Studies on Fossil and Extant Vertebrates from San Salvador (Watling's) Island, Bahamas

STORRS L. OLSON,
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and
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ABSTRACT

Olson, Storrs L., Gregory K. Pregill, and William B. Hilgartner. Studies on Fossil and Extant Vertebrates from San Salvador (Watling's) Island, Bahamas. *Smithsonian Contributions to Zoology*, number 508, 15 pages, 3 figures, 2 tables, 1990.—An attempt was made to obtain fossil vertebrates from the island of San Salvador, Bahamas, to compare its past fauna with that known from the islands of the Great Bahama Bank, from which San Salvador has always been isolated. Although previous agricultural practices and guano mining have rendered the caves of San Salvador a poor source of fossils, some Quaternary vertebrate remains were recovered, including the following new to the island: two turtles (Emydidae and Testudinidae, genera indeterminate), a crocodile (cf. *Crocodylus* sp.), Audubon's Shearwater (*Puffinus lherminieri*), Black-crowned Night Heron (*Nycticorax nycticorax*) and Turkey Vulture (*Cathartes aura*). Remains from recent Barn Owl (*Tyto alba*) pellets were also analyzed and included the Blue Grosbeak (*Passerina caerulea*), also apparently new to the island. Notes on the status of the extant fauna treat, among others, the following endemic or near-endemic taxa: the lizards *Cyclura rileyi* and *Leiocephalus loxogrammus*, the woodpecker *Melanerpes superciliosus nyeanus*, and the bat *Natalus tumidifrons*.

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Studies on Fossil and Extant Vertebrates from San Salvador (Watling's) Island, Bahamas

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Introduction

The paleontological record of vertebrates from the Bahamas, although containing much of interest, is rather meager, particularly considering the number of islands and banks in the archipelago. The sites hitherto known are believed to be late Pleistocene to Holocene in age (summarized in Olson, 1982). Because all these sites are on islands that form part of the Great Bahama Bank, it would be informative to obtain fossil faunas from islands of adjacent bank systems or individual islands that were isolated during the last glacial lowering of sea level, when the Great Bahama Bank was a single, very large island. For this reason, we chose to search for fossils on the island of San Salvador (formerly called Watling's Island).

San Salvador is relatively small (156 km^2), being approximately 16 km long by 8 km wide. The greatest elevation is only 119.2 feet (36.3 m). The island lies to the east of the Great Bahama Bank, but is not part of any bank system and has presumably been isolated from the rest of the archipelago throughout its history (Figure 1). The shoal water around the island is not extensive and the island would not have been greatly enlarged during periods of lower sea level. The nearest land is Rum Cay, some 37 km to the southwest.

The most outstanding physiographic feature of San Salvador is the extensive system of inland lakes that make up a large percentage of the surface area of the island (Figure 2). These saline lakes are the home of an undescribed small subspecies of the Double-crested Cormorant (*Phalacrocorax auritus*), which feeds on small killifish (*Cyprinodon* spp.) that appear to be the predominant kind of fish inhabiting the lakes. During periods of lowered sea level these lakes would presumably have been less saline and perhaps smaller.

San Salvador is composed almost entirely of marine carbonates and aeolianites (Adams, 1980) with many karstic features such as caves and sinkholes that on other islands frequently contain vertebrate fossils. Unfortunately, several factors make these features of limited paleontological value on San Salvador. Virtually the entire island was once under cultivation. Stone walls delimiting former agricultural plots extend over most of the island as testimony to once greater human activity. This land has for the most part now reverted to dense, nearly impenetrable scrub that makes prospecting for potential fossil sites difficult and unpleasant. Furthermore, in the previous century, caves and sinks on San Salvador, as elsewhere in the Bahamas, were heavily exploited for commercial export of fertilizer, at which time much fossiliferous sediment was removed.

> Most of the Bats' guano which is actually imported into England as an article of commerce is derived from numerous caves frequented by bats on Guanahani Island (St. Salvador) and on other islands belonging to the group of Bahamas, and passes in commerce under the name of Bahama or Guanahani guano. (Voelcker, 1878:68)

The loss to paleontology occasioned by this commerce has previously been lamented (Barbour, 1934; Hecht, 1955). To make matters worse, the great extent of agricultural development resulted in increased erosion so that caves and sinks were secondarily silted in by runoff. Many of the caves that we investigated on San Salvador were filled nearly to the top with such recent sediments. Nonetheless, we did succeed in finding a few fossiliferous sites containing some significant additions

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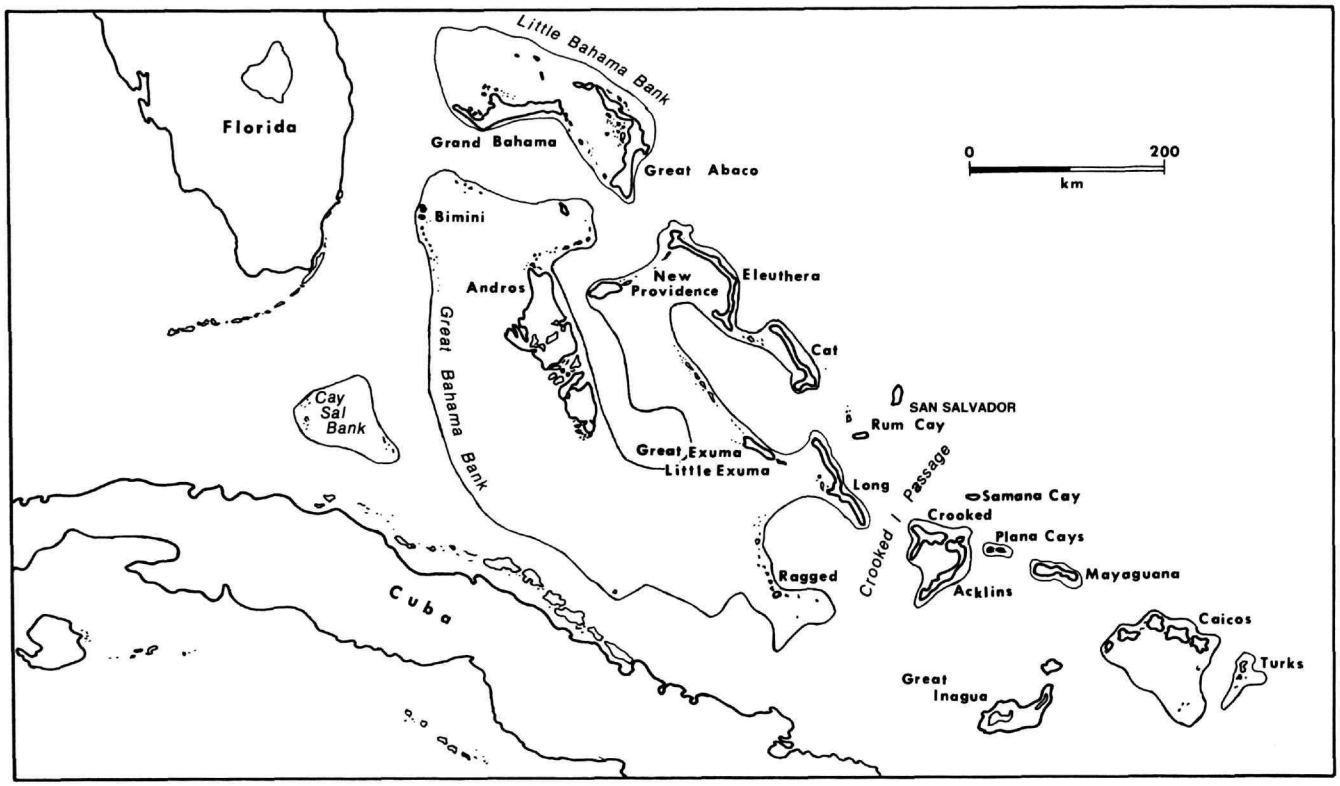

Figure 1.—Map of the Bahamas showing the islands and banks and the relatively isolated position of San Salvador, off the Great Bahama Bank.

to the fauna of the island, even though none yielded a comprehensive assemblage documenting a significant portion of the prehistoric fauna.

The only previous report of vertebrate remains from San Salvador is that of Wing (1969) who identified bones from an Amerindian midden known as the Palmetto Grove site near "Polaris Point" (= Rocky Point) at the northwest end of the island. According to Hoffman (1970), this midden is entirely pre-Columbian and is thought to date between 850 and 1200 AD.

The present authors, with Helen F. James, collected fossil and living vertebrates on San Salvador from 1 February to 23 February 1981. Olson returned on 18–23 March 1982 and collected a few birds but did not conduct any paleontological work. All specimens obtained are housed in the National Museum of Natural History, Smithsonian Institution.

We investigated over 40 potential paleontological sites in various parts of the island: 5 just west of Reckley Hill Settlement; 2 near Victoria Hill Settlement; Lighthouse Cave in Dixon's Settlement; various sea caves and crannies at Crab Cay; 5 sites west of Holiday Track Settlement near Kerr Mount; about 17 sites inland (NW) from South Victoria Hill Settlement and 3 additional ones farther south near Pigeon Creek; and at least 7 on or near Sandy Point. Of these more than 40 sites, only 3 produced significant numbers of vertebrate remains.

The fossil herpetofauna was identified by Pregill using the comparative osteology collections in the Department of Herpetology, San Diego Natural History Museum (SDSNH), and the Division of Amphibians and Reptiles, National Museum of Natural History, Smithsonian Institution. These reference specimens include frog and lizard skeletons obtained on our expedition to San Salvador. Bird and mammal remains were identified by Olson and Hilgartner using the comparative osteological collections of the National Museum of Natural History, Smithsonian Institution. The bulk of the remains were derived from recent Barn Owl (*Tyto alba*) pellets. Species occurring in this context that are common residents or migrants on San Salvador today and require no further comment are listed only in Table 1. More interesting records are discussed in the individual species accounts, which also include notes on species for which no bones were found. Remains that are obviously of some antiquity, appearing to be mineralized and genuine fossils are specifically mentioned. The heading "Material Examined" refers to paleontological specimens only. There is no recent synthesis of the herpetofauna of San Salvador. For the avifauna, there is the brief summary of Miller

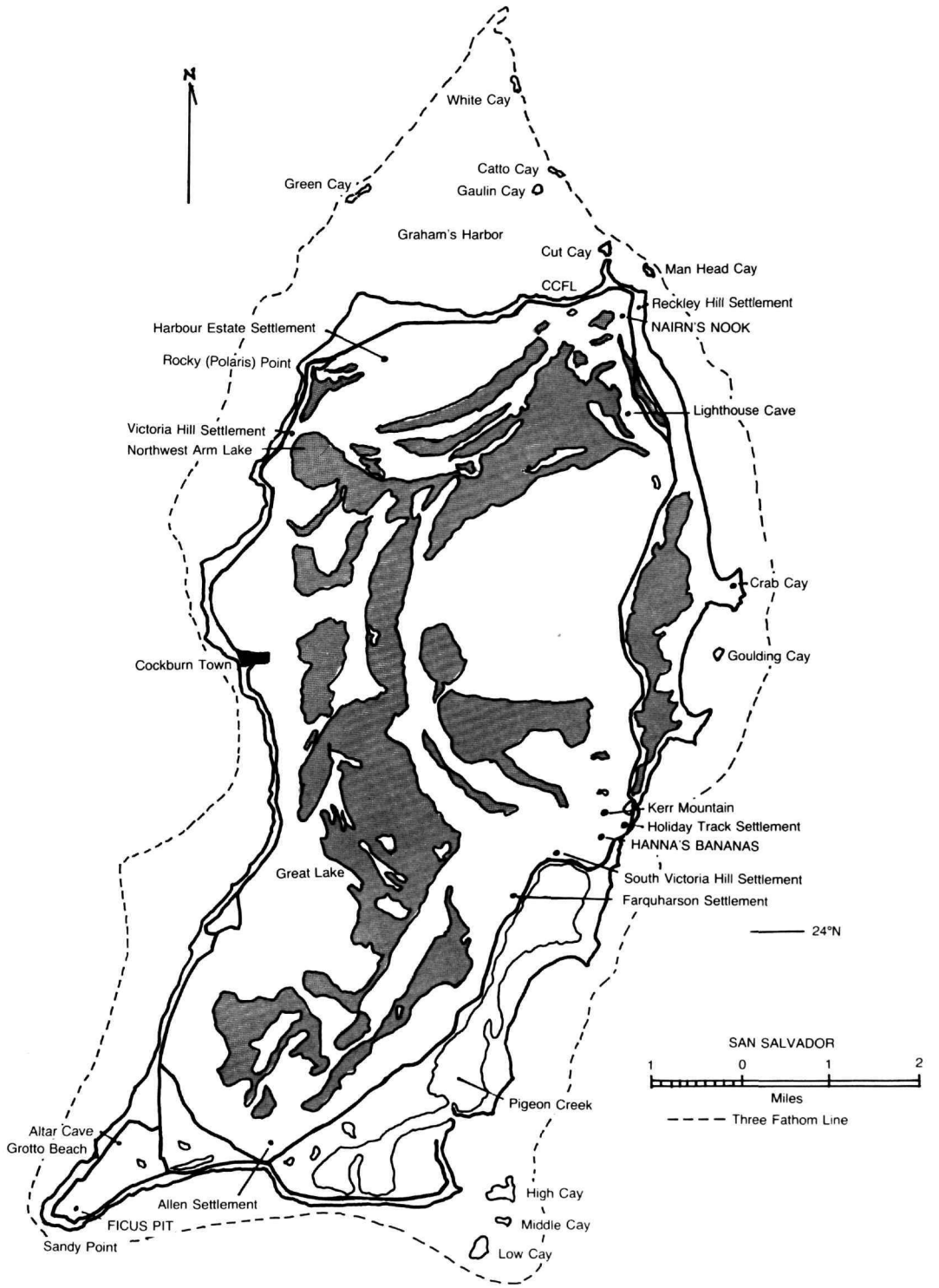

Figure 2.—Map of San Salvador showing the principal fossil collecting localities (in capitals) and the extensive system of inland lakes.

TABLE 1.—Vertebrate remains found on San Salvador, including those from recent Barn Owl (*Tyto alba*) pellets. In each column, the first number is the total number of specimens and the second is the minimum number of individuals. In addition, the iguana *Cyclura rileyi* and the rodent *Geocapromys ingrahami* have been reported from a pre-Columbian Amerindian midden, but the number of specimens and individuals was not stated (Wing, 1969). An asterisk (*) indicates species that are discussed more fully in the text, which also treats *Falco sparverius* and *Melanerpes superciliaris* that were not found in cave deposits. Those species for which there is no discussion occured only in the obviously recent owl pellet material.

Taxon	Ficus Pit	Hanna's Bananas	Nairn's Nook
AMPHIBIA			
**Osteopilus septentrionalis*	9/5	1/1	1/1
REPTILIA			
*Emydidae indet.	7/2	—	—
*Testudinidae indet.	1/1	—	—
**Anolis distichus*	13/6	5/2	3/2
**Anolis sagrei*	65/28	3/2	—
**Cyclura rileyi*	73/8	12/1	—
**Leiocephalus loxogrammus*	34/13	5/2	1/1
*cf. *Crocodylus* sp	—	2/1	—
AVES			
**Puffinus lherminieri*	8/4	1/1	—
**Ardeola virescens*	10/2	—	—
**Nycticorax nycticorax*	1/1	—	—
Ixobrychus exilis	1/1	—	—
**Cathartes aura*	2/2?	—	—
Porzana carolina	19/4	—	—
**Rallus longirostris*	1/1	—	—
cf. *Gallus gallus*	1/1	—	—
Arenaria interpres	1/1	—	—
**Sterna* cf. *fuscata*	25/12	—	—
**Anous stolidus*	14/4	—	—
Zenaida macroura	2/2	—	—
Zenaida cf. *aurita*	7/3	—	—
Columbina passerina	61/7	—	—
Coccyzus cf. *minor*	17/5	—	—
**Tyto alba*	5/1	—	—
**Athene cunicularia*	—	—	2/1
Tyrannus dominicensis	5/3	—	—
**Mimus polyglottos*	1/1	—	—
**Mimus gundlachii*	212/29	3/1	—
**Margarops fuscatus*	137/7	—	16/2
Dumetella carolinensis	7/2	—	—
Vireo crassirostris	12/4	—	—
Vireo sp.	1/1	—	—
Dendroica petechia	5/2	—	—
Dendroica sp.	6/3	—	—
Seiurus aurocapillus	3/3	—	—
Parulidae spp.	27/11	—	—
Coereba flaveola	58/14	1/1	—
Tiaris bicolor	1/1	—	—
**Passerina caerulea*	1/1	—	—
MAMMALIA			
**Macrotus waterhousii*	14/4	57/20	16/6
**Erophylla sezekorni*	9/4	1/1	—
**Natalus tumidifrons*	13/4	—	1/1
**Eptesicus fuscus*	1/1	—	—
Rattus sp.[1]	571/330	—	—
Mus musculus[1]	29/19	—	—

[1]Counts are of mandibles only.

(1978), whose report emphasized land birds and did not include a complete list of all species known from the island. We also obtained a small collection of recent birds that were prepared mainly as skeletons for comparative purposes. Weights of these specimens are given in Table 2.

ACKNOWLEDGMENTS.—Our expedition to San Salvador in 1981 was made possible by a grant from the National Geographic Society (No. 2271-80). We are especially indebted to Helen F. James, who assisted in every aspect of the field work and criticized the manuscript. We also thank Donald T. Gerace, director of the College Center of the Finger Lakes field station (CCFL) on San Salvador, without whose generous cooperation the field work would have been impossible. We are also most grateful to Thomas Hanna, Elmore Nairn, Sam A. Williams, and Israel Arnett, residents of San Salvador who guided us to cave sites and provided much useful information. We thank Donald W. Buden, Ronald I. Crombie, David W. Steadman, and an anonymous reviewer for many valuable comments on the manuscript.

The Fossil Localities

FICUS PIT.—This, our most productive site, is situated at the southwestern-most end of the island on Sandy Point (Figure 2). Our name for it comes from a very large fig tree (*Ficus* sp.) growing out of the bottom of the pit. This is among the largest of the many solution features in the area and is mapped as pit A3 in Mylroie (1980, fig. 5). The depth from ground level to the sediment floor is 9.7 m (32 feet), the floor being roughly circular, with a diameter of about 7 m, the opening at the surface being smaller. The bottom of the pit is considerably overhung by what appears to be the remains of a higher floor, suggesting that an earlier sink formed that later collapsed into one beneath it.

The floor underneath an overhang on the north wall was the site of a recent Barn Owl (*Tyto alba*) roost, with prey remains from regurgitated pellets scattered about the surface and into the loose, organic surface sediment. We collected these remains and dug three trenches and two additional test pits in the sediments of the floor. Sediment was passed through one quarter inch mesh and window screen. There was no apparent stratification except that a dark organic upper layer (~10–20 cm thick) overlay a yellowish, limey sediment of varying thickness. The considerable amount of roof-fall complicated digging and contributed to mixing of specimens of different ages when bones would fall into spaces between rocks. Differentiating between very recent (i.e., from pellets of the owls still inhabiting the pit) and evidently older bones (which were relatively scarce) was made more on the basis of appearance. Regardless of age, the accumulation of bones here was probably due almost entirely to the actions of owls, with the exception of some bats and a few of the larger birds and reptiles. A few specimens, most notably the distal portion of a humerus of a Turkey Vulture (*Cathartes aura*), appear very heavily mineralized, with a crystalline matrix inside the bone,

TABLE 2.—Weights of birds obtained on San Salvador, Bahamas. Weight is one of the better indicators of the overall size of a bird and may be a very useful systematic tool. For additional weights of Bahaman birds see Steadman et al. (1980). Weights are in grams and were taken with Pesola spring balances.

Taxon	Male	Female
Phalacrocorax auritus subsp.	1270	1035.7, 1125.5, 1175
Falco sparverius sparverioides	77	100
Columba leucocephala	216	
Zenaida aurita zenaida	155, 179	
Columbina passerina bahamensis	30.5, 34.5	28.5, 32
Coccyzus minor maynardi	61	
Crotophaga ani		94
Calliphlox e. evelynae	1.8, 3.0	
Melanerpes superciliaris nyeanus	77.5	
Mimus g. gundlachii	75	65
Margarops f. fuscatus	74.5, 95, 97, 99	80.5, 90.5, 93, 95.5, 100
Vireo c. crassirostris	13.5, 13.6	11.8, 14.0, sex? 14.2
Dendroica petechia gundlachi	9.3	8.0
Dendroica d. discolor	5.7	
Coereba flaveola bahamensis	n = 18 10.8–13.7 (mean 11.8)	n = 8 9.5–11.2 (mean 10.3)
Tiaris b. bicolor	8.5, 8.9, 10.0	
Passerina cyanella		11.9

and are much abraded, suggesting that they may be of considerable antiquity (possibly Pleistocene), perhaps having been originally deposited on the higher, earlier floor prior to its collapse.

HANNA'S BANANAS.—This sinkhole was shown to us by Thomas Hanna, who used the rich, moist sediments contained therein for cultivating bananas, a common practice in the Bahamas. Situated near Kerr Mount, on the eastern side of the island near Holiday Track Settlement (Figure 2), the sinkhole has a large, oval opening, a depth of about 6 m, and a roughly circular sediment floor with a diameter of about 7 m. We dug numerous trenches and test pits but most of the sediment was evidently recent and highly organic, this black layer extending to over a meter in depth in some places. Beneath ledges, an orangish inorganic sediment was reached at depths of about 0.25 to 0.5 m. The sediment was moist and did not lend itself to dry screening with fine mesh, so we had to remove it from the pit and spread it out to dry. Bones were scarce, consisting mainly of bats and a few lizards and birds. From a crevice high on one wall we obtained numerous very dark bones of the bat *Macrotus waterhousei* in dusty, white deposits of guano.

NAIRN'S NOOK.—This site, which takes its name from Elmore Nairn, who guided us to it, is a cave in a small escarpment a few hundred meters west of Reckley Hill Settlement at the northeast point of the island (Figure 2). The entrance is rather small and the cave extends about 4 m into the hill and consists of 3 small chambers, the last of which, about 0.6 m in diameter, contained 0.3 m or more of sediment that we excavated and screened. The bones recovered included those of domestic mammals, indicating deposition within the past few hundred years, and the other bones recovered are probably not of much, if any, greater age.

Species Accounts

AMPHIBIA

HYLIDAE

Osteopilus septentrionalis Duméril and Bibron

MATERIAL EXAMINED.—Ficus Pit: 1 sphenethmoid; 1 right, 5 left ilia; 1 urostyle, 1 right humerus. Hanna's Bananas: 1 right scapula. Nairn's Nook: 1 fragmentary left ilium.

REMARKS.—Some of these bones were surface collected, unmineralized, and obviously of recent origin. Others show sufficient mineralization to be of some antiquity. In either case, the fossils do not differ from comparable bones of modern *Osteopilus*, the osteology of which has been described by Trueb and Tyler (1974). The ilium of *O. septentrionalis* is distinguished by the more obtuse preacetabular angle than in *O. brunneus* (Jamaica) or *O. dominicensis* (Hispaniola). Extrapolating from the length of the ilia, the largest fossil individual had a snout-vent length of 75 mm, which is the average size of modern females of this species (males to 62 mm; Trueb and Tyler, 1974).

Osteopilus septentrionalis occurs throughout the Bahamas, Cuba, and the Cayman Islands, and has been introduced into Florida and Puerto Rico (Schwartz and Thomas, 1975), although some Florida populations may be natural (Duellman and Crombie, 1970). On San Salvador we encountered the species island-wide, although not abundantly. Most individuals were found beneath rocks and rubble in moist areas, and occasionally in epiphytes. The species is known as a fossil from the Cayman Islands (Morgan, 1977) and New Providence (Pregill, 1982).

REPTILIA

EMYDIDAE

Genus and species indeterminate

MATERIAL EXAMINED.—Ficus Pit: 1 ischium; 2 ilia; 1 metatarsal; 3 scraps of plastron.

REMARKS.—The well-mineralized ischium and ilia are referred to a species of emydid turtle based on their conformation with those elements in *Trachemys* and *Chrysemys*. In emydids, the ischium is straight, in contrast to the distinctly angled condition in testudinids, and the lateral process is relatively short and square. The ilia are enlarged proximally in emydids, whereas both ends of the bone are expanded in testudinids (Zug, 1971). The scraps of plastron exhibit the thickness, sculpturing, and texture characteristic of emydid turtles (C.R. Crumly, pers. comm.). The three girdle elements show a greater degree of ossification than would be expected in testudinids of comparable size. The fossils are undiagnostic below the family level. The fossils are from individuals at most 200 mm in carapace length.

Previous to this discovery there had been no evidence that turtles of any kind ever existed on San Salvador. The origin and relationships of emydids in the Bahamas have been unclear. West Indian pond turtles have recently been reviewed by Seidel and associates, whose conclusions concerning Bahaman populations are summarized here (Seidel, 1988; Seidel and Adkins, 1987; Seidel and Smith, 1986). All of the Antillean species of Emydidae are placed in the genus *Trachemys*, which also includes *T. scripta* of the southeastern United States, Mexico, and northern South America. The supposedly endemic Bahaman species *T. felis* from Cat Island and Eleuthera is considered synonymous with *T. terrapen* of Jamaica. *T. malonei* of Great Inagua is treated as an endemic subspecies of *T. stejnegeri* of Hispaniola and Puerto Rico. A population from New Providence is a hybrid swarm of turtles brought by man probably from other Bahaman islands, some individuals of which were introduced to North Andros, although there may be another population of *Trachemys* on South Andros. From such a curious pattern of distribution doubts have been expressed as to whether *Trachemys* occurs naturally in the Bahamas.

Although it would be fruitless to speculate on the specific identity of the San Salvador fossils, they do show that emydid turtles were indeed once a native component of the Bahaman herpetofauna. These turtles probably flourished in the large inland lakes of San Salvador and may have disappeared as a result of the increase in salinity following the last eustatic rise in sea level.

TESTUDINIDAE

Genus and species indeterminate

MATERIAL EXAMINED.—Ficus Pit: 1 right postorbital.

REMARKS.—This mineralized specimen is identified as a tortoise from its elongate, narrow, curved shape, whereas the postorbital bone in emydids is more nearly rectangular. It came from an individual with a skull length of approximately 60 mm, but is otherwise undiagnostic below the level of family.

Fossils of giant tortoises (*Geochelone* sp.) are recorded from the Great Bahama Bank on New Providence and Andros (Auffenberg, 1967; Pregill, 1982), but little can be determined about their specific identity and relationships.

IGUANIDAE

Anolis distichus Cope

MATERIAL EXAMINED.—Ficus Pit: 6 right, 5 left dentaries; 1 right, 1 left maxillae. Hanna's Bananas: 2 right, 2 left dentaries; 1 left maxilla. Nairn's Nook: 1 right, 1 left, and 1 fragmentary dentaries.

REMARKS.—Most of these bones appear to be rather recent, but at least one dentary from Ficus Pit shows the discoloration and encrustation of older fossils. Mandibles of this anole are distinguished from those of *A. sagrei* and other Bahaman species of *Anolis* by their pointed tooth crowns. Dentary tooth row lengths of fossils ranged from 6.0 mm to 7.5 mm, coming from individuals with snout-vent lengths of 43 mm to 54 mm (average 49 mm), which is typical of the size of modern *A. distichus* on San Salvador.

Anolis distichus occurs throughout Hispaniola and is scattered through the Bahamas north of the Crooked Island Passage. As a fossil it has been reported previously from New Providence (Pregill, 1982). *Anolis distichus ocior*, a subspecies that otherwise occurs only on Rum Cay, is neither abundant nor widespread on San Salvador today. We encountered small populations mainly in the more shaded interior regions, particularly in woods inland from Holiday Track Settlement, and at Watling's Castle, where they were also reported by Schwartz (1968). We obtained other individuals at the south end of the island near Grotto Beach and on Man Head Cay off the northeast coast.

Anolis sagrei Duméril and Bibron

MATERIAL EXAMINED.—Ficus Pit: 29 right, 28 left dentaries; 4 right, 4 left maxillae (plus miscellaneous uncounted dentary and maxillary fragments, 2 right articular/surangulars, 3 frontals, 10 humeri, 1 pelvis, and 1 tibia, all of which can be referred only to *Anolis* spp.). Hanna's Bananas: 2 right, 1 left dentaries.

REMARKS.—The unidentified material is undoubtedly from either *A. sagrei* or *A. distichus*. The dentary of *A. sagrei* is robust, with a wide dental shelf, and essentially parallel-sided tooth bases. The shape of the tooth crowns varies among individuals in that some have well-developed lateral cusps and others do not. Estimating from length of tooth row (5.4–9.0

mm, average 8.1 mm), fossil individuals (approximately 25% of the sample appears to be modern) ranged in snout-vent length from 34 to 57 mm (average 51 mm), the typical size range of *A. s. ordinatus* on San Salvador today. *Anolis sagrei* is the most abundant reptile in the San Salvador deposits, as it was on New Providence, the site of the only other fossil occurrence of the species in the Bahamas (Pregill, 1982). The species is ubiquitous on San Salvador today and also occurs widely throughout the islands of the Great and Little Bahama Banks, Cuba, and as an introduction to western Jamaica and Florida (Schwartz and Thomas, 1975).

Cyclura rileyi Stejneger

MATERIAL EXAMINED.—Ficus Pit: 2 left and 2 fragmentary dentaries; 1 right and 4 fragmentary articular/surangulars; 1 premaxilla; 1 frontal plus 1 fragment; 2 parietal; 3 left postorbitals; 1 left quadrate; 2 left pterygoids; 1 right ectopterygoid; 1 right, 1 left, and 1 fragmentary scapulae; 4 partial pelves; 38 vertebrae; 1 left ulna; 1 proximal end of tibia; 1 fifth metatarsal. Hanna's Bananas: 1 frontal plus 1 fragment; 9 vertebrae; 1 proximal end of femur.

REMARKS.—These large lizard fossils are easily identified as being from a rock iguana, *Cyclura*, and are referred to *C. rileyi* on geographical grounds, this being the only iguana known from San Salvador, where the nominate subspecies is endemic. The two other subspecies are confined to White Cay in the Exuma group (*C. r. cristatus*) and to Fortune Island, Fish Cay, and North Cay in the Crooked-Acklins group (*C. r. nuchalis*) (Schwartz and Thomas, 1975).

All of the iguana fossils are well mineralized. Some fossil individuals evidently achieved a size as much as 20 percent greater than the largest modern specimens from San Salvador, in which the maximum recorded snout-vent length of males is 306 mm, and of females is 254 mm (Schwartz and Carey, 1977). Estimated snout-vent lengths from our fossils are: scapulocoracoid, 317 mm; acetabular diameter of pelvis, 317 mm, 360 mm; dentary, 325 mm; frontal 340 mm; trunk vertebrae, 345 mm. Reduction in average maximum body size of modern versus fossil populations has been noted in other West Indian lizards and is thought to be correlated with increased mortality due to anthropogenic factors such as introduction of predators and habitat modification or destruction (Pregill, 1986).

Although Schwartz and Carey (1977:78) stated that *C. rileyi* was "abundant on the island of San Salvador," only 5 of their 18 specimens came from the main island, and then from an islet in Great Lake, whereas the other specimens came from Man Head Cay and Green Cay. Paulson (1966) had earlier noted iguanas in cormorant rookeries on islets in the interior lakes. The most recent census estimated no more than 500 individuals on the mainland (Gicca, 1980), but these must be largely confined to the interior islets, as we never encountered iguanas anywhere on the mainland. The species may ultimately benefit, however, from the fact that the interior regions have largely grown into impenetrable scrub. We observed iguanas only on Man Head Cay, where perhaps at most 50 individuals inhabited low tangles of sea grape (*Coccoloba*). Other populations are supposed to occur on Green Cay, Low Cay, and High Cay (Gicca 1980).

Iguana populations on San Salvador have doubtless been greatly reduced through hunting, predation on the eggs and young by introduced rats and feral cats, and in the past through habitat removal. The suggestion that "sea gulls" and ospreys (*Pandion haliaetus*) are "the only likely natural predator" [sic] of *Cyclura rileyi* (Gicca, 1980:10), is not to be taken seriously, as neither ospreys, which are almost entirely piscivorous, nor gulls (*Larus*), which would seldom, if ever prey on active terrestrial vertebrates, especially in dense vegetation, would ever be likely to catch iguanas. None of the long-time residents of San Salvador with whom we spoke recalled seeing "guanas" on the mainland for many years. One of them informed us that he knew of people who had eaten iguanas, although he himself would not partake of them because they reminded him "too much of a big lizard," an indisputable fact. Wing (1969) reported *Cyclura rileyi* from an Amerindian site near "Polaris" (= Rocky) Point on the northeast coast, indicating that the prehistoric human inhabitants of the island also probably ate this species. The bones of *Cyclura* from Ficus Pit and Hanna's Bananas show that the species was probably distributed over the entire island in the past. The remains from Ficus Pit appear quite old and there probably have been no iguanas in the vicinity of Sandy Point for several hundred years.

Leiocephalus loxogrammus Cope

MATERIAL EXAMINED.—Ficus Pit: 13 right, 9 left, and 2 fragmentary dentaries; 3 frontals; 1 parietal; 4 humeri; 2 pelves. Hanna's Bananas: 2 fragments of left dentaries; 1 frontal; 1 humerus, 1 left pelvis. Nairn's Nook: 1 humerus.

REMARKS.—The sample includes some elements of modern appearance, which, with the more mineralized bones, are indistiguishable from a large series of skeletons of *L. loxogrammus* from San Salvador that we prepared. Fossil individuals range in estimated snout-vent length from 65 to 93 mm (average 81 mm). The largest of 36 living specimens that we obtained was a male (USNM 220579) with a snout-vent length of 82 mm.

The species is endemic to San Salvador (*L. l. parnelli*) and Rum Cay (*L. l. loxogrammus*). On San Salvador it is most abundant on the southeast end of the island, from Kerr Mount south through Farquharson's and Allen's Settlements to Sandy Point. We saw none at the north end of the island and most of our series was obtained in open scrub at Kerr Mount. Specimens were particularly easy to obtain after the passage of a cold front on 4 February 1981 (38°F in Miami), when low temperatures and overcast skies made the lizards sluggish, whereas after the weather warmed again they were very difficult to catch.

CROCODYLIDAE

cf. *Crocodylus* sp

MATERIAL EXAMINED.—Hanna's Bananas: 1 partial left jugal; 1 body scute.

REMARKS.—The mid-section of a heavily mineralized jugal measures 26.5 mm in length, 11.7 mm in width, and came from an individual with a estimated skull length of 150 mm. The articular facet for the postorbital is well preserved on the ventromedial surface. The dorsal surface is deeply sculptured with pits, furrows, and rugosities. The other fossil is an oval, strongly keeled, nearly complete osteoscute, 14.7 mm in length.

Neither specimen is sufficient for positive generic identification, but *Crocodylus* is the only likely possibility, being the only crocodilian genus in the Antilles. *Crocodylus rhombifer* inhabits freshwater marshes on Cuba and the Isle of Pines, but also occurs as a fossil on Grand Cayman (R.I. Crombie, pers. comm.) and thus might once have ranged to the Bahamas as well. In the West Indies *Crocodylus acutus* is found in near-shore situations throughout Cuba, parts of Jamaica, and Hispaniola.

Crocodilians are known historically in the Bahamas only as waifs (Gardiner, 1886). A fossil vertebral fragment of a juvenile crocodile from New Providence suggests a former resident population, because juveniles are intolerant of salt water (Pregill, 1982). Lowered sea levels in the Pleistocene may have created much more suitable habitat for crocodiles in the Bahamas, at which time the presently saline interior lakes of San Salvador were probably ideal, as also suggested by the fossils of emydid turtles (see above).

AVES

PROCELLARIIDAE

Puffinus lherminieri Lesson

MATERIAL EXAMINED.—Ficus Pit: 2 right and 1 left coracoids; 1 proximal end of left humerus; 1 right tibiotarsus; 1 right and 1 left tarsometatarsus. Hanna's Bananas: 1 proximal half of right carpometacarpus.

REMARKS.—The coracoids and humerus from Ficus Pit and the carpometacarpus from Hanna's Bananas appear well mineralized and may have been derived from individuals that entered the sinks in search of nesting sites. The leg elements, especially the tibiotarsus, which is intact and perfectly preserved, appear quite recent and may represent prey of Barn Owls. Audubon's Shearwater has not been reported previously from San Salvador. Although commonly observed at sea in the Bahamas (Brudenell-Bruce, 1975), this species is difficult to detect at its breeding sites. Nesting has been reported at 8 localities in the Bahamas (Sprunt, 1984), although San Salvador was not mentioned. There is, however, a specimen in the Museum of Comparative Zoology, Harvard University, that was taken on Green Cay, San Salvador on 27 or 28 March 1934 by the *Utowana* expedition (Buden, 1990). Sprunt (1984) recorded *Puffinus lherminieri* from a different Green Cay, one on the Great Bahama Bank, but perhaps this is an error arising from the preceding specimen.

Presumably because of predation by man and introduced mammals, this shearwater is now mainly restricted to offshore cays and islets, whereas prior to the arrival of humans it probably bred on larger islands as well. The Barn Owls at Ficus Pit were preying rather extensively on terns that they must have caught while the birds were passing close by the shore, because there is no suitable breeding or roosting area for terns in the vicinity. For this reason, it cannot be stated with certainty that *P. lherminieri* was breeding on the mainland of San Salvador, although if shearwaters were coming sufficiently close to land as to fall prey to Barn Owls, this seems likely. Elsewhere in the Bahamas, *P. lherminieri* has been reported from a pre-Columbian midden deposit on Crooked Island (Wetmore, 1938; Olson and Hilgartner, 1982).

ARDEIDAE

Nycticorax nycticorax (Linnaeus)

MATERIAL EXAMINED.—Ficus Pit: 1 right quadrate lacking orbital process.

REMARKS.—This seemingly well-mineralized specimen differs from the quadrate of the Yellow-crowned Night-Heron, *Nyctanassa violacea*, which is ubiquitous in the Bahamas, and appears instead to be referable to the Black-crowned Night-Heron, a much rarer and more sporadically distributed species in the Bahamas. *Nycticorax nycticorax* has not been recorded previously from San Salvador.

VULTURIDAE

Cathartes aura (Linnaeus)

MATERIAL EXAMINED.—Ficus Pit: 1 left quadrate, 1 distal portion of left humerus.

REMARKS.—The Turkey Vulture is resident in the Bahamas only in the large northern islands of Grand Bahama, Abaco, and Andros, and is a rare vagrant to New Providence (Brudenell-Bruce, 1975). This is the first record from San Salvador. The heavily mineralized humerus may be of Pleistocene age. The preservation of the quadrate is different, raising the possibility that two different individuals may be involved.

The history of *Cathartes aura* in the West Indies is reviewed by Santana et al. (1986), who discounted previous rumors that the species may have been introduced to some of the islands where it now occurs. They considered it more likely that this vulture's colonization of various islands was the result of natural range expansion, an idea supported by the fossil evidence. Vagrant Turkey Vultures have been recorded on

numerous West Indian islands where they are not known to breed (Santana et al., 1986).

The only previous fossil records for *Cathartes aura* in the West Indies are from two cave deposits in Cuba (Arredondo, 1984). The presence of such a carrion-eating bird on San Salvador in the Pleistocene, or at least prior to the arrival of man, raises the question of what the birds might have fed on. Large reptiles may have provided a more dependable source of carrion than has been available in more recent times.

FALCONIDAE

Falco sparverius Linnaeus

REMARKS.—This species, which we did not find in cave deposits, was first reported from San Salvador by Paulson (1966), who obtained specimens belonging to the distinctive Cuban subspecies *F. s. sparverioides* Vigors, to which he also referred specimens taken earlier on Great Inagua. This subspecies is also known from Cat Island, Eleuthera, and several other islands in the Southern Bahamas (Buden, 1987a,b). Only light-phase birds are known from the Southern Bahamas (Buden, 1987b). Paulson (1966:4) observed "at least seven dark-phase and thirty-five or forty light-phase individuals" on San Salvador, presumably in 1963. The birds were common during our visit and although we made no attempt to census them, we circumnavigated the island numerous times and probably saw most or all of the individuals present. We encountered only two dark phase birds. R. Miller (pers. comm.) mentioned that dark phase birds were more common in the past.

RALLIDAE

Rallus longirostris Boddaert

MATERIAL EXAMINED.—Ficus Pit: 1 proximal end of right tarsometatarsus.

REMARKS.—This specimen appears recent and was probably brought as prey of Barn Owls but was somewhat unexpected as there is no suitable habitat for Clapper Rails in the vicinity of Ficus Pit.

STERNIDAE

Sterna cf. *fuscata* Linnaeus

MATERIAL EXAMINED.—Ficus Pit: 1 furcula; 1 left tibiotarsus; 12 right (2 juvenile), 11 left tarsometatarsi.

REMARKS.—These specimens are probably all from Sooty Terns, although the Bridled Tern, *Sterna anaethetus*, might be included. Two of the tarsometatarsi are from very young birds that had probably just fledged, indicating breeding in the vicinity. See *Anous stolidus*.

Anous stolidus (Linnaeus)

MATERIAL EXAMINED.—Ficus Pit: 4 right, 3 left femora; 4 right, 3 left tarsometatarsi.

REMARKS.—All of the specimens of terns are from very recent owl pellet material. Neither *A. stolidus* or *S. fuscata* is listed from San Salvador by Miller (1978), who emphasized land birds, however. Both species are marine and are summer residents in the Bahamas, where they breed on offshore islets. See also *Tyto alba*.

TYTONIDAE

Tyto alba Scopoli

MATERIAL EXAMINED.—Ficus Pit: 1 right coracoid; 1 right humerus; 3 pedal phalanges.

REMARKS.—These specimens are recent and probably from a single juvenile individual. Miller (1978:284–285) was the first to report Barn Owls from San Salvador, where he found a pair on 30 November 1976 "in a deep pit on the extreme south of the island, and on 12 December a nest with one adult and three dead eggs was located in a cave in this pit." This was very likely Ficus Pit. Owls apparently were not in residence during our visit in 1981, although we flushed one from a palm tree in forest near Harbour Estate Settlement.

The large numbers of individuals of Sooty and Noddy terns taken by the Ficus Pit Barn Owls was unexpected. We assume that they must have taken advantage of morning or evening flights of the terns that passed close by the shore, as we cannot envision the owls ranging very far out to sea to capture such prey. This is but another example of the opportunistic nature of these efficient predators. Another interesting aspect is that terns are represented only by elements of the hind limb, so that the carcasses must have been processed elsewhere and at least the wings and heads stripped off.

Buden (1974) studied prey remains of Barn Owls in the southern Bahamas and concluded that although the owls took more mammals than reported for other island populations of the species, they preyed on a greater percentage of birds and reptiles than do mainland birds. Although the birds at Ficus Pit took large numbers of rats, they, too, included many birds in their diet (Table 1). Among avian prey, *Margarops fuscatus* and *Mimus gundlachii* predominated in the sample. These are conspicuous, relatively bold, large passerines that are probably easily obtained. See also *Margarops fuscatus*.

STRIGIDAE

Athene cunicularia (Molina)

MATERIAL EXAMINED.—Nairn's Nook: 1 left mandibular articulation; 1 distal end of left tibiotarsus.

REMARKS.—These specimens are probably relatively recent in origin and are within the size range of Florida birds. The fossil and recent status of Burrowing Owls in the Bahamas is reviewed by Olson and Hilgartner (1982), who found Pleistocene fossils from New Providence to be smaller than the Florida race, which is the one currently found in the Bahamas.

Paulson (1966) did not encounter Burrowing Owls on San Salvador, the first report being that of Miller (1978), who considered the birds to be winter residents only. We observed Burrowing Owls on several occasions during our stay in winter of 1981. The absence of this species in the owl pellet fauna at Ficus Pit is conspicuous, because *Tyto* may prey heavily on Burrowing Owls, as shown in Pleistocene deposits from Puerto Rico (Olson and Hilgartner, unpublished data).

PICIDAE

Melanerpes superciliaris (Temminck)

REMARKS.—In the Bahamas, this species occurs only on Abaco, Grand Bahama (where now evidently extinct—see Bond, 1980:9), and San Salvador, each with its own endemic subspecies. Fossils of this woodpecker have also been reported from Little Exuma and New Providence (Olson and Hilgartner, 1982). The race on San Salvador, *M. s. nyeanus*, has been found only on the northern end of the island, where it prefers moist forested areas with stands of *Sabal palmetto* in which it nests. The absence of remains of this species in the Ficus Pit deposits suggests that it does not occur in the Sandy Point area, where there is now little or no suitable habitat for it in any case.

Miller (1978) estimated the population of San Salvador at 100–160 pairs. If this was not a gross overestimate, the species must have declined precipitously in the past decade. We searched intensively for this species, especially in the area around Harbour Estate Settlement. That this area was once well populated by woodpeckers is attested to by the number of nest holes still present in the palm trees. Despite our exertions, we could not be sure of having seen more than two or three individuals the whole time we were on the island. Olson searched the same area equally diligently in 1982 without encountering a single bird of this species, though he may have heard one call once. Because a bird as easy to hear and see as this species can hardly escape detection when actively sought, perhaps the species may be nearing extinction on San Salvador. That conclusion had been reached erroneously once before, however (Nye, 1899), only to have the species reappear (Riley, 1903).

A possible cause for renewed concern is the prevalence of the Pearly-eyed Thrasher, *Margarops fuscatus*, an aggressive species known to usurp nest holes and destroy the eggs and young of much larger species, such as the Puerto Rican Parrot, *Amazona vittata* (Snyder et al., 1987). Paulson (1966) suggested that *Margarops* was in the process of expanding its range and becoming more abundant in the Bahamas, and it was particularly common on San Salvador in the areas where the woodpeckers had obviously once been. Increase in distribution and abundance may be true of *Margarops* elsewhere as well (Snyder et al., 1987). This species may thus pose a threat to hole-nesting birds wherever it occurs.

The single male specimen of *Melanerpes s. nyeanus* that we examined weighed 77.5 g, which puts it in the range of the diminutive subspecies *M. s. caymanensis* of Grand Cayman (males 68–81 g, females 63–78 g—Olson et al., 1981) as opposed to *M. s. superciliaris* of Cuba (male 111 g, female 83 g, female? 106 g—Olson, 1985 and unpublished data). Interestingly, the posterior margins of the palatines in this bird are truncate and thus distinct from the more slender, tapered outline of the palatines in a series of *M. s. superciliaris* and *M. s. caymanensis*.

MIMIDAE

Margarops fuscatus (Vieillot)

Mimus gundlachii Cabanis

REMARKS.—The Pearly-eyed Thrasher and Bahaman Mockingbird are the most abundantly represented birds in the owl pellets at Ficus Pit. It has been suggested that *Margarops* may be expanding its range in recent years (Snyder et al., 1987:199). Previous fossil records from the Bahamas and Puerto Rico appear to be erroneous (Olson and Hilgartner, 1982; Olson in Snyder et al., 1987:199–200). None of the bones from Ficus Pit appears to be particularly old, although one carpometacarpus referred to *Mimus gundlachii* is well mineralized and encrusted. Likewise a humerus, carpometacarpus, and coracoid of *Mimus gundlachii* from Hanna's Bananas may be of some antiquity, but the San Salvador deposits in general are too scanty for the absence of genuine fossils of *Margarops* to mean much.

FRINGILLIDAE

Passerina caerulea (Linnaeus)

MATERIAL EXAMINED.—Ficus Pit: 1 mandible.

REMARKS.—This specimen is from a recent owl pellet. The Blue Grosbeak is an uncommon migrant in the Bahamas (Brudenell-Bruce, 1975). The mandible from Ficus Pit is evidently the first record of the species from San Salvador.

MAMMALIA

PHYLLOSTOMIDAE

Macrotus waterhousii Gray

MATERIAL EXAMINED.—Ficus Pit: 4 right, 4 left dentaries; 2 complete, 1 proximal left humeri; 1 complete, 1 proximal right radii; 1 proximal right femur. Hanna's Bananas: 11 right, 9 left dentaries; 3 complete, 7 proximal, and 6 distal right humeri; 5 complete, 5 proximal and 11 distal left humeri; numerous other postcranial fragments. Nairn's Nook: 1 right dentary; 1 distal right humerus; 3 complete, 2 proximal and 1 distal left humeri; 1 right, 3 left radii; 1 right, 3 left femora; miscellaneous other postcranial elements.

REMARKS.—With the exception of a humerus and radius from Ficus Pit and the material from Nairn's Nook, these

specimens all appear to be well mineralized fossils that probably accumulated as a result of roosting activity rather than in owl pellets. We did not encounter this species in life, either in caves or in mist nets. It is known historically from San Salvador from two specimens (Koopman et al. 1957; Buden, 1975) taken 12 July 1903 by the Baltimore Geographic Society expedition (USNM 217271-217272). As this was the most common bat in the fossil deposits, it appears that the species may have diminished in numbers subsequently.

Buden (1975) recognized two subspecies of *M. waterhousii*: the nominate form in Hispaniola, Jamaica, Puerto Rico, and the southern Bahamas; and *M. w. minor* Gundlach in Cuba and the northern Bahamas, including San Salvador. Unfortunately, no measurements comparable to those in Buden (1975) could be taken from our fossil sample.

Erophylla sezekorni (Gundlach)

MATERIAL EXAMINED.—Ficus Pit: 1 complete edentulous mandible; 1 right dentary; 3 complete, 1 proximal right humeri; 2 complete, 1 distal left humeri. Hanna's Bananas: 1 distal left humerus.

REMARKS.—The Ficus Pit material is all recent and probably from owl pellets. The scarcity of this species in the cave deposits contrasts markedly with its relative abundance on the island today. The species probably occurs throughout the Bahamas. It was first recorded from San Salvador by Buden (1976) on the basis of 2 specimens then in the collection of Albert Schwartz. We obtained 19 recent specimens (10 males, 9 females) from Altar Cave and in nets near Graham's Harbour. The males weighed 14.5–18.3 g (mean 16.4 g), and females 15.5–17.8 g (mean 16.9 g).

In his revision of the species, Buden (1976) recognized two subspecies: *E. s. sezekorni* in the Bahamas, Cuba, Jamaica, and the Cayman Islands; and *E. s. bombifrons* (Miller) on Hispaniola, and Puerto Rico. He synonymized the name *planifrons* Miller, once used for the Bahaman populations, with the nominate race.

NATALIDAE

Natalus tumidifrons (Miller)

MATERIAL EXAMINED.—Ficus Pit: 3 right, 4 left dentaries; 3 right, 3 left humeri. Nairn's Nook: 1 distal end of right humerus.

REMARKS.—The material contains both recent and fossil bones. This small bat is practically endemic to San Salvador, the type series having been obtained "in a cave near Sandy Point" (Miller, 1903:119). The only other island from which the species has been reported in life is Abaco (Allen, 1905), although Koopman et al. (1957) mention a mandible they obtained in a cave on Great Exuma. Such a distribution is obviously relictual and, as noted by Olson and Pregill (1982), closely resembles the Bahaman distribution of the West Indian Red-bellied Woodpecker (*Melanerpes superciliaris*).

Because so little is known about this species, our observations may be worth noting. We obtained a series of 26 individuals (14 males, 12 females; preserved as 1 skin plus skull and trunk, 17 complete skeletons, and 8 in fluid) 25 of which were obtained on 2 February 1981 and one on 7 February 1981, from a cave on Sandy Point known as Altar Cave (Mylroie, 1980). In all likelihood this is the same cave from which the type series was obtained. This cave has a wide (8 m) but low (1 m) entrance, and extends about 30 m to open into a large chamber. Individuals of *Natalus* were found hanging on a low portion of wall near the opening into this chamber, in contrast to those of *Erophylla sezekorni*, which were in recesses high in the ceiling.

We also observed *N. tumidifrons* in the vicinity of the pond between Graham's Harbour and Reckley Hill Settlement at the north end of the island, where scrub forest graded into mangroves. Here we ran a line of two 12 m mist nets for 8 nights in February 1981 without catching a single *Natalus*. The bats actually seemed to favor feeding in the openings created by the net lanes that we cut in the vegetation and at dusk could be seen nimbly dodging around and over the nets. Only once did we see an individual strike a net, from which it escaped. After the bats seemed to be well accustomed to the nets, we placed a net with smaller mesh at right angles to the other two, but the *Natalus* detected it and avoided it easily. By contrast, in 16 net nights we took 5 specimens of *Erophylla sezekorni* and released at least 2 others. The *Natalus* seemed to be active only for a very short period at dusk and may have been feeding on mosquitos, of which there was great store.

The tumescence on the forehead, the so-called "natalid gland"(Dalquest and Werner, 1954:150), from which the species takes its name, is actually characteristic of adult males of all the species of *Natalus*. This gland was noticeable in only 3 of the 13 males we obtained. Interestingly, the pelage of these 3 specimens was somewhat darker, more tan, below than in the remainder of the series, and they weighed slightly more. We weighed the specimens on a 30 g Pesola spring scale and each individual registered at 3.0 g, with the exception of the 3 darker, tumescent males, which were about 3.5 g.

The skeletal specimens reveal an extraordinary adaptation apparently unique to *N. tumidifrons*. All the bones of the thorax—ribs, vertebrae, and sternum—are coalesced to form a single, thin-walled cone (Figure 3). Although the ribs may be expanded in other species of *Natalus*, none of those examined (*N. mexicanus*, *N. major*, *N. lepidus*, *N. tumidirostris*) showed any real approach to the condition seen in *N. tumidifrons*.

VESPERTILIONIDAE

Eptesicus fuscus (Beauvois)

MATERIAL EXAMINED.—Ficus Pit: 1 left dentary.

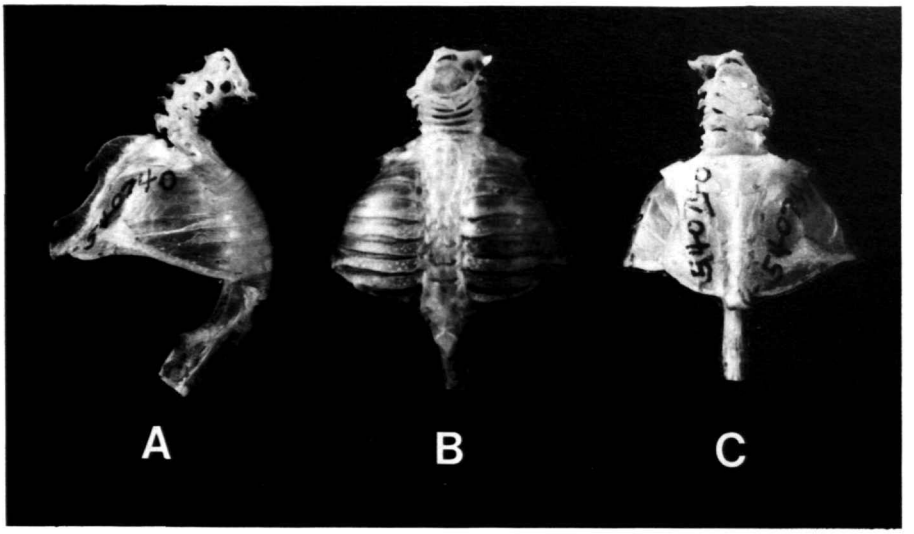

FIGURE 3.—Thorax of *Natalus tumidifrons* (USNM 540755) showing the complete fusion of the ribs, vertebrae, and sternum: A, lateral view; B, dorsal view; C, ventral view. ×2 Photographs by Victor E. Krantz, Smithsonian Institution.

REMARKS.—This well fossilized bone is our only evidence of this species on San Salvador. The only previous record from the island was of "11 females . . . taken in an an old church at Cockburntown . . . in February, 1934, by Dr. Thomas Barbour" (Allen and Sanborn, 1937:227). Buden (1985) reviewed the systematics of this species in the Bahamas, assigning most populations to the Cuban subspecies *E. f. dutertreus*, but reserving the name *bahamensis* (type locality New Providence) for the populations of New Providence and San Salvador, based mainly on smaller size. The examples from San Salvador were said to be "somewhat intermediate in size between these two groups but tend to average closer to the New Providence sample" (Buden, 1985:22). Interestingly, our fossil was noticeably larger and more robust than the specimen of *bahamensis* from New Providence with which we compared it (USNM 121917).

CAPROMYIDAE

Geocapromys ingrahami Allen

REMARKS.—The Bahaman hutia is known as a living animal only from tiny East Plana Cay in the southern Bahamas. Records of the species from elsewhere in the Bahamas are reviewed by Olson and Pregill (1982), who note some of the problems involved with determining the natural, prehistoric distribution of this species. The only report for San Salvador consists of "a few individuals"from an Amerindian midden (the Palmetto Grove site) near "Polaris Point"(= Rocky Point) on the northwest end of the island (Wing, 1969). These specimens were subsequently lost (Olson and Pregill, 1982). The absence of any remains of *Geocapromys* in our fossil sites, especially Ficus Pit, suggests that these rodents may not have been native to the island and were brought here by Amerindians. Unfortunately, the prehistoric faunas of these sites are not felt to be adequately representative to allow this determination to be made.

Concluding Remarks

The vertebrate fauna of San Salvador is considerably attenuated and impoverished even by comparison with that of islands of the Great Bahama Bank, which itself is not especially diverse. The extent to which this impoverishment is the result of the island's isolation and lack of previous connection with a larger land area, or is attributable to the massive perturbation of the island's ecosystems occasioned by extensive agriculture in the past, is one of the questions we had hoped to address through the fossil record. Unfortunately, for the reasons outlined in the introduction, the fossil record of San Salvador has so far not been sufficient to be able to resolve such problems.

Reptiles that are common or widespread on the Great Bank but absent from San Salvador are the colubrid snake *Alsophis vudii*, the boiod snake *Tropidophis canus*, the anole *Anolis smaragdinus*, and the ground lizard *Ameiva auberi*. Bahaman birds that are unexpectedly absent from San Salvador include the flycatchers *Myiarchus sagrei* and *Contopus caribaeus*, the thrush *Turdus plumbeus*, the vireo *Vireo altiloquus*, the warbler *Geothlypis rostrata*, the tanager *Spindalis zena*, and the finch *Loxigilla violacea* (Miller, 1978:283). Among bats, at least

Tadarida brasiliensis is conspicuous by its absence and other species might be expected as well, yet our fossil deposits yielded only the same four species known historically from the island. If habitat destruction in the agricultural period was responsible for the extirpation of some of these species, at least some birds and bats might be expected to have recolonized the island now that much of it has reverted to scrub. Certainly a migratory species such as *Vireo altiloquus* should have no trouble dispersing to the island and its absence is truly puzzling. Nonetheless, without a more comprehensive fossil record we will not know whether the absence of any of these species is due to natural causes or to human interference.

Three of San Salvador's eight resident species of amphibians and reptiles were not recovered as fossils: the gecko *Sphaerodactylus corticola*, the rare blind snake *Leptotyphlops columbi*, and the frog *Eleutherodactylus planirostris*. This is probably only a reflection of the fact that these are all small, recondite species that are unlikely to fall prey to barn owls. We did, however, commonly encounter both the gecko and the frog island-wide by turning palm trash and other surface litter. We never found the blind snake, despite a relentless search. At least one resident spoke of seeing them while tending her garden, but rarely, and only after persistent rains.

Incomplete as it is, the fossil record has shown us that the fauna of San Salvador once included species that no longer occur on the island. The presence of pond turtles and crocodiles is in all likelihood attributable to the interior lakes of the island having been less saline during glacial periods of lowered sea level. The disappearance of the tortoise would presumably result from the same forces that caused the extinction of large tortoises throughout the West Indies and North America, whether due to climatic changes or to overkill by man. The former presence of Turkey Vultures (*Cathartes aura*) is difficult to explain, though a more diverse fauna of larger reptiles, especially in the inland lakes, may once have supplied a more reliable source of carrion than is available now.

Literature Cited

Adams, Robert W.

1980. General Guide to the Geological Features of San Salvador. *In* Donald T. Gerace, editor. *Field Guide to the Geology of San Salvador*, pages 1–66. Miami: CCFL [College Center of the Finger Lakes] Bahamian Field Station.

Allen, Glover M.

1905. Notes on Bahama Bats. *Proceedings of the Biological Society of Washington*, 18:65–72.

Allen, Glover M., and Colin Campbell Sanborn

1937. Notes on Bats from the Bahamas. *Journal of Mammalogy*, 18:226–228.

Arredondo, Oscar

1984. Sinopsis de las aves halladas en depósitos fosilíferos Pleisto-Holocénicos de Cuba. *Reporte de Investigación del Instituto de Zoologia*, 17:1–35.

Auffenberg, Walter

1967. Notes on West Indian Tortoises. *Herpetologica*, 23(1):34–44.

Barbour, Thomas

1934. Supplementary Comments. *In* Barbara Lawrence, New *Geocapromys* from the Bahamas. *Occasional Papers of the Boston Society of Natural History*, 8:193–194.

Bond, James

1980. *Twenty-third Supplement to the Check-list of Birds of the West Indies (1956)*. 14 pages. Philadelphia: Academy of Natural Sciences of Philadelphia.

Brudenell-Bruce, P.G.C.

1975. *The Birds of the Bahamas*. 142 pages. New York: Taplinger.

Buden, Donald W.

1974. Prey Remains of Barn Owls in the Southern Bahama Islands. *Wilson Bulletin*, 86(4):336–343.

1975. A Taxonomic and Zoogeographic Appraisal of the Big-eared Bat (*Macrotus waterhousii* Gray) in the West Indies. *Journal of Mammalogy*, 56(4):758–769.

1976. A Review of the Bats of the Endemic West Indian Genus *Erophylla*. *Proceedings of the Biological Society of Washington*, 89(1):1–16.

1985. Additional Records of Bats from the Bahama Islands. *Caribbean Journal of Science*, 21(1–2):19–25.

1987a. The Birds of Cat Island, Bahamas. *Wilson Bulletin*, 99(4):579–600.

1987b. The Birds of the Southern Bahamas. *British Ornithologists' Union Check-list*, 8: 119 pages. London, British Ornithologists' Union.

1990. Report on the Birds Collected During the Armour- *Utowana* West Indian Expeditions. *Bulletin of the British Ornithologists' Club*, 110(1):14–20.

Dalquest, Walter W., and Henry J. Werner

1954. Histological Aspects of the Faces of North America Bats. *Journal of Mammalogy*, 35(2):147–160.

Duellman, William E., and Ronald I. Crombie

1970. *Hyla septentrionalis*. *Catalogue of American Amphibians and Reptiles*, 92.1–92.4.

Gardiner, J.

1886. Alligators in the Bahamas. *Nature*, 34:546.

Gicca, Diderot

1980. The Status and Distribution of *Cyclura r. rileyi* (Reptilia: Iguanidae) a Bahamian Rock Iguana. *Caribbean Journal of Science*, 16(1–4): 9–12.

Hecht, Max K.

1955. The Comparison of Recent and Fossil Amphibian, Reptilian, and Mammalian Faunas in the Bahamas [preliminary report on field work]. *Year Book of the American Philsophical Society*, 1954: 133–135.

Hoffman, Charles A., Jr.

1970. The Palmetto Grove Site on San Salvador, Bahamas. *Contributions of the Florida State Museum Social Sciences*, 16:1–26.

Koopman, Karl F., Max K. Hecht, and Emanuel Ledecky-Janecek

1957. Notes on the Mammals of the Bahamas with Special Reference to the Bats. *Journal of Mammalogy*, 38(2):164–174.

Miller, Gerrit S., Jr.

1903. A New Nataline Bat from the Bahamas. *Proceedings of the Biological Society of Washington*, 16:119–120.

Miller, J. Robert

1978. Notes on Birds of San Salvador Island (Watlings), the Bahamas. *Auk*, 95(2):281–287.

Morgan, Gary S.

1977. Late Pleistocene Fossil Vertebrates from the Cayman Islands, British West Indies. 260 pages. Master's Thesis, University of Florida, Gainesville.

Mylroie, John E.

1980. Caves and Karst of San Salvador. *In* Donald T. Gerace, editor, *Field Guide to the Geology of San Salvador*, pages 67–91. Miami: CCFL [College Center of the Finger Lakes] Bahamian Field Station.

Nye, Willard, Jr.

1899. A Bahaman Bird (*Centurus nyeanus*) Apparently Extinct. *Auk*, 16(3):273.

Olson, Storrs L.

1985. Weights of Some Cuban Birds. *Bulletin of the British Ornithologists' Club*, 105(2):68–69.

Olson, Storrs L., editor

1982. Fossil Vertebrates from the Bahamas. *Smithsonian Contributions to Paleobiology*, 48: iii + 65 pages.

Olson, Storrs L., and William B. Hilgartner

1982. Fossil and Subfossil Birds from the Bahamas. *In* Storrs L. Olson, editor, Fossil Vertebrates from the Bahamas. *Smithsonian Contributions to Paleobiology*, 48:22–56.

Olson, Storrs L., Helen F. James, and Charles A. Meister

1981. Winter Field Notes and Specimen Weights of Cayman Island Birds. *Bulletin of the British Ornithologists' Club*, 101(3):339–346.

Olson, Storrs L., and Gregory K. Pregill

1982. Introduction to the Paleontology of Bahaman Vertebrates. *In* Storrs L. Olson, editor, Fossil Vertebrates from the Bahamas. *Smithsonian Contributions to Paleobiology*, 48:1–7.

Paulson, Dennis R.

1966. New Records of Birds from the Bahama Islands. *Notulae Naturae*, 394:1–15.

Pregill, Gregory K.

1982. Fossil Amphibians and Reptiles from New Providence Island, Bahamas. *In* Storrs L. Olson, editor, Fossil Vertebrates from the Bahamas. *Smithsonian Contributions to Paleobiology*, 48:8–21.

1986. Body Size of Insular Lizards: A Pattern of Holocene Dwarfism. *Evolution*, 40(5):997–1008.

Riley, J. Harvey

1903. The Second Known Specimen of *Centurus nyeanus* Ridgway. *Auk*, 20(4):434.

Santana C., Eduardo, Greg A. Potter, and Stanley A. Temple

1986. Status and Seasonal Patterns of Abundance of Turkey Vultures in Puerto Rico. *Journal of Field Ornithology*, 57(3):235–238.

Schwartz, Albert S.
1968. Geographic Variation in *Anolis distichus* Cope (Lacertilia Iguanidae) in the Bahama Islands and Hispaniola. *Bulletin of the Museum of Comparative Zoology,* 137(2):255-310.
Schwartz, Albert S., and Michael Carey
1977. Systematics and Evolution in the West Indian Iguanid Genus *Cyclura. Studies on the Fauna of Curaçao and Other Caribbean Islands,* 173:15-97.
Schwartz, Albert S., and Richard Thomas
1975. A Check-list of West Indian Amphibians and Reptiles. *Carnegie Museum of Natural History Special Publication,* 1:1-216.
Seidel, Michael E.
1988. Revision of the West Indian Emydid Turtles (Testudines). *American Museum Novitates,* 2918: 41 pages.
Seidel, Michael E., and M. Dale Adkins
1987. Biochemical Comparisons among West Indian *Trachemys* (Emydidae: Testudines). *Copeia,* 1987(2):485-489.
Seidel, Michael E., and H.M. Smith
1986. *Chrysemys, Pseudemys, Trachemys* (Testudines: Emydidae): Did Agassiz Have It Right? *Herpetologica,* 42(2):242-248.
Snyder, Noel F.R., James W. Wiley, and Cameron B. Kepler
1987. *The Parrots of Luquillo: Natural History and Conservation of the Puerto Rican Parrot.* xiii + 384 pages. Los Angeles: Western Foundation of Vertebrate Zoology.
Sprunt, Alexander, IV
1984. The Status and Conservation of Seabirds of the Bahama Islands. *In* J.P. Croxall, P.G.H. Evans, and R.W. Schreiber, editors, Status and Conservation of the World's Seabirds. *ICBP Technical Publication,* 2:157-168. Cambridge: International Council for Bird Preservation.
Steadman, David W., Storrs L. Olson, John C. Barber, Charles A. Meister, and Margaret E. Melville.
1980. Weights of Some West Indian Birds. *Bulletin of the British Ornithologists' Club,* 100(2):155-158.
Trueb, Linda, and Michael J. Tyler
1974. Systematics and Evolution of the Greater Antillean Hylid Frogs. *Occasional Papers of the Museum of Natural History University of Kansas,* 24:1-60.
Voelcker, Augustus
1878. On Bats' Guano. *Journal of the Royal Agricultural Society of England,* series 2, 14:60-72.
Wetmore, Alexander
1938. Bird Remains from the West Indies. *Auk,* 55(1):49-55.
Wing, Elizabeth S.
1969. Vertebrate Remains Excavated from San Salvador Island, Bahamas. *Caribbean Journal of Science,* 9:25-29.
Zug, George R.
1971. Bouyancy, Locomotion, Morphology of the Pelvic Girdle and Hindlimb, and Systematics of Cryptodiran Turtles. *Miscellaneous Publications, Museum of Zoology, University of Michigan,* 142: 98 pages.

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