A late-Holocene bird community from Hispaniola: Refining the chronology of vertebrate extinction in the West Indies

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Abstract
We report 4800+ late-Holocene, non-passerine avian fossils from Trouing Jean Paul, a high-elevation limestone sinkhole in the Morne La Visite region, Massif de la Selle, Haiti. The fossils represent prey remains of two extant owls, the widespread Tyto alba and the Hispaniolan endemic T. glaucops. Among 23 species of birds, only one is extinct (an undescribed woodcock, Scolopax new sp.). Two other species (the petrel Pterodroma hastata, and the Hispaniolan endemic pauraque Siphonorhis brewsteri) are rare today, the latter now found mainly in dry forest at lower elevations. Two other species (the doves Zenaida aurita and Columbina passerina) are widespread and common today on Hispaniola (and elsewhere) but no longer occur at high elevations. The age of the bone deposit at Trouing Jean Paul (c. 1600–600 cal. BP) is based on six radiocarbon dates from individual bones of the extinct woodcock. The only other extinct Hispaniolan vertebrate with multiple direct radiocarbon dates is the sloth Neocnus comes, with the youngest of seven dates (from five sites) being c. 5000 cal. BP. The fossil assemblage at Trouing Jean Paul does not include the extinct species found in older Holocene sites, such as Neocnus comes and associated species (three other sloths, two monkeys, four rodents, a caracara, flightless rail, and giant barn-owl). Rather, the Trouing Jean Paul fossils portray a late-Holocene bird community that already had experienced four or more millennia of Amerindian presence, but had not yet been influenced by the activities of European or African peoples over the past 500 years. Although only c. 1000 years old, the Trouing Jean Paul bird community has species associations without a modern analog, even if the extinct woodcock is excluded.

Keywords
birds, fossils, Haiti, long-term community change, radiocarbon dating, vertebrate extinction, West Indies

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Introduction
West Indian islands have received considerable attention in recent years from conservation biologists who are interested in improving the prospects for survival of indigenous plants and animals, which include a number of endemic species that are rare or endangered (e.g. Borroto-Páez et al., 2012a, 2012b; Latta et al., 2005). Paleontologists can contribute to an improved understanding of the species composition of West Indian plant and animal communities by identifying fossils from time intervals either before human arrival or at least during periods with less cumulative human impact than today. These fossil assemblages typically represent both living and extinct species, thereby documenting which indigenous species are gone from modern biotas, as well as distributional changes in extinct species (Martin and Steadman, 1999; Morgan and Woods, 1986). Such information allows conservation planning to consider distributions and species associations that cannot be discerned from studying only the fragmented modern biotas.

Fossil research is especially important on West Indian islands where much of the vertebrate extinction revealed through fossils took place after human arrival, during the current interglacial interval known as the Holocene (Pregill et al., 1994; Steadman et al., 2005, 2007; Woods, 1989). Regional changes in climate, sea level, and vegetation were minor within the Holocene relative to those that took place during the immediately preceding glacial–interglacial transition from c. 18,000 to 10,000 years ago (Curtis et al., 2001; Escobar et al., 2012; Schubert and Medina, 1982). While mindful that climate and sea level are always dynamic through time to some extent, the relative stability of the Holocene makes it less likely that factors such as climate and sea level were involved in major biotic changes, such as extinction. Understanding how the West Indian plant and animal communities have changed during the Holocene, both before and after human presence, adds long-term perspective to concepts of community stability as well as to conservation efforts. Such perspective will be vague, however, unless the fossils come from well dated contexts.

Until now, none of the fossil birds reported from the large island of Hispaniola (= Haiti + Dominican Republic) has been associated with radiocarbon dates (Bernstein, 1965; Olson, 1974, 1976a; Steadman and Hilgartner, 1999; Wetmore, 1922; Wetmore and Swales, 1931). Without a chronological framework, we cannot begin to decipher the possible causes of extinctions and range changes, nor can we learn which species were associated with which others, i.e. we cannot piece together the species composition of vertebrate communities at any given time in the past.

To address this situation, we studied a large set of avian fossils from an ancient barn owl roost in a limestone sinkhole called Trouing Jean Paul (TJP) in the Morne La Visite region of southern Haiti (Figure 1). The site lies on a plateau within Parc National La Visite, which comprises c. 3000 ha of pine forest, broadleaf cloud forest, savanna, and juniper forest in the Massif de la Selle.
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(Dávalos and Brooks, 2001; Judd, 1987; Woods, 1986). The area immediately around TJP is pine forest dominated by the Hispaniolan endemic Pinus occidentalis. The abundant fossils from TJP represent numerous species of amphibians, reptiles, mammals, and birds; among these groups, only the non-passerine bird fossils reported herein have been analysed rigorously. Importantly for our research, the TJP fossils retain enough collagen for radiocarbon dating.

Site setting, methods

Trouing Jean Paul is 750 m W of the Rivière Blanche, and 1.5 km W of the tiny settlement of Cassé Dent (18°20′15″N, 72°16′50″W; see Sheet 5771 III, Series E732, Haiti, 1:50,000). The site was discovered on 29 March 1983 by Paul Paryski, who returned to the limestone sinkhole with Jean Claude Duvalier on 12 May 1983. Paryski and Duvalier were part of a team, led by Charles A Woods, to survey the modern and prehistoric fauna of Parc National La Visite. Upon noting surficial fossils of the insectivores Nesophontes sp. and Solenodon paradoxus, and the rodents Brotomys voratus and Plagiodontia aedium, the TJP fossil deposit was explored, mapped, and excavated on 16–17 July, 20 September, and 7 November 1983, and 15–16 February 1984, by field teams that variously included Winnie Attie, Daniel Cordier, Brent Mitchell, and Charles Woods. ‘Trouing’ is the Haitian Creole word for cave. The name ‘Jean Paul’ is taken from the first names of Jean Claude Duvalier and Paul Paryski.

The entrance to TJP is developed at 1825 m elevation. The entrance chamber is 20 m long at a decline of 31°, leading to 50+ m of additional cave passage divided into five rooms with slopes from 0 to 59°. All bird fossils reported in this paper derive from the relatively horizontal floor of Room 1, which is the first room past the entrance chamber. This partially illuminated room is 10 m high, 5 m wide, and 8.9 m long. Countless thousands of fossils were collected from three areas of the floor, designated as the Eastern, Southern, and Western pockets. The fossils are from surficial contexts rather than from subsurface sediments, which were essentially absent in this portion of the cave. Each fossil is associated with a four-part set of grid coordinates. The first number is the number of meters east of an E–W datum point within the cave. The second is the number of meters north of a N–S datum point within the cave. The third is the number of meters below a vertical datum point outside of the cave. The fourth value of the grid coordinates is a capital letter (A, B, C, or D) that designates the 0.5 m × 0.5 m quadrat within the square meter pinpointed by the three numbers. A is the NW quadrat, B the NE, C the SE, and D the SW. To illustrate this system, the grid coordinates for the tibiotarsus of Scolopax new sp. depicted in Figure 2(b) are 48·7·59·D, which means 48 m E, 7 m N, 59 m deep, and in the SW quadrat.

Figure 1. (a) The Caribbean region. (b) Hispaniola, showing the location of the Trouing Jean Paul fossil locality.
We identified 4857 non-passerine avian fossils through direct comparisons with modern skeletal specimens in the Ornithology Collection of the Florida Museum of Natural History, University of Florida (UF). Except for noting several specimens of the osteologically distinctive Hispaniolan Crossbill (*Loxia leucoptera megaplaga*), the several thousand fossils of Passeriformes from TJP have yet to be identified beyond the ordinal level. No modern skeletal specimens of *Siphonorhis brewsteri* exist, so our comparisons were based on specimens of four other species of Caprimulgidae, namely *Caprimulgus carolinensis*, *Nyctidromus albicollis*, *Phalaenoptilus nuttalli*, and *Chordeiles gundlachii*. To identify the extinct woodcock to the generic level, we compared the fossils with specimens of the North American *Scolopax minor*. In the Results section we provide osteological justification for some of the more challenging identifications. All of the fossils from TJP are housed in the Vertebrate Paleontology Collection at UF.

Unless cited otherwise, the modern status of species of birds in the mountains of southern Haiti, and from Hispaniola in general, is taken from Dávalos and Brooks (2001), Keith et al. (2003), Latta et al. (2006), and Rimmer et al. (2005). While brief, the observations of Dávalos and Brooks (2001) on 3–4 January 2001 are particularly pertinent because they focused on Parc National La Visite in Massif de la Selle. The four other substantial mountain ranges in Hispaniola are also shown in Figure 1.

### Results

We identified 23 species of non-passerine birds from 4857 fossils at Trouing Jean Paul (Table 2). Because the entire fossil assemblage consists of several hundred thousand bones of small vertebrates (frogs, lizards, snakes, birds, bats, insectivorans, and rodents), we interpret the site to represent a roost where owls (*Tyto* spp.) deposited boney pellets of their prey. Two species of *Tyto* are present among the fossils, the nearly cosmopolitan Common Barn Owl *Tyto alba* and the smaller Ashy-faced Owl *Tyto glaucops*, which is endemic to Hispaniola. Both species of *Tyto* are widespread in Hispaniola today. The fossils of *T. alba* confirm that this species, believed perhaps to be a recent colonist to Hispaniola (Keith et al., 2003), has a history there measured in millennia rather than decades. We found no fossils of *T. ostologa*, the
large, extinct species of barn owl that occurs in older Hispaniolan fossil sites (see Discussion).

The five most abundant species together represent 89.5% of all avian fossils identified at TJP. The most common species is the Zenaida Dove (Zenaida aurita). The post-cranial bones of *Z. aurita* are larger than in *Z. macroura* and are more gracile than in *Z. asiatica*. Today, the granivorous *Z. aurita* is widespread on Hispaniola, being common in the lowlands but rare in the mountains, with no records from elevations as high as that of TJP. Aside from the 1509 adult fossils referred to *Z. aurita*, there are several thousand fossils of juvenile doves (not counted in Table 2) that are from the 1509 adult fossils referred to *Z. aurita*, *Z. macroura*, or, in most cases, even *Z. asiatica*. Juvenile doves, perhaps more restless and naïve on their night-time roosts than adults, seem to have been taken by the barn owls more frequently than the adults.

The second most common species (*N* = 1222) is the Black Swift (*Cypseloides niger*), an aerial insectivore that is widespread...
Table 3. Osteological characters to distinguish Siphonorhis from four other genera of Caprimulgidae that occur in the West Indies or North America.

<table>
<thead>
<tr>
<th>Character</th>
<th>Siphonorhis brevistri fossils</th>
<th>Chordeiles gundlachii fossils</th>
<th>Caprimulgus vociferus fossils</th>
<th>Phoebгонoptilus nutalli fossils</th>
<th>Nycticornion albicollis fossils</th>
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<tr>
<td>Humerus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Palmar rotation of crista pectoralis</td>
<td>Much</td>
<td>Little</td>
<td>Little</td>
<td>Little</td>
<td>Little</td>
</tr>
<tr>
<td>Curvature of corpus humeri</td>
<td>Much</td>
<td>Little</td>
<td>Much</td>
<td>Much</td>
<td>Little</td>
</tr>
<tr>
<td>Fossa musculo brachialis</td>
<td>Narrow</td>
<td>Broad</td>
<td>Narrow</td>
<td>Broad</td>
<td>Narrow</td>
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<tr>
<td>Ulna</td>
<td></td>
<td></td>
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<tr>
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<td>Elongate</td>
<td>Short</td>
<td>Elongate</td>
<td>Intermediate</td>
<td>Intermediate</td>
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<tr>
<td>Disto-ventral surface of corpus ulnae</td>
<td>Rounded</td>
<td>Flat</td>
<td>Rounded</td>
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<td>Rounded</td>
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<td></td>
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<td>Sphatium intermetacarpale</td>
<td>Broad</td>
<td>Narrow</td>
<td>Broad</td>
<td>Narrow</td>
<td>Broad</td>
</tr>
<tr>
<td>Facies articularis digitalis minoris</td>
<td>Large</td>
<td>Small</td>
<td>Small</td>
<td>Small</td>
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<tr>
<td>Tibiotarsus</td>
<td>Large, located more proximad</td>
<td>Small</td>
<td>Intermediate</td>
<td>Small</td>
<td>Small</td>
</tr>
<tr>
<td>Corpus tibiartesi</td>
<td>Narrow,long</td>
<td>Short, wide</td>
<td>Short, wide</td>
<td>Short, wide</td>
<td>Intermediate</td>
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<tr>
<td>Tarsoemetatarsus</td>
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<td>Cristae hypotarsi</td>
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<td>Wide</td>
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<tr>
<td>Corpus metatarsi</td>
<td>Narrow,long</td>
<td>Wide</td>
<td>Wide</td>
<td>Prominent</td>
<td>Prominent</td>
</tr>
<tr>
<td>Fossa metatarsi I</td>
<td>Inconspicuous</td>
<td>Inconspicuous</td>
<td>Prominent</td>
<td>Prominent</td>
<td>Prominent</td>
</tr>
<tr>
<td>Length humerus/length femur</td>
<td>26.5/20.4 = 1.30</td>
<td>36.0/20.9 = 1.72</td>
<td>30.9/21.2 = 1.46</td>
<td>30.8/20.1 = 1.53</td>
<td>33.9/23.0 = 1.47</td>
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<tr>
<td>Length tarsometatarsus/length femur</td>
<td>23.8/20.4 = 1.17</td>
<td>13.8/20.9 = 0.66</td>
<td>17.4/21.2 = 0.82</td>
<td>17.9/20.1 = 0.89</td>
<td>22.4/23.0 = 0.97</td>
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and common today on Hispaniola. Given the rapid and acrobatic flight of C. niger and other swifts (including the White-collared Swift Streptoprocne zonaris), we presume that predation by owls occurred at night when the swifts occupied their cliffside roosts and nests. The third most common species (N = 1120) is the Least Pauraque (Siphonorhis brevistri). Unlike swifts, this aerial insectivore flies slowly and perches in trees and on the ground. It is uncommon and local nowadays on Hispaniola, confined to elevations <800 m. Among the many osteological characters to support referral of these fossils to the genus Siphonorhis (Table 3, Figures 3, 4 herein; also see Olson, 1985), the very short humerus and long tarsometatarsus (relative to length of the femur) are particularly distinctive. The length of the humerus in the Siphonorhis fossils from TJP ranges from 24.3 to 28.9 mm (mean = 26.7 mm, N = 19), which compares reasonably well with the measurement of a single Haitian fossil specimen of S. brevistri from St. Michel de l’Atalaye (25 mm) versus 31.5 mm in the presumably extinct S. americana of Jamaica, as reported by Olson and Steadman (1977). Olson (1985) gave these measurements of humeral length in Siphonorhis (N = 1 in each case): 24.8 mm in S. brevistri; 27.4 mm in the presumably extinct S. dairqui of Cuba; and 31.5 mm in S. americana.

The fourth most common species at TJP is an extinct woodcock (Scoplopex sp.; Figure 2) to be described in a separate paper on its comparative osteology and systematics. The 340 woodcock fossils include unbroken examples of all major postcranial skeletal elements. The Hispanician Woodpecker (Melanerpes striatus) ranks fifth in abundance (N = 155). This endemic omnivore is a common and widespread habitat generalist on Hispaniola today.

We refer 63 fossils to one form or another of pigeon (Patagioenas spp.). The young age (only 3–6 weeks) that is evident in 18 of these specimens hinders species-level identification. The other 45 pigeon fossils represent three species, in a size sequence from small (White-crowned Pigeon P. leucocephala, N = 1) to mediumsized (Scaly-naped Pigeon P. squamosa, N = 32) to large (Plain Pigeon P. inornata, N = 12). The Scaly-naped Pigeon is common today in broadleaf forest at La Visite, where we have found no records of the White-crowned Pigeon or Plain Pigeon.

Two of the three tody fossils are complete humeri with total lengths of 13.91 mm and 14.17 mm. We refer them to the Narrow-billed Tody Todus angustostris rather than the sympatric Broad-billed Tody T. subulatus because of these measurements from modern specimens: T. angustostris (UF 26861) – 14.12 mm; and T. subulatus (UF 8069, 8070) – 15.48 mm, 15.82 mm. The third tody fossil is a complete femur with a total length of 10.53 mm (compared with 10.77 mm in UF 26861, and 11.11 mm in UF 8070). Today, T. angustostris can occur at nearly any elevation on Hispaniola, whereas T. subulatus does not occur at elevations as high as that of TJP. Both species are endemic to Hispaniola.

Discussion

Paleoecology

The fossils from Trouing Jean Paul represent the late-Holocene montane avifauna of Hispaniola as sampled through the prey remains of two species of owls, Tyto alba and T. glaucops. The species composition in any predator-derived fossil site has biases related to the feeding habits of the predator(s) that deposited the bones (Pregill, 1981: 56; Steadman and Hilgartner, 1999). For TJP, these biases are expressed most obviously in body mass. The owls themselves are the two largest species of birds, with Tyto alba montana having 474 g (male) and 566 g (female) (Table 2). The body mass of T. glaucops is unreported, but because T. glaucops is c. 10–20% smaller than T. alba, the body mass would be c. 380–430 g for males, and c. 320–400 g for females. The seven species of birds weighing ≥ 200 g are represented by 188 bones (3.9% of all non-passerine fossils), including those of the owls. The six species weighing from 100 to 199 g represent 40.4% of these fossils, whereas those weighing 50 to 99 g (four species) make up only 7.2%. Finally, 48.5% of the non-passerine fossils are from species weighing < 50 g. We note that the thousands of unstudied passerine fossils from TJP are mainly from species having body masses <100 g, with most of them <50 g. The largest avian prey reported by Wetmore and Swales (1931: 234–236) from modern roosts of T. glaucops in Haiti and the Dominican...
Republic were pigeons (Columba [= Patagioenas] sp.), just as for the fossils at TJP.

**Range changes**

At least four of the 23 species identified from the TJP fossils are no longer present in the Morne La Visite area. The first and most absolute absence is that of the extinct woodcock Scolopax new sp. No species of woodcock exists today in the Caribbean. The only extinct West Indian species of Scolopax is S. anthonyi from two late-Quaternary cave sites (Cueva Catedral, Cueva Clara) in Puerto Rico (Olson, 1976b, 1978). Thus it would not be surprising to discover extinct species of woodcocks elsewhere in the Greater Antilles, i.e. on Jamaica or Cuba. The geographic distribution on Hispaniola of the extinct woodcock is speculative; it may have been exclusively montane or it could have been more widespread.

Three other species of birds recovered from TJP exist on Hispaniola but are extralocal. For the endemic Least Pauraque Siphonorhis brewsteri, the status was described as follows by Keith et al. (2003: 155): ‘Local and increasingly scarce resident of semiarid scrub habitat from sea level to elevations as high as about 800

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**Figure 3.** Humeri (a–e), ulnae (f–j), and carpometacarpi (k–o) of Siphonorhis brewsteri (a, f, k, fossils from Trouing Jean Paul), Phalaenoptilus nuttalli (b, g, l, all from UF 45404, ♀), Caprimulgus vociferus (c, h, m, all from UF 42505, ♀), Nyctidromus albicollis (d, i, n, all from UF 43526, ♂), and Chordeiles gundlachii (e, j, o, all from UF 41196, ♂). Scale bar = 50 mm.

**Figure 4.** Femora (a–e), tibiotarsi (f–j), and tarsometatarsi (k–o) of Siphonorhis brewsteri (a, f, k, fossils from Trouing Jean Paul), Phalaenoptilus nuttalli (b, g, l, all from UF 45404, ♀), Caprimulgus vociferus (c, h, m, all from UF 42505, ♀), Nyctidromus albicollis (d, i, n, all from UF 43526, ♂), and Chordeiles gundlachii (e, j, o, all from UF 41196, ♂). Scale bar = 50 mm.
m; also occurs in mixed, broadleaf, or pine forest (Dod, 1992: 92), but it is most numerous in dry habitats up to about 300 m elevation. For the Zenaida Dove Zenaida aurita, Keith et al. (2003: 142) stated: ‘Common resident … of open country, second growth, scrub, gardens, and cultivated areas in the lowlands. Not found in rain forest and rare in the interior mountains; highest known elevation is … 900 m …’. For the Common Ground-dove Columbina passerina, Keith et al. (2003: 143–144) stated: ‘Common to abundant resident throughout the island in the lowlands, especially in pastures, fields, clearings, and second growth, becoming scarcer as elevation increases; highest known elevation is one at 1100 m in pine forest of Sierra de Bahoruco …’.

For none of these three extralocal species does it seem logical that their prehistoric occurrence at TJP (elevation 1825 m) was because the Morne La Visite area once sustained dry forest. In fact, the presence among the passerine fossils of a pine-obligate species, the Hispianlian Crossbill (Loxia [luculoptera] megaplagia), is strong evidence that pine forest was present near TJP at the time of fossil deposition (although not to the exclusion of other habitat types). Because fires in montane Hispaniola tend to be more destructive to broadleaf forests than to pine forests (Martin and Fahey, 2006; Martin et al., 2010), we suspect that the millennia of human-set fires have expanded the land cover of pine forests at the expense of broadleaf forests. Nevertheless, such a shift in vegetation type would not account for the formerly expanded ranges of species that prefer dry forests. Furthermore, we do not believe that the onset of the ‘Little Ice Age’ (LIA) at 500 cal. BP can account for the loss of dry forest species in the Morne La Visite area because the LIA in the circum-Caribbean region seems to have been characterized by cooler and drier climate (Hodel et al., 2005; Winter et al., 2000).

It could be that the range of suitable habitat and elevation for the three extant but extralocal species of birds was greater before non-native mammals (mongoose, cats, rats, mice, pigs, goats, cows, horses) arrived during the past 500 years. The mechanism for such a shift is unknown; perhaps some evidence would emerge if the non-native mammals were studied in any detail. Another possibility is that the area near TJP had a substantial Amerindian presence during the late Holocene, with enough forest clearance that species such as Zenaida aurita and Columbina passerina found suitable habitat there. Regardless, the 22 extant species of birds identified at TJP represent an avian community with no modern analog. In other words, nowhere on Hispaniola today does this set of species occur together. As more late-Holocene avian fossils are studied, we predict that non-analog bird communities will become the rule, not the exception.

A species from TJP that certainly has declined in distribution and population is Pterodroma hasitata, the Black-capped Petrel, which is endangered but maintains what might be its last Hispaniolan stronghold in the study area. Dávalos and Brooks (2001: 37) noted that ‘The steep north-facing limestone escarpment of La Selle is of great importance for what is probably the world’s largest colony of Black-capped Petrel …’. Fossils of Black-capped Petrels are common at TJP and in many other Hispaniolan caves (DWS, personal observation). Similarly, Patagioenas pigeons, which also are common as fossils at TJP, have been experiencing island-wide declines in recent decades (Latta et al., 2006). We are unaware of modern records of P. leucocephala or P. inornata in the Morne La Visite region, but we hesitate to discount that they may still occur there occasionally, which is why they are not classified as ‘locally extirpated’ in Table 1.

Finally, as many as one-third of the extant species found at TJP are presently considered threatened as a result largely of habitat destruction (Latta et al., 2006). Thus it seems likely that further range retractions can be expected unless more parks and preserves are established and maintained. Expansion of protected areas seems unlikely in the face of human population pressure.

**Chronology of extinction**

Non-chiropteran mammals in the TJP fossil assemblage include the insectivorous Nesophontes sp. and Solenodon paradoxus, and the rodents Brotomys voratus and Plagiodontia adrium. Solenodon paradoxus and P. adrium still survive (barely) in Hispaniola, whereas the other two probably are extinct but are known from historic (= post-Columbian) times (Borroto-Páez et al., 2012b; Miller, 1929; Turvey et al., 2008; Woods, 1981). By contrast, TJP lacks fossils of the other extinct species of mammals recorded from various other Hispaniolan caves (see Borroto-Páez et al., 2012b), such as sloths (Acrotomus ye, A. simorhynchus, Neocnus comus, N. toupiti, Megalocnus zile, Parocnus serus), platyrhine monkeys (Insulacebus toussaintiana, Antillothrix bennisis), and large rodents (Bromyots contractus, Quemisius gravis, Halexobolon phenax, Isolobodon montanus, Plagiodontia araeum, Rhizoplagiadonta lencati). Rather than surviving to within the last millennium (and thus potentially recorded from TJP), we believe it is likely that most or all of these 14 species became extinct at least several millennia earlier. Six of seven AMS 14C dates on individual bones of the sloth Neocnus comes (from five Haitian caves) lie within the Holocene (Steadman et al., 2005) although none of these dates is younger than c. ~5000 cal. BP.

Our understanding of the chronology of human arrival on individual West Indian islands is improving (e.g. Fitzpatrick, 2006, 2011), but much remains to be learned. The initial arrival of humans on Hispaniola is dated crudely at c. 6000–7000 cal. BP (Cooke et al., 2011; Fitzpatrick and Keegan, 2007; Morgan and Woods, 1986; Steadman et al., 2005); we believe it likely that most Hispaniolan species of sloths, monkeys, and rodents died out within the next several millennia, before the time interval represented at TJP.

Before our discovery of the woodcock Scolopax new sp., three extinct species of birds were known on Hispaniola only from fossils, namely the caracara Milvago alexandri, flightless rail Nesotrachis steganinos, and giant Hispaniolan barn owl Tyto ostologa (Olson, 1974, 1976a, 1978; Wetmore, 1922). TJP yielded no evidence of these three species. In preliminary sorting of avian fossils from a number of Hispaniolan sites, we also have noted that specimens of the extinct caracara, rail, and owl occur only in sites that feature a subset of the 14 extinct species of sloths, monkeys, and rodents mentioned at the beginning of the previous paragraph. This is at least partially a ‘chicken and egg’ situation in that we are not sure which extinctions came first, those of the large mammals versus those of the giant barn owl that ate them or the caracara that scavenged their carcasses. Regardless, it seems likely that these losses, which are documented for the only well-dated large mammal (Neocnus comus) to have taken place in the middle Holocene (c. 5000 cal. BP; Steadman et al., 2005), occurred close enough together in time (within centuries rather than millennia) that they might not be easy to distinguish from each other with the resolution available through radiocarbon dating. Perhaps a major, expensive AMS 14C dating effort, such as that of Steadman et al. (2002) in Tonga, could begin to tease apart each other with the resolution available through radiocarbon dating. Perhaps a major, expensive AMS 14C dating effort, such as that of Steadman et al. (2002) in Tonga, could begin to tease apart


