically, everything is happening in the subduction zone of the Caribbean plate, west of the South and North American plates, therefore on the Pacific Ocean side.

If we escape a fixed view of Caribbean geography.

If we accept:

- That 59 million years ago, there was a peninsula east of proto-GAARlandia, which formed proto-Granola and KaruWétu, which is at the origin of the formation of the islands north of Martinique, Dominica, and Sombrero.

- That the Eastern Caribbean arc is made up of archipelagos of continental islands, remnants of larger islands. That the islands of Martinique, Saint Lucia, Saint Vincent, the Grenadines, and Grenada are the remains of the large island of Matīna, which was submerged. That the islands off the coast of Venezuela, Aruba, Curaçao, Bonaire, Tortuga, Blanquilla, Testigas, and Margarita, are also remnants of the proto-Matina.

- That the proto-Matina was connected 35 million years ago, via GAARlandia (Bridge of the Aves), to the proto-Saba Bank, which itself remained connected to the proto-Jaragua-Jamaica long enough to allow the dispersal of a Testudine lineage, as well as lineages, for example, of the Hylodes originating from the proto-Matina, even as far as the western end of the proto-Jaragua-Jamaica.

- That on this large continental island of Matīna, on the orogenic belt bordering northern South America, the ancestors of Testudines evidently coexisted with the ancestors of animal species: mammals, amphibians, reptiles, and sedentary birds, mollusks, and insects...

Everything becomes coherent.



Acknowledgments: – I warmly thank Ansèl Fong and David Maceira, biologists from Santiago de Cuba, who since 2013 have encouraged me to persevere in my herpetological and geological research. Thanks to Christine Naime, Pascal Vatblé and David Belfan for their observations, their interest and passion for the Living and therefore for the search for data relating to Martinican and Caribbean biodiversity, and for their photographs of Mòlòkòy present in Martinique. My thanks also go to Roger Mauvois for this fundamental information in geology, as well as to Garcin Malsa and Ronald Brithmer for their readings and critiques of my publications. Thanks to Yvan Ineich and Gilles Bœuf for their warm encouragement. Thanks to Mélodie Philippon and her team from the Universities of the Antilles and Montpellier who invited me to Guadeloupe in January 2024, to participate in the launch of a research program, SUBUTTEC Kick-off relating to the paleogeology and paleobiology of the Eastern Caribbean; special thanks to Jean-Jacques Cornee and Manuel Pubellier who enlightened me in my understanding of geological processes and phenomena. Special thanks to Lenny Montheil for the development of his map specifying the context of the emerged lands of the Caribbean 35 Ma ago..

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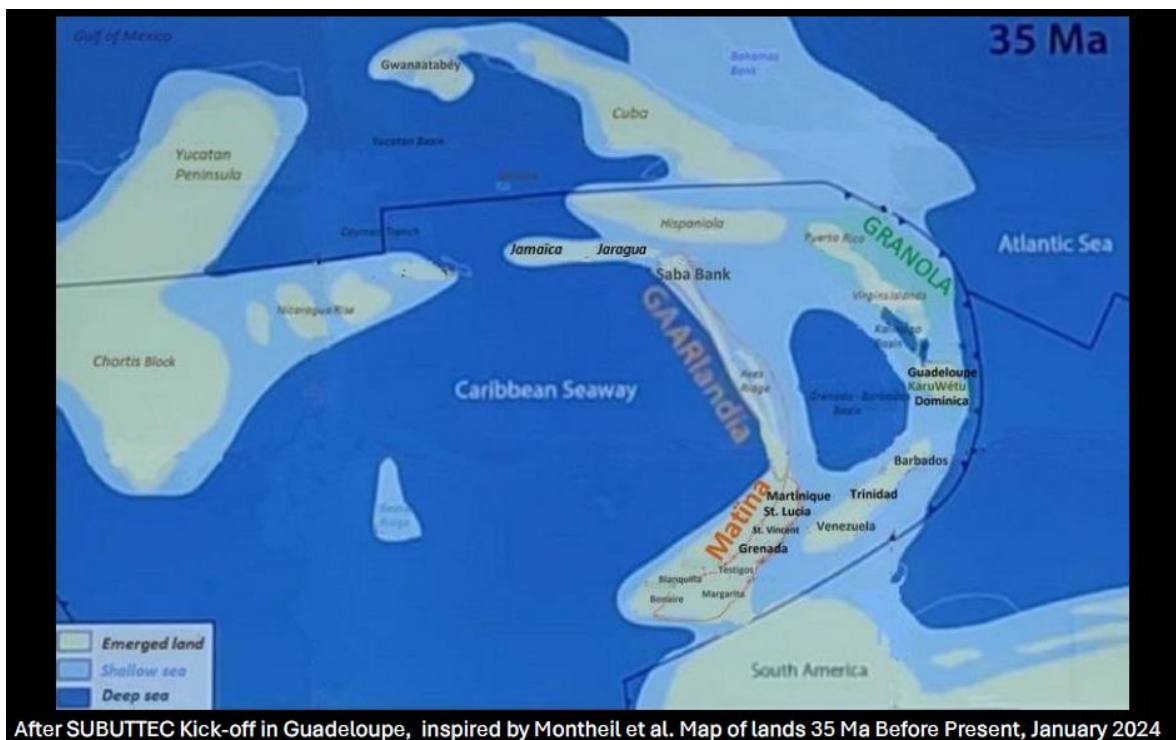
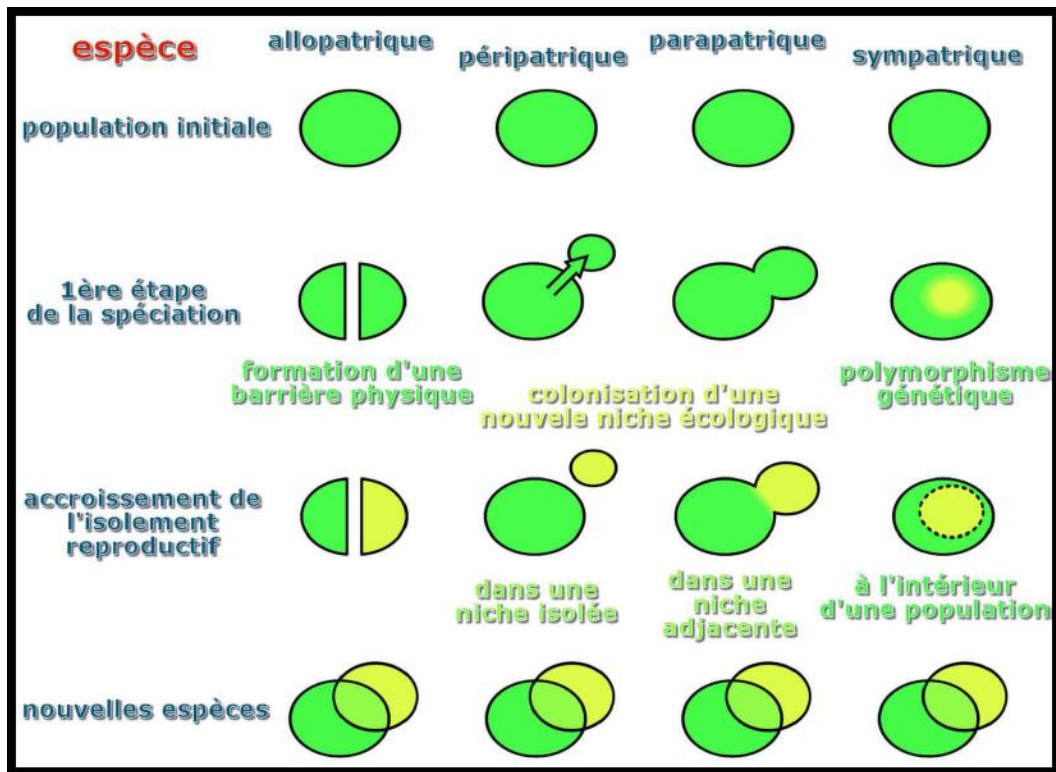
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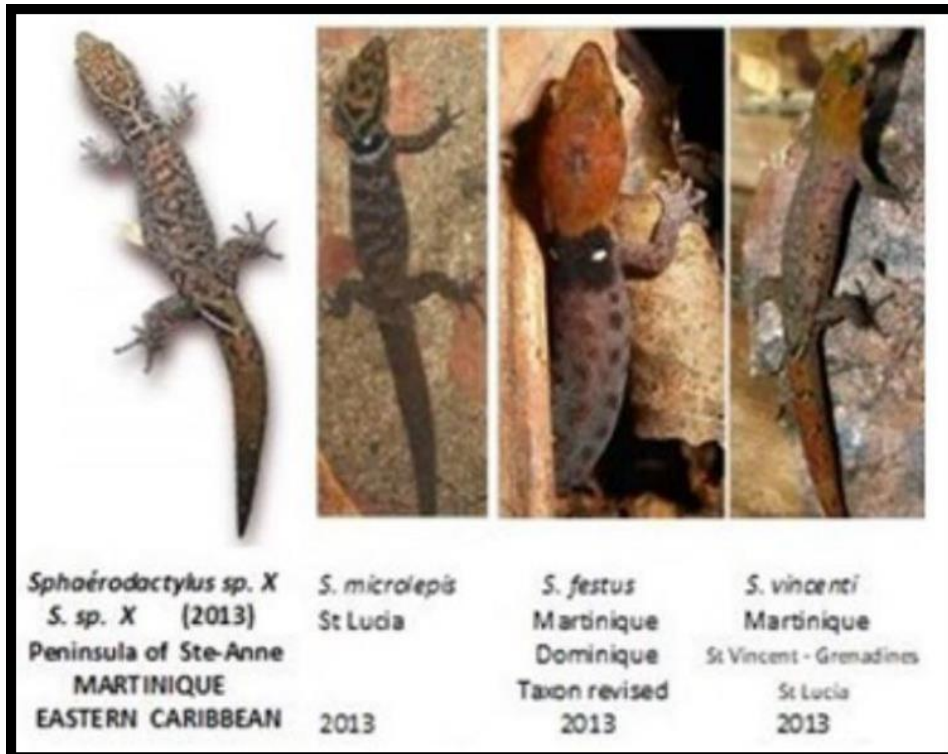
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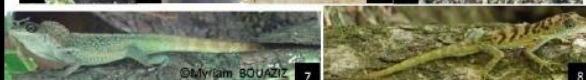
Non-exhaustive citation by the author of terrestrial animal species endemic to the Eastern Caribbean, including extinct species; but not including a number of species of terrestrial molluscs and freshwater aquatic species (from rivers) which are also endemic to our Eastern Caribbean, particularly Martinique.





Zanndoli

Anolis



Diversité de phénotypes
et multitudes de lignées
en Martinique
pour une seule espèce
d'*Anolis* reconnue comme
telle, en l'état des
connaissances actuelles :

Dactyloa roquet





Iguana delicatissima

Living in the North of Martinique, up to the latitude of Chancel Islet.



Endemic island iguanas of the Caribbean



Hylodes

Eleutherodactylus johnstonei



Diversité de
phénotypes
et multitudes de lignées
en Martinique

Contexte et scénario
d'isolement
géographique
similaires, lié à
l'histoire géologique
tectonique,
entre l'hylode
considérée comme
*Eleutherodactylus
johnstonei*
en Jamaïque,

et l'Allobate
Colostethus chalcopis
strictement
endémique de
Martinique
découverte en 1994



Allobate
Chalcopis

*Colostethus
chalcopis*

Strictement
endémique des
pitons et
massifs de la
Pelée au nord
de la
Martinique





Chofé Solèy, *Gymnophthalmus pleii*
 espèce endémique de Martinique et Sainte-Lucie



Gwo Mabouya *Thecadactylus rapicauda*

Gecko endemic to the Caribbean and northern South America

Found in Central America, Mexico (Yucatan)

Ti Sèpan Tè

Stenostomes

Tetracheilostoma bilineatum
 3 phénotypes correspondant
 à trois lignées distinctes
 en Martinique





Bothrops lanceolatus
3 phénotypes
correspondant à trois
lignées en Martinique





Holotropide de l'Herminier,
Leiocephalus herminieri
(Dumeril & Bibron, 1837)



Scinque de Martinique,
Capitellum metallicum (Plée, 1820)
et **Grand Scinque de Martinique,**
Mabuya mabouya (Bonnaterre, 1789)
Deux espèces de lézards disparues de Martinique

**Espèces éteintes de lézards qui furent
strictement endémiques de la Martinique**



**Kourès ou
Couleuvre de
Martinique**

*Erythrolamprus
cursor*

Espèce considérée comme étant éteinte



Matoutou Falèz



Caribena versicolor

Espèce de mygale
strictement
endémique de la
Martinique

Le Dynaste
Hercule, connu
scientifiquement
sous le nom de
Dynastes reidi,
est l'un des
coléoptères les
plus
impressionnants
et emblématiques
que l'on trouve en
Martinique.

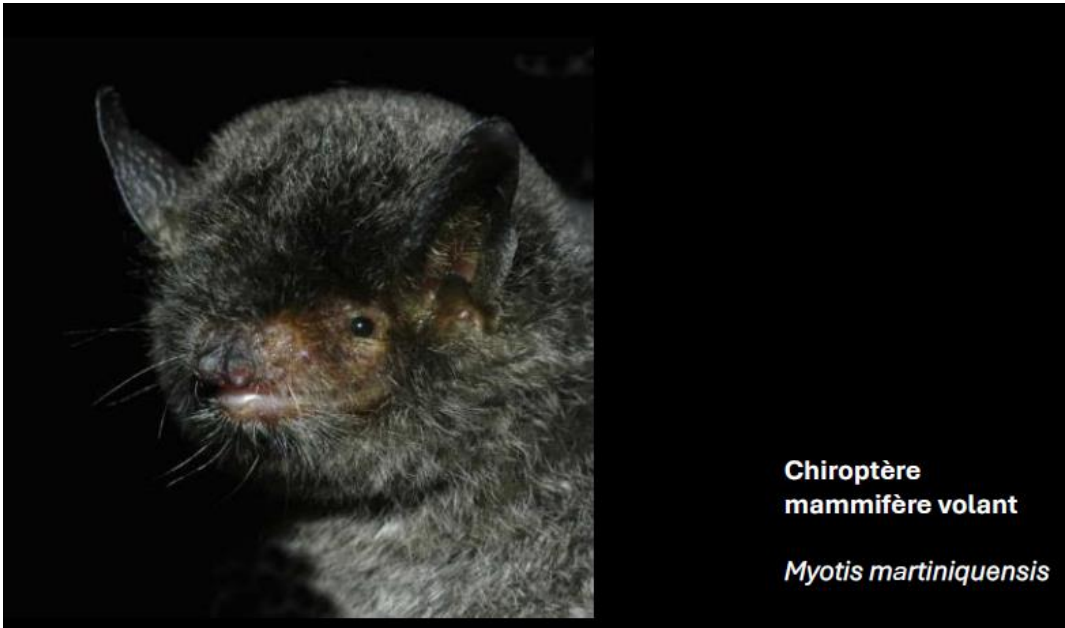


Scarabée
Dynastes reidi



*Didymocentrus
martinicae*







Espèce éteinte

Rat Piloni ou Rat Musqué,
Megalomys desmarestii
(J. Fischer, 1829)

1902

L'Agouti,
Dasyprocta antillensis
(Carl Von Linné, 1758)

Le Tatou à Neuf bandes, *Dasypus novemcinctus*
Toujours présent à Grenade, mentionné et dessiné par Du Tertre comme étant présent en Martinique.

**Espèces éteintes de mammifères terrestres
qui furent présents en Martinique**





L'Oriole de la Martinique,
Icterus bonana
Espèce strictement endémique de
la Martinique



Ramphocinclus brachyurus



Kano ou Koukou Tè,
Speotyto cunicularia
(Molina, 1782); genre d'hiboux
disparu de la Martinique

**Espèce
éteinte**



Colibri à tête bleue
Riccordia bicolor
Endémique de la Martinique
et de la Dominique.



Femelle en train de couvrir (Engoulevent coré)

Engoulevent coré,
Hydropsalis cayennensis (Gmelin, 1789), oiseau
très discret présent au nord de l'Amérique du Sud,
et présence énigmatique parmi toutes les îles de la
Caraïbe orientale, observée uniquement et
seulement en Martinique



**Espèce
éteinte**



Ara martinica

