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A NEW SUBSPECIES OF THE DOUBLE-CRESTED CORMORANT, *PHALACROCORAX AURITUS,* FROM SAN SALVADOR, BAHAMA ISLANDS

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Abstract.—An isolated population of Double-crested Cormorants, apparently endemic to the extensive system of saline lakes on the island of San Salvador in the Bahamas, is described as a new subspecies, *Phalacrocorax auritus heuretus,* that is smaller than the smallest mainland subspecies, *P. a. floridanus.* The reduced size of the San Salvador cormorants may be an adaptation to the small size of the local fishes that constitute its prey. The total population of *P. a. heuretus* on San Salvador is probably less than 600. Breeding records of *P. auritus* and *P. brasilianus* in the Bahamas and West Indies are reviewed.

An undescribed population of cormorant breeds in mangroves around Great Lake on San Salvador Island, Bahamas. Specimens were first collected 104 years ago, but since then there has been much confusion about their specific identification. Two species of cormorants occur in the southeastern United States and the northern Caribbean (Clapp et al. 1982). The larger, more northern, Double-crested Cormorant, *Phalacrocorax auritus,* and the smaller, more southern, Olivaceous Cormorant *P. brasilianus,* differ strikingly in plumage during courtship, but after incubation the "nuptial plumes" are dropped and both species are essentially all black. None of the specimens of cormorant from San Salvador is in courtship plumage, however, and the diminutive size of the birds, without consideration of other characters, has almost universally led investigators to identify them as *P. brasilianus.* (For use of the specific name *P. brasilianus* rather than *P. olivaceus,* the name in general use in recent U.S. publications, see Browning [1989].)

San Salvador (formerly Watling or Watling's Island, the names found generally in the ornithological literature), best known for reputedly being the site of Columbus' first New World landfall (Richardson & Goldsmith 1987), is the easternmost of the northern Bahamas (Fig. 1). It is composed entirely of raised coral and lies at 24°02′N, 74°28′W, east of the Great Bahama Bank, of which it never formed a part, even during glacial maxima of the Pleistocene, when sea levels were significantly lower. San Salvador is about 10 × 23 km and 156 km^2 in area, with an elevation of about 43 m at its highest point. Although formerly completely converted to agriculture, the predominant vegetation is now dense, semideciduous scrub. The main physiographic features of San Salvador are the many hypersaline interior lakes, the largest of which is Great Lake. Inland waters constitute about one third of the surface area of the island. Mangrove swamps occur chiefly on the fringes of the saline lakes and ponds.

Our interest in this problem was aroused when Miller, who was uncertain about identification of the San Salvador cormorant, with his student Hans Gabler, collected two adult specimens in 1978, which were sent frozen to the Smithsonian and were routinely prepared as study skins (USNM 582413–582414). Because the specimens were small, with short tails and anomalous facial characteristics, we suspected that they might represent a new form of *P. brasilianus*

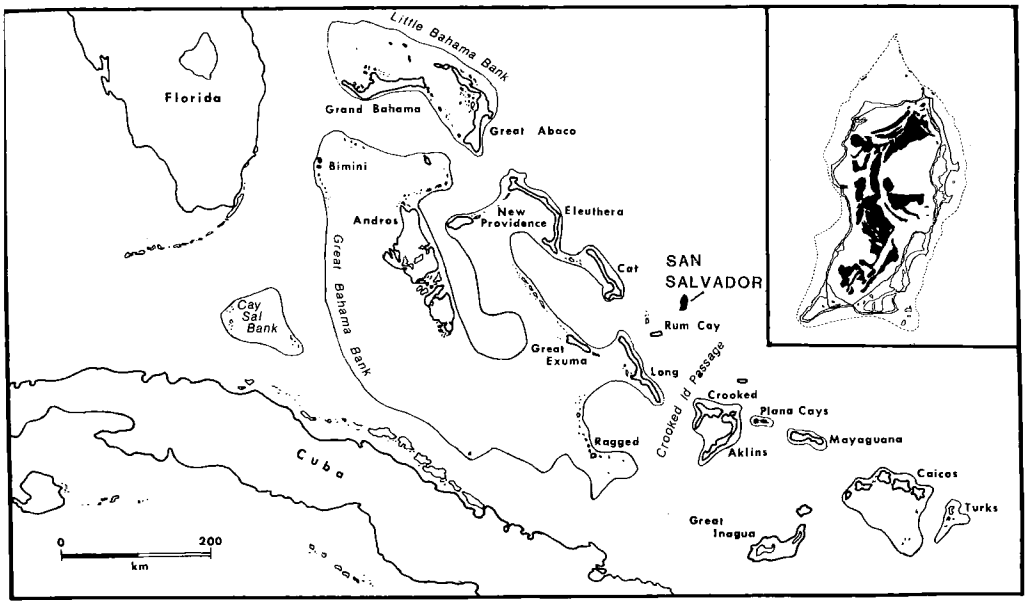

Fig. 1. Map of the Bahamas showing the position of San Salvador and the extensive system of shallow banks (contour line = 50 fathoms [91 m]). Inset: Map of San Salvador showing extent of the inland lakes in black.

having some of the characteristics of *P. auritus.*

Subsequent study of all previously-taken museum specimens from San Salvador in United States collections, as well as a more recently collected series of skins and skeletons, showed, on the contrary, that the interior lakes harbor an undescribed diminutive form of *P. auritus,* markedly smaller than the small southeastern race, *P. a. floridanus.*

The nomenclatural history of the San Salvador cormorant is less complicated than it might be because the island does not figure prominently in the ornithological literature and few specimens have been collected. Ridgway (1891) reported two cormorants taken on San Salvador on 1 March 1886 during a U.S. Fish Commission cruise aboard the "Albatross" (USNM 108821–108822). One of these he identified as *P. mexicanus* (=*P. brasilianus*) and the other as *P. dilophus* (=*auritus*) *floridanus.* Cory (1892a), reporting on a collection from San Salvador made in fall 1891, recorded eight specimens of *P. dilophus floridanus,* four of which are still in the Field Museum of Natural History in Chicago (FMNH 96432–96433, 96439–96440). In his list of West Indian birds, however, Cory (1892b:85) cited both species for the island, presumably on the authority of Ridgway.

Riley (1905a, 1905b) visited San Salvador from 11 to 13 July 1903 and reported a colony of cormorants, under the name *P. vigua mexicanus,* breeding in tall mangroves. Although he claimed to have shot cormorants, none were catalogued into the Smithsonian collection with his other specimens from San Salvador. Worthington visited San Salvador on 10 March 1909 and collected an immature cormorant (CMNH 30908) that was identified as *P. brasilianus* (Todd & Worthington 1911). Paulson (1966) recorded Olivaceous Cormorants nesting on San Salvador in late December 1965, based on three specimens he collected that are now in the Schwartz-Klinikowski collection in the Museum of Zoology, Louisiana State University (originally SK 6653–6655, now LSUMZ 141214–141216). The most recent report is that of Miller (1978), who, on the

Table 1.—Measurements of various cormorant populations.

Population	Sex	Wing (mm)			Tail (mm)			T/W ratio	
		n	Range	Mean	*n*	Range	Mean	*n*	Range
P. brasilianus	male	10	257–272	(265.6)	10	147–165	(155.5)	10	0.56–0.62
Texas	female	8	251–265	(257)	8	140–162	(145.8)	8	0.54–0.61
P. brasilianus	male	2	260, 263		2	151, 165		2	0.58, 0.62
Cuba	female	4	237–245	(242)	4	137–149	(143.8)	4	0.56–0.61
P. a. heuretus	male	8	260–280	(270.6)	8	123–132	(128.3)	8	0.45–0.49
San Salvador	female	8	259–276	(263.1)	7	117–132	(121.9)	7	0.45–0.48
P. a. heuretus	male	2	272, 277		2	131, 140		2	0.50, 0.51
Grand Bahama	female	1	260		1	120		1	0.46
P. a. floridanus	male	32	282–316	(303.1)	30	130–157	(144.3)	30	0.45–0.51
Florida	female	17	275–305	(288.9)	15	125–152	(135.5)	15	0.45–0.51
P. a. floridanus	male	4	290–307	(299.3)	4	140–154	(145.5)	4	0.46–0.50
Cuba	female	11	262–305	(286.6)	9	123–158	(139.2)	9	0.45–0.52
P. a. floridanus	male	4	305–320	(311.3)	3	151–165	(156.3)	3	0.50–0.53
Grand Bahama Andros Great Sal	female	4	285–285	(285)	3	130–141	(135.8)	3	0.46–0.49

basis of observations during five visits between 1973 and 1976, recorded Olivaceous Cormorants breeding on Great Lake, although he was not certain of their specific identity.

Handbook and checklist coverage of the San Salvador cormorant has been varied. Hellmayr & Conover (1948:139–140) cite Cory's four specimens from the "Interior Lake, San Salvador" under *P. a. floridanus,* but give the breeding range of that species as being "on some of the Bahama Islands (Great Abaco, Andros, Bimini, etc.), in Cuba (formerly) and on the Isle of Pines," without mentioning San Salvador. Under *P. brasilianus* they give the breeding range as being "in the Bahama Islands (Watling's Island), Cuba and the Isle of Pines," but they list no Field Museum specimens from the Bahamas. Bond (1956:7–8) cites *P. auritus floridanus* from ten Bahaman islands, including Watling [sic], and implies, but does not specifically indicate, breeding. Under *P. brasilianus mexicanus,* he lists only Watling's Island in the Bahamas and adds, parenthetically, "found breeding." Bond (1980) states that "*P. olivaceus* [=*brasilianus*] is known to breed on San Salvador and Great Inagua, and there is probably a colony on Cat Island (J. Robert Miller in litt). The larger *P. auritus* supposedly nests on some of the northernmost Bahamas, but definite information is lacking." The fifth edition of the A.O.U. Check-list (1957:36–37) and the revised first volume of Peters' Check-list (Dorst & Mougin 1979:170) essentially paraphrase Bond (1956). The A.O.U. Check-list, sixth edition (1983:38–39), also mentions that the Olivaceous Cormorant is "resident" on Cat Island and Great Inagua in the Bahamas.

Olivaceous Cormorants from Cuba, Texas, Mexico, and northern Central America (*P. brasilianus mexicanus*) are smaller than any of the currently recognized forms of the Double-crested Cormorant, there being no overlap in wing length (Table 1) between *P. brasilianus* and *P. auritus floridanus,* the smallest form of that species hitherto known. Bill size is likewise small in *P. brasilianus.* This general indication of overall size is what has led to misidentification of specimens of cormorants from San Salvador as *P. brasilianus.*

Plumage and facial characters, however, are more reliable for separating the two spe-

Table 1.—Extended.

Culmen (mm)			Tarsus (mm)			Mid toe (mm)		
n	Range	Mean	*n*	Range	Mean	*n*	Range	Mean
9	46–40	(47.5)	10	48.5–53	(51.3)	10	67–72	(70.6)
7	42.5–47	(44.5)	8	46–57	(50.5)	8	67–70	(68.4)
2	47, 48		2	47.5, 52		1	70.5	
4	41–47	(44.1)	4	47–50	(47.9)	2	70, 71	
5	43.5–49	(45.8)	5	49–57	(53.6)	3	68–72.5	(70)
5	43–49.5	(45.2)	5	51–54	(53.1)	4	66–75	(70.1)
1	48		2	52, 60		2	71, 81.5	
1	42		1	50		1	67	
32	47–61	(56.5)	32	57.5–66.5	(62.6)	29	83–98	(93.3)
19	51–60	(54.6)	19	56–66	(60.6)	18	77–93	(87.6)
4	53–59	(56.8)	4	60–66	(62)	4	84–97	(91.3)
11	44.4–58	(53)	11	55.5–65	(60.5)	10	75–93	(83.5)
4	55–60	(57.6)	2	62, 65		1	90	
3	54–57	(55.1)	3	59–60	(59.3)	3	78–82	(81)

cies (Table 2) and are well shown by Palmer (1962:plate opposite p. 184), Morrison & Gardner (1979:fig. 1), and Peterson (1980: 41). The San Salvador cormorants (Fig. 2) share with *P. auritus* essentially bare lores (orange-yellow in life) whereas in *P. brasilianus* the lores are sparsely feathered (Fig. 3). The feathered margin of the throat pouch is rounded in *P. auritus* and in the San Salvador cormorant, extending medially well beyond the level of the eye. In *P. brasilianus,* the margin is straight and scarcely reaches the level of the eye. The throat pouch and lower cheek are outlined in white in the breeding Olivaceous Cormorant, producing a characteristic "V" at the gape (Fig. 3), and white plumes and filoplumes decorate the head and neck. The eastern populations of *P. auritus* have black head tufts or crests during courtship, but, unlike the western subspecies, *P. a. cincinatus* and *P. a. albociliatus,* have no white on the head. Neither white feathers nor crests have as yet been noted in the field or in specimens of San Salvador birds. The dorsal feathers (notably the scapulars and upper wing coverts) are pointed in *P. brasilianus* but are more rounded in *P. auritus* and San Salvador birds (Fig. 4). In *P. brasilianus,* the tail is relatively longer in comparison with wing length and is more rounded than in *P. auritus* (Table 1).

Qualitative differences between the skeletons of *P. auritus* and *P. brasilianus* are slight. In the following cranial features, the population from San Salvador differs from *P. brasilianus* and agrees with *P. auritus*: (1) premaxilla in lateral or dorsoventral views less gracile, rising more steeply at the nasofrontal hinge; (2) posterior margins of palatines more truncated; (3) mandible in lateral view less gracile; (4) lacking the distinct ventral bowing in the region of the dentary/post-dentary articulation, with the ventral margin of the mandible thus appearing straighter. All of the major limb elements are noticeably more robust in San Salvador specimens than in *P. brasilianus.* This is especially true of the femur, in which the shaft is much heavier and the head markedly larger.

In all of these qualitative external and skeletal characters, the San Salvador cormorant agrees with *P. auritus,* of which it clearly represents an undescribed form differing in size.

Fig. 2. Subadult *Phalacrocorax auritus heuretus* on San Salvador, Bahama Islands, in 1981 shows pale lores and inconspicuous light feathering at posterior margin of throat pouch.

Most of the recently-collected specimens were prepared as complete skeletons and flat skins. Because size is the only character distinguishing the new subspecies, and skeletons provide many more measurements (and more accurate ones) than traditional study skins, a complete skeleton and flat skin has been designated holotype of the new subspecies.

Phalacrocorax auritus heuretus, new subspecies

Holotype.—Complete skeleton and flat skin USNM 556831 (original number SS-82-2), male (testes 5 × 14 mm), collected on Northwest Arm Lake, San Salvador Island, Bahamas, 19 Mar 1982, by Storrs L. Olson and Bertram N. Forbes.

Measurements of holotype.—Measurements (mm) are lengths of bones unless otherwise specified: mandible, 97.3; rostrum from nasofrontal hinge, 51.4; cranium from nasofrontal hinge, 52.5; width of sternum across first costal facet, 45.2; width of pelvis across antitrochanters, 32.8; greatest length of coracoid, 60.0; humerus, 125.5; ulna, 133.3; carpometacarpus, 57.7; femur, 49.2; tibiotarsus, 87.0; tarsometatarsus, 51.1. The following standard skin measurements were taken from the fresh specimen: culmen, 49.5; wing chord, 264; tail, 132. Weight: 1270 g.

Paratypes.—Seven complete skeletons and flat skins (3 males, 3 females, 1 unsexed): USNM 555523, 556828–556830, 556842–556844; and one unsexed incomplete postcranial skeleton, USNM 555585; a juvenile female postcranial skeleton with flat skin, USNM 556845; 12 study skins from San Salvador (2 adult males, 3 adult females, 1 unsexed adult, 3 immature males, 2 immature females, 1 unsexed immature):

Fig. 3. Adult *Phalacrocorax brasilianus* in breeding plumage, on Cat Island 1 December 1978 shows all-dark lores and the conspicuous white feathering on cheek and posterior margin of the throat pouch.

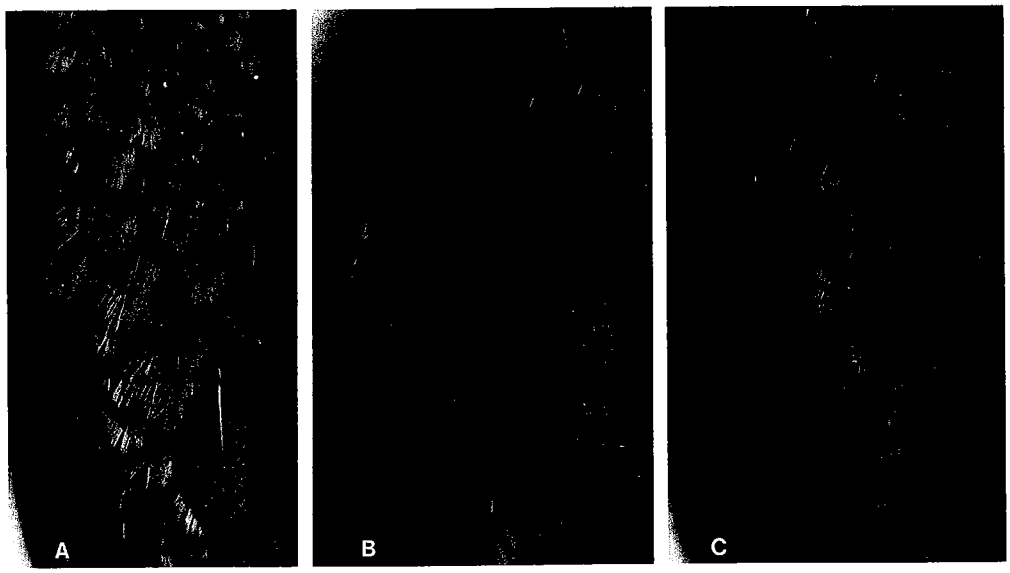

Fig. 4. Dorsal feathers of cormorants: *Phalacrocorax auritus floridanus* (*a*) and *P. a. heuretus* (*b*) are rounded at the tip while those of *P. brasilianus* (*c*) are more pointed.

CMNH 30908, FMNH 96432–96433, 96439–96440, SK 6653–6655 (=LSUMZ 141214–141216), USNM 108821–108822, 582413–582414. Three possibly mislabeled study skins from "Great" (=Grand) Bahama (1 adult male, 1 adult female, 1 immature male: FMNH 96426–96427, 96438) are tentatively referred to this subspecies (see below).

Other material examined.—Study skins: 8 *P. auritus floridanus,* Bahamas (4 males, 3 females, 1 unsexed): FMNH 7, SK (=LSUMZ) 1; 16 *P. a. floridanus,* Cuba (4 males, 11 females, 1 unsexed): AMNH 1, CMNH 7, FMNH 3, SK (=LSUMZ) 1, USNM 4; 53 *P. a. floridanus,* Florida (34 males, 17 females, 2 unsexed): AMNH 19, USNM 34; 6 *P. brasilianus mexicanus,* Cuba (2 males, 4 females): CMNH 2, SK (=LSUMZ) 3, USNM 1; 18 *P. b. mexicanus,* Texas (10 males, 8 females): AMNH 18. Skeletons: 11 *P. a. auritus*; 13 *P. a. flori-*

Table 2.—Comparison of characters in cormorants.

Character	*P. auritus*	*P. a. heuretus*	*P. brasilianus*
Lores	bare	bare	feathered
Gular pouch	rounded, extends behind eye	rounded, extends behind eye	cut off straight at level of eye
Gloss on head, neck	greenish	greenish	purplish
Head tufts or crests during courtship	curly, black	not recorded	wispy, white
White flecking on head and neck during courtship	absent in east coast populations	not recorded	present
White border to pouch during courtship	absent	not recorded	present
Shape of dorsal feathers	rounded	rounded	pointed
Tail length and shape	shorter, more squared	shorter, more squared	longer, more rounded

danus; and 16 *P. brasilianus mexicanus*: all in USNM, UF, and collection of P. Brodkorb.

Diagnosis.—Similar in morphology and coloration to *P. a. floridanus,* but markedly smaller, and consequently also smaller than any other population of *P. auritus,* with virtually no overlap in most measurements (Tables 1 & 3). Weights are also less than reported for other subspecies of *P. auritus* (Table 4). Weights and most external morphological measurements, except for those of tail and tail/wing ratios, are near those of *P. brasilianus mexicanus,* the smallest race of that species (Tables 1 & 4).

In skeletal measurements (Table 3), *P. a. heuretus* is much smaller than in any of the other forms of *P. auritus,* there being almost no overlap, even with the smallest subspecies, *P. a. floridanus.* Although generally more similar in size to *P. brasilianus,* the series of cormorant skeletons from San Salvador is clearly quite distinct mensurally from nominate *P. brasilianus* from Central America. The size of the cranium is virtually identical in these two series, yet the length of the rostrum and mandible averages greater in *P. brasilianus,* reflecting the relatively longer, more gracile bill in that species. In postcranial measurements, although there is some overlap, *P. a. heuretus* is consistently larger than *P. brasilianus.* The exception is in the carpometacarpus, the measurements for which are practically identical in these two populations. Given the larger size of *P. a. heuretus,* this may indicate a somewhat decreased flying ability associated with its more sedentary nature because when reductions in wing size take place, it is the distal elements that become reduced first (Livezey 1989).

Within both *P. auritus* (Palmer 1962) and *P. brasilianus* (P. C. Rasmussen in litt. 1990), high latitude populations are larger than those from nearer the Equator in conformity with Bergman's Rule. In the case of the San Salvador cormorant, however, latitude alone cannot account for the extreme size reduction because birds that breed at about the same latitude in southern Florida and further south on Cuba belong to the larger subspecies *P. a. floridanus.*

Range.—Known to breed only in the mangroves around some of the interior lakes of San Salvador in the eastern Bahama Islands, but possibly resident on other Bahaman islands (Cat Island, Buden 1987b). Subadult specimens of a male and a female (FMNH 96427, 96438, Table 1) that were collected by D. J. Sweeting, "one of Cory's hired guns" (David Willard in litt.), on "Great" (=Grand) Bahama Island on 23 and 7 October 1891, respectively, and an immature male collected there by Cory on 8 January 1879 (FMNH 96426, Table 1) are small and suggest either previous breeding of *P. a. heuretus* on that island (cf. Allen 1905), inter-island wandering or perhaps mislabelling. The last is suggested by the fact that Cory himself collected cormorants on San Salvador on 7 October 1891 and Sweeting collected specimens of other bird species on San Salvador on 3, 5, 12, 14, and 17 October 1891 (Willard in litt.). All Double-crested Cormorants collected on Cuba and the Isle of Pines belong to the larger subspecies, *P. a. floridanus* (Table 1).

Etymology.—The subspecific epithet is the latinized version of the Greek adjective, *euretós*, meaning "found," and refers both to our discovery of the cormorant's unsuspected specific relationship and to Columbus' discovery of the New World and possible landfall on San Salvador.

Discussion.—In the absence of adult specimens from the courting or early nesting periods, it is still unknown whether *P. a. heuretus* assumes breeding crests on the head. It is also uncertain whether *P. a. heuretus* is now restricted in its breeding to San Salvador. All but three of the specimens of *P. auritus* that we have examined from other Bahaman islands are significantly larger (Table 1) and are probably migrants of either the northern race, *P. a. auritus,* or the southeastern U.S. form, *P. a. floridanus.* In

Table 3.—Skeletal measurements (mm) of cormorants (*Phalacrocorax*).

Element		*n*	Range	Mean
Length of mandible	*P. brasilianus*	14	93.2–103.1	99.4
	P. a. heuretus	8	92.9–104.4	98.5
	P. a. floridanus	13	107.8–123.3	115.9
	P. a. auritus	11	109.1–127.1	118.3
Length of rostrum from nasofrontal hinge	*P. brasilianus*	14	47.0–56.6	53.7
	P. a. heuretus	7	48.7–56.3	51.7
	P. a. floridanus	13	58.8–68.6	63.6
	P. a. auritus	10	59.6–67.6	64.3
Length of cranium from nasofrontal hinge	*P. brasilianus*	14	48.7–53.9	51.6
	P. a. heuretus	7	48.9–54.6	51.8
	P. a. floridanus	13	55.0–61.1	58.0
	P. a. auritus	11	56.0–63.3	59.7
Width of sternum across first costal facet	*P. brasilianus*	15	39.0–46.3	42.9
	P. a. heuretus	7	44.1–48.8	47.0
	P. a. floridanus	13	49.2–56.7	52.6
	P. a. auritus	11	51.8–58.1	55.2
Width of pelvis across antitrochanters	*P. brasilianus*	16	28.5–31.5	30.1
	P. a. heuretus	6	30.0–33.5	32.1
	P. a. floridanus	13	32.1–36.1	34.2
	P. a. auritus	10	32.1–38.3	35.9
Greatest length of coracoid	*P. brasilianus*	15	55.5–62.6	59.9
	P. a. heuretus	9	57.7–62.5	60.4
	P. a. floridanus	13	62.1–71.1	67.0
	P. a. auritus	11	67.4–75.0	71.4
Length of humerus	*P. brasilianus*	15	110.2–125.1	118.6
	P. a. heuretus	9	120.7–131.4	126.6
	P. a. floridanus	13	131.2–151.5	139.4
	P. a. auritus	10	138.6–154.9	145.5
Length of ulna	*P. brasilianus*	15	117.8–134.9	126.4
	P. a. heuretus	9	126.1–138.2	133.8
	P. a. floridanus	13	133.7–161.0	147.2
	P. a. auritus	11	148.1–160.4	155.0
Length of carpometacarpus	*P. brasilianus*	15	55.4–63.5	58.3
	P. a. heuretus	9	54.7–61.0	58.4
	P. a. floridanus	12	62.8–71.6	66.7
	P. a. auritus	11	68.1–74.5	70.7
Length of femur	*P. brasilianus*	16	44.9–50.4	47.6
	P. a. heuretus	9	46.5–51.2	49.3
	P. a. floridanus	13	50.6–57.5	53.8
	P. a. auritus	11	54.2–61.7	57.6
Length of tibiotarsus	*P. brasilianus*	15	79.0–88.5	84.0
	P. a. heuretus	9	87.0–94.1	91.0
	P. a. floridanus	13	95.1–109.4	100.6
	P. a. auritus	11	100.8–110.8	105.5
Length of tarsometatarsus	*P. brasilianus*	14	47.6–53.3	49.9
	P. a. heuretus	9	51.0–54.2	52.7
	P. a. floridanus	13	56.4–64.8	59.9
	P. a. auritus	11	59.5–65.2	62.5

Table 4.—Weights of adult cormorants (*Phalacrocorax*). Those of *P. brasilianus mexicanus* (from New Mexico), *P. auritus heuretus* (San Salvador) and *P. a. albociliatus* (New Mexico) are from USNM specimens; those of *P. a. auritus* (Maine and Minnesota) and *P. a. floridanus* (Florida) are from Clapp et al. (1982).

Species	Males			Females		
	n	Range	Mean	*n*	Range	Mean
P. brasilianus	14	1150–1550	1393	8	1100–1450	1256
P. a. heuretus	1	1270		3	1036, 1126, 1175	1112
P. a. floridanus	6	1327–2079		5	1391–1665	
P. a. auritus	22	1986–2807		15	1750–2400	
P. a. albociliatus	16	2200–2750	2453	17	1750–2400	2056

recent years, *P. auritus* has not been found breeding elsewhere in the Bahama Islands (Bond 1980), but Allen (1905:119) reported small colonies of breeding Double-crested Cormorants observed during July 1904 on Abaco (10 pairs), Great Sal Cay (3 nests), and "Great" (=Grand) Bahama near Riding Point (nests only, birds "through breeding"). Cory (1880:198) collected two young that were out of the nest but were unable to fly, at Fresh Creek on Andros Island 18 January 1879 and Bonhote (1903) saw 8 to 10 pairs at empty nests at Wide Opening on the same island 31 January 1902. Bryant (1859) found Double-crested Cormorants "very abundant nesting in mangroves" in the Biminis. Young were "nearly fledged" 29 February 1859. The only specimen evidence for these records are two specimens that Allen collected 16 July 1904 on Great Sal Cay that are in the Museum of Comparative Zoology (MCZ 40186, 115000) and a male that Bonhote collected at Wide Opening, Andros, in the British Museum (BM 1924-4-10-180). All three of these specimens and five others from Andros and Grand Bahama have measurements that are within the range of *P. a. floridanus* (Table 1).

The Olivaceous Cormorant, on the other hand, is known to breed in the interior lakes of Great Inagua in the southernmost Bahamas (Buchheister 1966, Alexander Sprunt IV, National Audubon Society, Tavenier, Florida, 1984 in litt.; Buden 1987a, no specimens available) and on Cuba and the Isle of Pines (Garrido & Garcia Montaña 1975: 25; specimens examined). Sprunt (pers. comm., 1984) also reports seeing both *P. auritus* and *P. brasilianus* (some with white feathering) on Long Island, Bahamas, in late September 1984. Buden (1987b) reported that natives on Cat Island say that cormorants nest there. Of three skulls that he picked up on Cat Island in 1986 (specimens in MCZ), two were referable to *P. a. floridanus,* whereas the other was very small, like the birds of San Salvador. Miller, however, observed and photographed (Fig. 3) what appear to be prominent white borders on the throat pouches of cormorants breeding on Cat Island, and suspects that this population may also be referable to *P. brasilianus.* Some of the San Salvador cormorants in adult or near-adult plumage (FMNH 96438, USNM 555523, USNM 556844), however, retain a narrow fringe of pale buff or creamy immature feathers on the posterior edge of the gular pouch (Fig. 2), which might be confused in the field with the white nuptial feathers bordering the gular pouch in *P. brasilianus.* In adults of the latter species, however, the white is much brighter and is also present on the lower cheek, extending posteriorly from the angle of the gape to produce a marked "V" shape.

It is therefore highly desirable to obtain breeding specimens of cormorants from any other islands in the Bahamas, especially Long and Cat Islands and Great Inagua and

to obtain more observations and specimens of *P. a. heuretus* from San Salvador in courtship plumage.

Corroborating evidence of the specific identity of the San Salvador cormorant is potentially available from ectoparasites. Warren T. Ateyo (University of Georgia, 1983 in litt.) found on the San Salvador cormorant specimens a mite, *Michaelia watsoni,* a species known to parasitize *P. auritus,* but not *P. brasilianus.* Three kinds of feather lice (Mallophaga) inhabit the wings, body, and the inside of the throat pouch in cormorants, with different species of each being found on *P. auritus* and *P. brasilianus* (Emerson 1972:34–35). Unfortunately no lice have yet been found on specimens from San Salvador despite a vigorous search by K. C. Emerson. Neither did Miller find any in the gular pouches of four freshly collected birds and two live nestlings examined in 1981 and 1982.

On San Salvador, cormorants are restricted to the very extensive system of shallow interconnected inland lakes that dominate the physiography of the island (see Fig. 1, inset). These lakes are hypersaline and, although salinity may fluctuate with rainfall, evaporation rates greatly exceed precipitation (Rivers, 1985). Salinities measured in February 1976 and 1978 varied from 38‰ to 46‰ (Marshall 1982), whereas 14 determinations made in February and March 1985 were as high as 51‰ to 89‰. Analysis of fossil foraminifera and ostracodes revealed post-Pleistocene episodes of lower salinities (Bowman & Teeter 1982, Sanger & Teeter 1982), as also suggested by the former presence of an emydid turtle and a crocodilian on the island (Olson et al. 1990). Nevertheless, modern conditions present extremes of salt stress and only very euryhaline fishes can survive in these lakes. The ichthyofauna yet known consists of a poeciliid, *Gambusia manni,* an atherinid, *Atherinomorus stipes,* and killifishes, *Cyprinodon laciniatus* and a complex of several other species of *Cyprinodon.* Grant Gilmore (Harbor Branch Oceanographic Institute, Fort Pierce, Florida, in litt.) reports that none of the adult fish among more than 1000 specimens that he collected on San Salvador exceeded 50 mm in length.

Little is known of the food habits of cormorants on San Salvador except that they appear to feed nearly exclusively on *Cyprinodon* in the interior lakes. The few birds that are noted on the coastal beaches usually appear to be sick or injured. The stomachs of two birds collected by Olson in the Northwest Arm of Great Lake 19 March 1982 were crammed with small *Cyprinodon* (30–35 mm). He also found regurgitated remains of similar-sized *Cyprinodon* on sandbars in Great Lake from which cormorants had just been flushed. Owre (1967:131) reported the stomach contents of 11 of the larger *P. a. floridanus* taken in Florida, 9 in marine waters and 2 in fresh water. In contrast to the small size of the fish available to the San Salvador cormorants, the Florida prey remains, some headless, of 27 individuals of 7 species of fish ranged from 86 to 499 mm; the smallest intact fish was 136 mm. It seems possible that the diminutive subspecies *P. a. heuretus* is adapted to feeding on the small fishes in the inland lakes of San Salvador. Storer (1966) demonstrated a close relationship of size of prey and size of predators between sexes and among species of hawks of the genus *Accipiter,* but whether well-documented examples of small prey taken by small subspecies of piscivorous birds exist is less certain.

The San Salvador cormorant has been recorded as breeding during both winter and summer, but documentation of the latter is inadequate. Miller, on annual visits to San Salvador between 1973 and 1984, mainly in November, December, and January, found some asynchrony within and between colonies. Egg laying started in November and extended into early December; hatching began in early December; and most young were out of the nest by the end of January. From January to June 1976, he

recorded no breeding activity. Paulson (1966:2) also found "fully fledged young" on 31 December 1965. A juvenile female (USNM 556845), collected 1 February 1981, has wings and tail 80% grown, with the feather bases still ensheathed, and the head, throat, and hind neck entirely covered with down. Todd & Worthington (1911:404, 443) called Great Lake "the home of one or more rookeries of Mexican Cormorants," on the basis of Worthington's visit to an abandoned rookery 16 March 1909, where he found "dead young, about half grown, in various stages of decomposition." On the other hand, in mid-July, Riley (1905b:351) found "heavily incubated eggs, young sitting on the edge of nests and some already in the water with their parents, although they could not fly apparently." Breeding is also protracted in *P. a. floridanus* in Florida; egg dates extend from late December to early June (Bailey 1925:17; specimens in USNM collection).

Although no precise census has been made of the entire population of cormorants on San Salvador, it must certainly be small. Miller has found five breeding colonies of cormorants in red and black mangroves, *Rhizophora mangle* and *Avicennia nitida,* on San Salvador, four on Great Lake and one on a nearby pond. The colonies are widely scattered and not easily accessible. It is possible, but not highly likely, that one or two other small colonies exist, there being only three lakes that Miller did not check completely. In the 1981–1982 breeding season, the total nest count was 269. In 1982–1983, there were 256 nests, but 44 were probably unused older structures. The greatest number of individuals seen at one time was a raft of 110–130 birds recorded in April and May by Miller (1978:284), who also speaks of a small active colony east of Guana Cay on the south edge of Great Lake. Paulson (1966) found "more than 20 nests . . . on a large mangrove-covered island in a lake about 2.5 mi. SE Cockburn Town." He also observed a "moderate number . . . in flight over and fishing in Great Lake east of Cockburn Town" and speculated that there may be other colonies.

If 1981–1982 and 1982–1983 were average breeding seasons and if Miller's nest count for the latter season was complete, the total post-juvenile population of *P. a. heuretus* on the island was probably less than 600, with 424 breeding adults plus another 100 to 150 prebreeding yearlings and two-year-olds. Riley (1905b:351) found that young cormorants were "quite an item in the domestic economy of the islanders." Although the San Salvador cormorant is totally protected under the 1975 Bahamas Wild Birds Protection Act, in the experience of both Miller and Olson on San Salvador in recent years, cormorants are still shot for food and considered excellent table fare. Miller noted parts of butchered cormorants around Little Lake in early December 1977.

In view of its apparent uniqueness and the limited size of its population, the San Salvador cormorant ought to be a high conservation priority in the Bahama Islands. Continuing censuses of breeding pairs and counts or estimations of prebreeding populations of cormorants are needed, along with a search for breeding populations on other islands.

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