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Evidence for historical human-induced extinctions of vertebrate species on La Désirade (French West Indies)

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ABSTRACT

Pit cave 6 on Pointe Gros Rempart (Baie-Mahault, La Désirade, French West Indies) is a stratified fossil-bearing site. While the archaeological material and faunal remains from the oldest assemblage demonstrate it to have formed during the Amerindian period, the second assemblage dates to the first one-hundred years of the island's colonial period (mid-18th to mid-19th centuries). Faunal analysis revealed the presence of 4 now locally extinct or extinct species, three of which have never before been documented on La Désirade (*Ameiva* sp., *Leiocephalus* cf. *cuneus* and *Alsophis* sp.). Changing faunal spectrums (invertebrates and vertebrates) due to environmental destabilisation combined with aspects of the island's colonial economy demonstrate habitat degradation and over-grazing to be the principal causes of extinctions and or extirpations.

Introduction

The Lesser Antilles are one of 34 hot spots of world biodiversity (Myers et al., 2000) whose indigenous flora and fauna have been dramatically affected by human activity. In fact, this region has lost a substantial portion of its indigenous amphibian, reptile (Henderson, 2004; Powell and Henderson, 2005), bird (Greenway, 1967; Wiley, 1986; Wiley et al., 2004), and mammal species (Morgan and Woods, 1986; Grouard, 2010). Moreover, these numbers probably underestimate the actual loss of vertebrate species, as they are based on comparisons with species documented by 18th century naturalists, although the majority of available information unfortunately derives from early 20th century sources. The earliest extinctions, such as the *Ara* on Martinique (Williams and Steadman, 2001) and the *Boa* on Guadeloupe (Lorvelec et al., 2007; Breuil, 2009), also remain the most debated. For example, recent work with fossil-bearing cave deposits on the island of Marie-Galante in the centre of the Lesser Antilles archipelago documented several extinct taxa (e.g. boa, curly-tailed lizard) that provide evidence for a much richer faunal spectrum than is evident from records concerning the earliest period of European colonisation (Sierpe, 2011; Stouvenot et al., 2014; Bochaton et al., 2015).

Addressing the multiple factors contributing to the disappearance of a species relies on the most precise understanding possible of its historical context (Fritts and Rodda, 1998). The study of abundant faunal remains often preserved in archaeological sites (e.g. Wing, 2001; Olson and Máiz López, 2008; Turvey et al., 2010) alongside natural, often better fossilised accumulations in karstic contexts (e.g. Pregill et al., 1994; Steadman and Hilgartner, 1999), provide an ideal source of information for addressing this issue. Karstic contexts are also likely to record substantial periods of time prior to or contemporary with an island's prehistoric occupation. As such, they can furnish new data concerning the composition and evolutionary history of past faunal communities as well as accompanying natural or anthropogenic modifications of local environments.

A focus on archaeological or natural faunal assemblages may, in fact, represent the only means for addressing extinctions in many island contexts. This is certainly true when historical sources or the work of early naturalists are unavailable, as is typically the case with La Désirade. Located 10 miles off the coast of Grande Terre, this small island was colonised by Europeans relatively late but not before the eighteenth century. Visited only occasionally by fisherman, the island remained isolated for a substantial period and, unlike the larger islands of Guadeloupe, did not receive detailed attention by naturalists who visited the

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archipelago in the 18th and 19th centuries. The first descriptions of the island's indigenous fauna therefore appeared as late as the mid-20th century, in particular the work of Father Pinchon (Danforth, 1939; Pinchon, 1953, 1967).

Here we present an analysis of vertebrate remains recovered from pit cave 6 on Pointe Gros Rempart. Bone and teeth from the site demonstrate the presence of three squamate taxa and a mammal that have since disappeared from La Désirade. The combination of sedimentological, malacological, and archaeological data supports the local extinction of this fauna being associated with the European colonisation of the island and ensuing deterioration of natural habitats. The comparison of our data with the economic history of the island allow us to investigate the environmental factors involved in human-driven extinction of several terrestrial species on a small island untouched by substantial historical plantation.

Geographic context

The small island of La Désirade (31 km^2) forms part of the Guadeloupe island group (Fig. 1), with one-third of its surface covered by a large plateau ringed to the west, south, and east by a series of raised marine terraces cut by erosion. The island's original dry forest vegetation is related to the low relief (highest point 276 m) that limits annual rainfall. The current landscape is composed of parcels of land dedicated to subsistence agriculture or savanna with cacti or croton coppices supporting browsing goats. Although several patches of forest do survive in the ravines that incise the flanks of the plateau, the majority of wooded areas represent secondary forest growth on disused agricultural fields (Rousteau et al., 1994).

Historically, La Désirade was home to an indigenous Amerindian population as illustrated in the island's 43 pre-Columbian evidences of occupation including lithic workshops, ceremonial sites, and villages (De Wall, 2006). Although several date to the Early Ceramic Age (~550 BC–AD 500), the majority dates from the Late Ceramic Age (~AD 500–1500). The lack of archaeological evidence leaves the occupation of the Island after the first European populations arrived in the West Indies poorly documented. Some authors argue nevertheless that Amerindian populations continued to occupy the island for several centuries (Barbotin, 2010). French colonisation from neighbouring Guadeloupe did not begin before 1728, when a leper hospital was established on the Island (Lasserre, 1957). The human-induced modification of La Désirade's natural environment likely began shortly after the arrival of European colonisation. For example, *Lignum vitae* was exploited throughout the 18th century to meet the needs of European navies (Moreau, 1992; Barbotin, 2010) to such a point that today it is listed as endangered.

The population of the island was never very high (Barbotin, 2010), reaching 40 to 50 inhabitants/km^2 in the second half of the 18th century, and increasing again to 70 inhabitants/km^2 in the middle of the 19th century (Lasserre, 1957). Population levels remained relatively stable until the 1950s, being conditioned by the island's extremely limited economic resources connected to poor soil quality. Subsistence economies therefore centred around fishing and small-scale farming as well as cotton cultivation, sheep herding and creole gardens (Lasserre, 1957).

Geologically, La Désirade consists of a Mesozoic basement of volcanic, plutonic and siliclastic rocks surmounted by Cenozoic limestones. The littoral zone is skirted by remnant Pleistocene limestones, which form the youngest marine terraces. One of these terraces, Pointe Gros Rempart, not far from the town of Baie-Mahault, juts 200 m into the ocean and rises no more than a dozen metres above sea level (Fig. 1). No less than 25 caves and depressions have been documented on this heavily karstified landform and consist either of vadose shafts or collapsed dissolution features opening onto the surface (i.e. banana holes, Harris et al., 1995).

Pit cave 6 on Pointe Gros Rempart (16°19′41.56″ N, 61° 0′49.18″ O WGS 84), hereafter referred to simply as PGR6, is a banana-hole (Fig. 2) with a partially preserved roof forming a 2 to 3 m deep rock shelter. While the 2 m high ceiling allows for easy movement, collapsed blocks at the entrance protect the rock shelter from the elements. The combination of easy access and protection from the elements makes for an ideal setting for denning animals or human occupation.

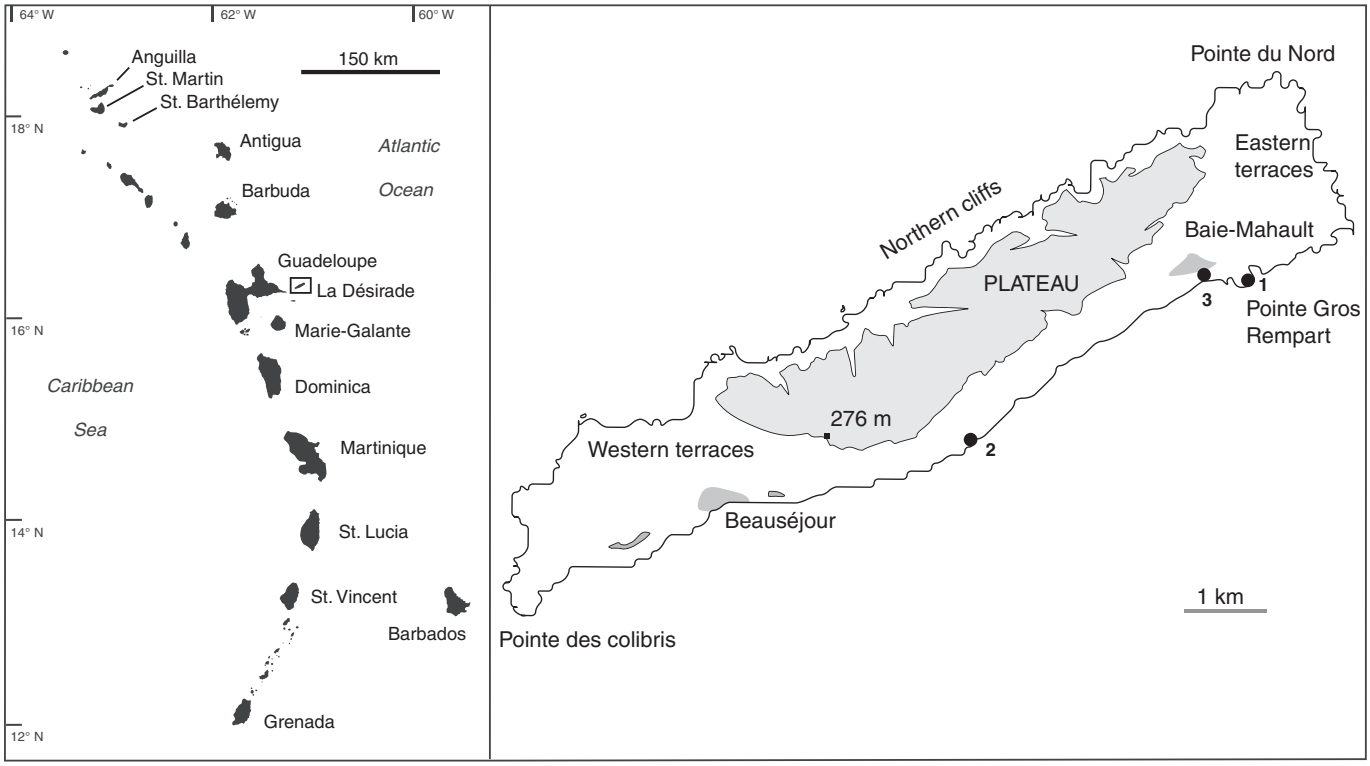

Figure 1. Left — Location of La Désirade. Right — Location of pit cave 6 on Pointe Gros Rempart (1) and Amerindian sites having produced fossil deposits: L'Escalier (2) and Petite Rivière (3).