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MERCURY CONTAMINATION IN FREE-RANGING GREAT EGRET NESTLINGS (*ARDEA ALBUS*) FROM SOUTHERN FLORIDA, USA

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Abstract—Between March and June of 1994 and 1995, mercury (Hg) concentrations were determined from 393 blood and 164 growing scapular feathers from 252 great egret nestlings (*Ardea albus*). Nestlings came from eight colonies located in Water Conservation Area 3 in the Everglades region in southern Florida. The ages of these birds ranged from 1 to 44 d (bill length 1.1 to 10.2 cm). Mercury concentrations in blood and feathers of first-hatched great egret nestlings sampled during 1994 averaged 1.2 μg/g (range = 0.07–3.9) wet weight and 16 μg/g (4.5–40) dry weight, respectively. During 1995, first-hatched chicks had blood and feather Hg concentrations that averaged 0.8 μg/g (0.2–1.7) and 9.7 μg/g (2.3–26), respectively. In both years, Hg concentrations in blood and feathers were significantly correlated, and a significant correlation also was found between Hg in blood and age of the chicks. Blood and feather Hg concentrations differed significantly between years, with higher concentrations during 1994. Birds from JW1 and L67 colonies had the highest concentrations of Hg in blood and feathers. Mercury concentrations did not differ between chicks of different hatch order. Mercury in feathers of great egret nestlings from southern Florida are approximately six times higher when compared to feather Hg concentrations of nestling wading birds sampled elsewhere.

Keywords—Great egret *Ardea albus* Mercury Florida

INTRODUCTION

Fish-eating birds constitute an excellent indicator of mercury (Hg) contamination because they are a top predator in the aquatic food web [1]. Wide-ranging or migratory birds (such as adult great egrets, *Ardea albus*) are difficult to use as monitors of environmental Hg contamination because it usually is difficult to determine where their exposure occurred. However, sampling Hg concentrations in tissues of nestling birds constitutes an efficient way of measuring local environmental contamination since these birds are fed prey that has been captured by their parents in the vicinity of the breeding colonies [2].

Feathers serve as a useful and nondestructive tissue for Hg analysis because Hg and other metals are sequestered in the sulfhydryl groups of the keratin as feathers grow. Once feather growth is completed, the blood supply atrophies and metal contained in feathers remains extremely resistant to further change [3,4].

In recent years, high Hg concentrations in tissues of wading birds from southern Florida have been implicated as a possible cause of the decline of some of these species in the area [5–7]. High concentrations of Hg also have been reported from fresh water fishes in the Water Conservation Areas (WCAs) of the Everglades, some of which had Hg concentrations that were higher than the maximum allowed in human foods [8].

The objectives of this study were to determine the concentrations of Hg in blood and growing feathers of free-ranging young great egrets hatched in colonies located in WCAs in southern Florida and to see if tissue Hg concentration varied with age, geographic location, year, or hatch order.

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METHODS

During late March to early June of 1994 and 1995, a total of 393 blood samples (286 from 1994 and 107 from 1995) and 164 growing scapular feathers (81 from 1994 and 83 from 1995) were collected from 252 great egret chicks (125 from 1994 and 127 from 1997). Blood and feather samples came from eight colonies located in WCAs 3A and 3B in the Everglades ecosystem (Frog City South, $n = 2$ chicks; Deer Island, $n = 4$; Mud Canal, $n = 20$; Alley North, $n = 28$; Tamiami East, $n = 31$; JW1, $n = 33$; L67, $n = 60$; and Hidden/L28, $n = 74$) (Fig. 1). During 1994, all chicks within a nest were sampled for Hg, whereas in 1995, Hg in blood and feathers was measured only from the largest chick in each nest (A chick). Ages were determined by known hatch or laying dates for 190 of the 252 chicks sampled (138 of the 185 nests) and ranged from 1 to 44 d ($\bar{x} = 17.5$ d; SD = 8.0). Each time a bird was handled, bill length was measured with a plastic ruler to the nearest millimeter from the base of the bill to the tip of the maxilla and ranged from 1.1 to 10.2 cm ($\bar{x} = 4.5$ cm; SD = 1.5). Bill length was used as an estimator of age in this study because it was determined in all but two of the chicks.

During both years, blood was drawn from the jugular vein and stored in 3-ml heparinized containers. The amount of blood collected ranged from 0.3 to 0.6 ml. Blood was kept refrigerated until it was analyzed. Two or three growing feathers were collected from the scapular region, stored in sealed plastic bags, and kept at room temperature until analysis.

The frequency of bleeding varied by colony and ranged from every 3 to every 14 d. These variable collection times were the result of a desire to record both short-term variations in blood Hg concentrations as well as to document geographic variation among colonies. Growing scapular feathers were collected once from each chick, usually during the last visit to the nest.

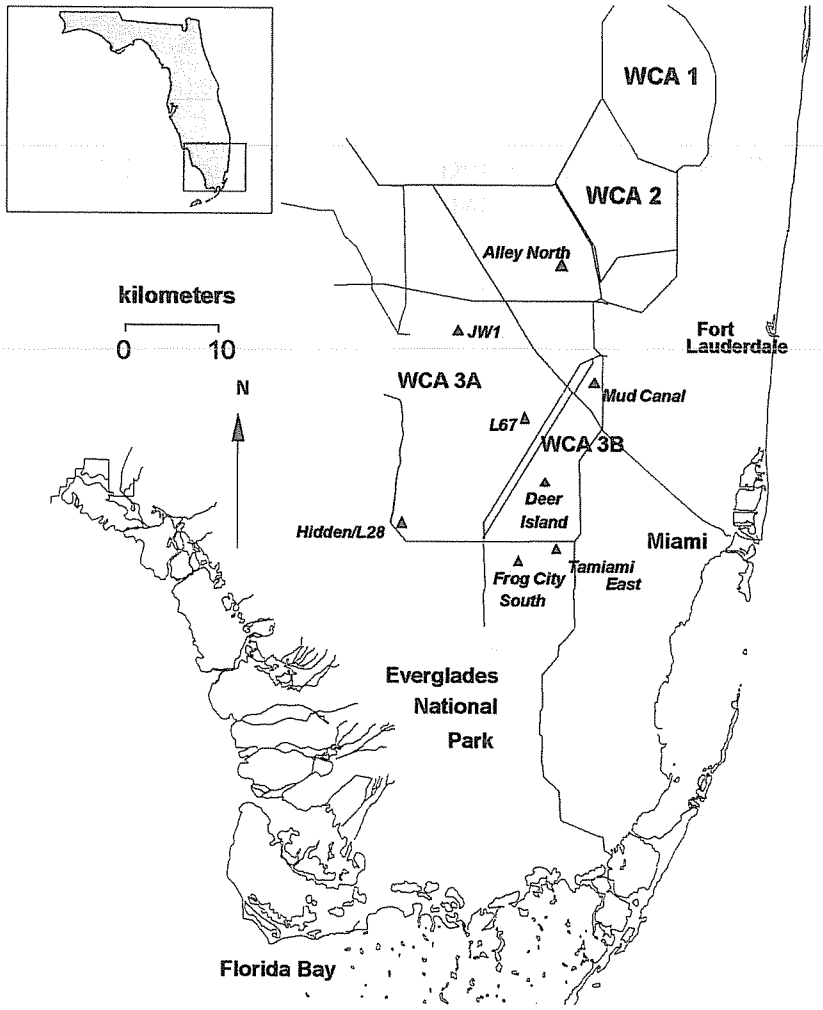

Fig. 1. Map of the study area in southern Florida, showing locations of colonies sampled (triangles) in Water Conservation Area 3 in relation to water management boundaries and areas of major habitation.

Mercury analysis

Total Hg concentrations in blood and feathers of great egret nestlings were determined by the Department of Environmental Protection Chemistry Laboratory in Tallahassee, Florida, USA. At least 0.1 ml of unclotted blood was pipetted into a Nalgene tube, and both the volume and weight of the blood were recorded. Trace metal grade sulfuric acid (5.0 ml) and trace metal grade nitric acid (2.0 ml) were then added to each sample. After adding the acids, samples were placed in a 58°C water bath for 30 min to liquify the blood. At this point, 40 ml of deionized water, 10 ml of 8% potassium permanganate, and 4 ml of 5% potassium persulfate were added to each sample. Samples were left to react with the potassium permanganate and the potassium persulfate for at least 12 h. Due to difficulty in handling and weighing single feathers, multiple feathers were grouped and placed in preweighed, large-mouth polyethylene or propylene containers. Up to 1.0 g of growing feathers were then liquified with 30 ml of trace metal grade sulfuric acid and with 12 ml of trace metal grade nitric acid and allowed to sit at room temperature for 24 to 72 h. Aliquots of 7 ml of the feather digestates were then heated with potassium permanganate and potassium persulfate as described in the blood preparations. After blood and feather tissues were completely digested, total Hg concentration was determined with a cold vapor atomic absorption spectrophotometer (Varian AA300/400 with SPS5 autosampler; Mulgrove, Victoria, Australia). Matrix duplicates, matrix spikes (methyl mercury chloride; Strem Chemical, Newburyport, MA, USA), method blanks, standard reference materials (DORM-1; NRC Canada, Institute for Environmental Chemistry, Ottawa, Canada), and a low-level quantitation verification standard were included as quality controls. Results were reported as acceptable if sample matrix spike recoveries were between 80 to 120%, precision between sample duplicates was less than 20%, and standard reference material recoveries were between 90 and 110%. The method detection limit was between 0.020 and 0.025 μg/g. Unless otherwise noted, concentrations are expressed in μg/g on a wet or dry weight basis for blood and feather samples, respectively.

Statistical analysis

The relationship between bill length and blood Hg concentration was first studied by combining all the data through a correlation analysis. No pattern was observed, however, probably because of the great variability in Hg concentrations between colonies (see Fig. 2 for an example of a positive significant correlation between bill length and Hg in blood when only birds from one colony were included in the analysis). To further study this relationship, correlation coefficients between date of collection and blood Hg concentrations were

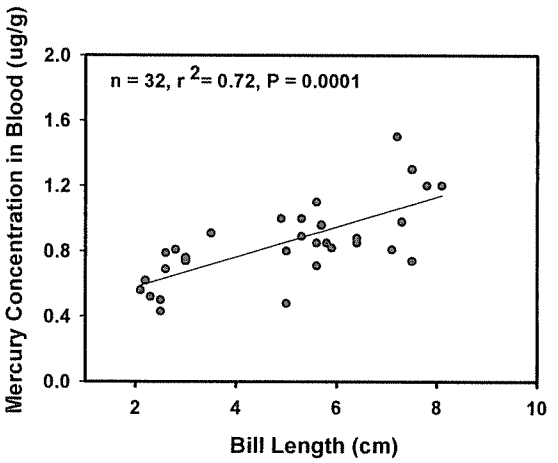

Fig. 2. Correlation between total Hg concentration in blood (μg/g) and bill length (cm) in great egret nestlings from Alley North colony.

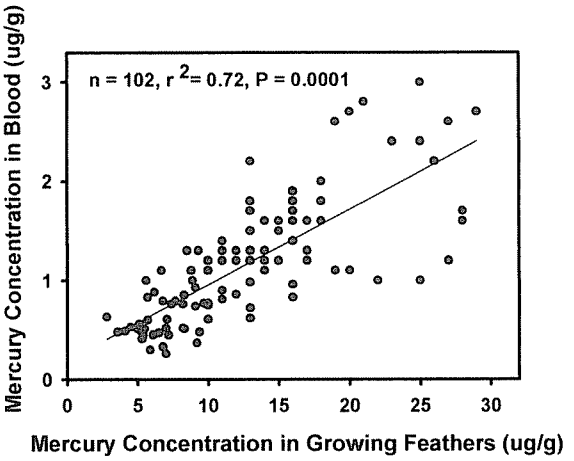

Fig. 3. Correlation between total Hg concentration in blood and growing scapular feathers (μg/g) from great egret nestlings.

calculated for each bird separately, and the proportion of chicks that had positive correlation coefficients was then calculated and tested for significance using a two-sided sign Z test [9]. Only chicks that were sampled at least twice were included in this analysis. Since growing feathers were sampled only once, correlation coefficients were calculated for blood Hg concentrations only. For birds in which Hg in both blood and feathers was known, a Pearson correlation analysis was used to determine if Hg in blood and feathers was significantly correlated with each other. Analyses of covariances were used to assess the effects of year, colony, and hatch order on Hg concentrations in blood and feathers. To control for differences in age, bill length was used as a covariate in all of these analyses (bill length was chosen over age in days because bill length was known from almost all the birds sampled). For multiple comparisons, differences between means were determined using Tukey's studentized range test. Since the age of the birds sampled differed among colonies and years, mean Hg concentrations in blood and feathers are expressed as least square means (LSM). This method predicts an average blood and feather Hg concentration for each colony and year while adjusting for differences in bill length.

Comparisons of Hg concentrations between years and colonies were done using only first-hatched chicks since, during 1995, data were collected only from A chicks. During 1995, comparisons between colonies were performed using Hg data from feathers only. Since all birds from each brood were sampled for Hg only during 1994, the effect of hatch order on Hg concentrations was determined only during that year. This analysis was done only in those nests that had either two or three chicks, that were sampled for Hg in blood and/or feathers at least twice, and whose brood size remained unchanged during the study period.

All statistical tests were performed using the SAS statistical software package (Version 6.12, Cary, North Carolina, USA).

RESULTS

Mercury concentrations in blood and growing feathers of first-hatched great egret nestlings sampled in 1994 averaged 1.2 μg/g (n = 148, SD = 0.6, range = 0.07–3.9) and 16 μg/g (n = 14, SD = 7.1, range = 4.5–40), respectively. First-hatched nestlings in 1995 had blood and feather Hg concentrations that averaged 0.8 μg/g (n = 107, SD = 0.3, range = 0.2–1.7) and 9.7 μg/g (n = 83, SD = 5.0, range = 2.3–26), respectively (Table 1). Blood and feather Hg concentrations of first-hatched chicks were higher in 1994 compared to 1995 (ANCOVAs, F = 10.23, df = 1, p = 0.0019 for blood and F = 11.75, df = 1, p = 0.00029 for feathers).

Overall, Hg concentrations in blood and feathers of great egret nestlings were significantly correlated with each other (n = 102, r^2 = 0.72, p = 0.0001) (Fig. 3). For both years, Hg in blood increased with age of the chick, and during 1994, this increase occurred regardless of hatch order (n = 43, Z = 2.89, p = 0.0009 for first-hatched chicks; n = 31, Z = 3.05,

Table 1. Summary of total Hg concentrations (μg/g) in blood (wet wt.) and growing scapular feathers (dry wt.) of great egret nestlings during 1994 and 1995, by hatch order (A chick hatched first, B second, and C third)

	Mercury in blood		Mercury in Feathers	
Chicks	1994[a]	1995[b]	1994[a]	1995[b]
A	1.2 (148; 0.6)[c]	0.8 (107; 0.3)	16 (44; 7.1)	9.7 (83; 5.0)
B	1.2 (121; 0.7)	—[d]	15 (32; 6.0)	—
C	1.1 (17; 0.7)	—	9.4 (5; 3.5)	—
All chicks combined	1.2 (286; 0.7)	0.8 (107; 0.3)	15 (81; 6.6)	9.7 (83; 5.0)

[a] Least square means calculated for bill lengths of 4.4 cm and 5.6 cm for Hg in blood and feathers, respectively.
[b] Least square means calculated for bill lengths of 5.5 cm and 7.1 cm for Hg in blood and feathers, respectively.
[c] (n; SD).
[d] No samples collected.

Table 2. Mercury concentrations in feathers and blood of nestling piscivorous freshwater birds, piscivorous marine birds, and raptors with concentrations of Hg in feathers and blood (μg/g) expressed as dry and wet weight, respectively, unless otherwise specified

Species	Age (days)	Country	Exact location	Year (s)	Type of feather	Hg concentration in feathers	Hg concentration in blood	Source
Piscivorous freshwater birds								
Great egret (*Ardea albus*)	—[a]	United States	Ohio	1972–1973	Wing	2.6[b,c] (1.3–3.7) (n = 11)	—	[23]
	—	United States	Southern Florida	1987–1990	Wing/tail	7.1 ± 5.1[d] (n = 9)	—	[16]
	1–44[e] (18)	United States	Southern Florida	1994–1995	Growing scapulars	12 ± 5.8 (n = 165)	1.7 ± 0.6 (n = 393)	This study
Great blue heron (*Ardea herodias*)	—	United States	Ohio	1972–1973	Wing	1.9[b,c] (0.5–4.3) (n = 7)	—	[23]
	—	United States	Southern Florida	1987–1990	Wing/tail	3.5 ± 2.3 (n = 7)	—	[16]
	18–71	United States	California	1993–1994	—	2.3 (n = 45)	1.2 (n = 13)	[10]
Great white heron (*Ardea herodias occidentalis*)	—	United States	Southern Florida	1987–1990	Wing/tail	4.7 ± 2.6 (n = 10)	—	[16]
Roseate spoonbill (*Ajaia ajaja*)	—	United States	Southern Florida	1987–1990	Wing/tail	2.0 ± 1.5 (n = 32)	—	[16]
Black-crowned night-heron (*Nycticorax nycticorax*)	—	United States	Ohio	1972–1973	Wing	2.7[b,c] (2.3–4.3) (n = 7)	—	[23]
	21–28	China	Szechuan, Hong Kong	1992	Breast	1.8 ± 0.3 (n = 16)	—	[29]
Eastern great white egret (*Egretta alba modesta*)	1–70	Korea	Cheonan City	1981	Coverts, abdominals, remiges	0.5 ± 0.7[c] (n = 25)	—	[26]
	12	Korea	Cheonan City	1981	Coverts	0.2[c] (n = 1)	—	[17]
	21–28	China	Hong Kong	1992	Breast	0.3 ± 0.03 (n = 8)	—	[29]
Wood stork (*Mycteria americana*)	—	United States	Southern Florida	1987–1990	Wing/tail	3.8 (n = 1)	—	[16]
	—	United States	Florida	1991	Breast	1.9 ± 0.2 (n = 15)	—	[30]
	—	Costa Rica	Tempisque River	1990–1992	Breast	0.5 ± 0.05 (n = 36)	—	[30]
Little egret (*Egretta garzetta*)	21–28	China	Hong Kong	1992	Breast	2.2 ± 0.9 (n = 7)	—	[29]
Pond heron (*Ardeola bacchus*)	21–28	China	Szechuan	1992	Breast	2.4 ± 0.7 (n = 5)	—	[29]

Table 2. Continued

Species	Age (days)	Country	Exact location	Year (s)	Type of feather	Hg concentration in feathers	Hg concentration in blood	Source
Piscivorous marine birds								
Common tern (*Sterna hirundo*)	<28	United States	New York	1980	Breast	1.4 ± 0.6 (n = 16)	0.4 ± 0.3 (n = 16)	[11]
	—	United States	New York	1991	Wing	2.0 ± 0.2 (n = 14)	—	[22]
					Breast	2.6 ± 0.2 (n = 21)		
	20–23	United States	Massachusetts	—	Breast	3.1 ± 0.0002 (n = 21)	—	[31]
	15–22 (19)	Germany	Wadden Sea	1991	Back	3.0 ± 0.5[c] (n = 13)	—	[21]
Common loon (*Gavia immer*)	21–280	United States	Minnesota	1984–1990	Breast	0.9 ± 2.0[c] (n = 8)	—	[32]
	28–49	Canada	Central Ontario	1992	Wing	2.3 ± 0.6 (n = 17)	0.14 ± 0.1 (n = 35)	[12]
Great skua (Catharacta skua)	—	United Kingdom	Shetland	1987	Body	1.3 ± 0.4[c] (n = 40)	—	[33]
Black-head gull (*Larus ridibundus*)	15–30 (22)	Germany	Wadden Sea	1991	Back	0.9 ± 0.5[c] (n = 36)	—	[21]
Herring gull (*Larus argentatus*)	24–37 (29)	Germany	Wadden Sea	1991	Back	1.3 ± 0.6[c] (n = 39)	—	[21]
Brown noddy (*Anous stolidus*)	—	United States	Hawaii	1990	Breast	0.06 ± 0.003 (n = 20)	—	[4]
Double-crested cormorant (*Phalacrocorax auritus*)	—	United States	California	1993–1994	—	3.7 (n = 15)	—	[10]
Franklin's gull (*Larus pipixan*)	—	United States	Minnesota, South and North Dakota, Montana	1994	Breast	1.0 ± 0.1 (n = 60–76)	—	[34]
Birds of prey								
Bald eagle (*Haliaeetus leucocephalus*)	49–77	United States	Oregon, Washington	1979—1981	—	—	1.1 (0.1–4.2)[f] (n = 91)	[13]
	56–77	United States	Oregon	1980–1987	—	—	0.5 (0.2–1.4) (n = 15)	[14]
	NR	United States, Canada	Great Lakes Basin	1985–1989	Breast	9.0 (1.5–27) (n = ?)	—	[35]
	42–63	United States	Florida	1991–1993	Contour	4.0 (0.7–14.3) (n = 61)	0.2 (0.02–0.6) (n = 48)	[15]
Peregrine falcon (*Falco peregrinus*)	23–25	Sweden	Northern, southern, central	1971–1978	Wing/tail	6.3 ± 2.4 (n = 23)	—	[36]

[a] Not reported.
[b] Median, range (in parentheses), and number of samples examined (standard deviation not reported).
[c] Hg feather concentration (μg/g) expressed on a wet weight basis.
[d] Mean ± standard deviation and number of samples examined.
[e] Range of age in days (average age in parentheses).
[f] Geometric mean, range (in parentheses), and number of samples examined.

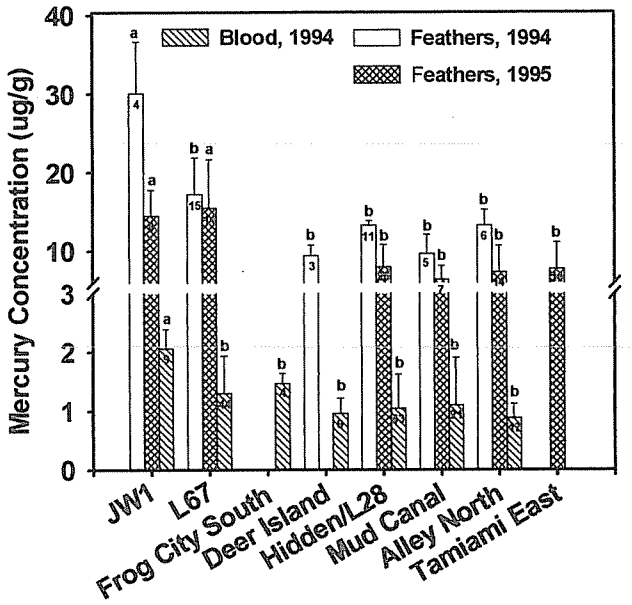

Fig. 4. Total Hg concentrations in blood and growing scapular feathers (μg/g wet weight and dry weight, respectively) of first-hatched great egret chicks during 1994 and 1995 by colony. Values shown are least square means (LSM) ± SD calculated for bill lengths of 4.7 cm and 6.4 cm for blood and feathers, respectively. Numbers on bars represent sample sizes. For within tissue-year comparisons, bars with different letters denote differences between the means ($p < 0.05$).

$p = 0.0005$ for second-hatched chicks during 1994; and $n = 36$, $Z = 2.41$, $p = 0.004$ during 1995). There were not enough samples to test this hypothesis for third-hatched chicks.

Differences in Hg concentrations among colonies were detected in both years of study. During 1994, first-hatched chicks from JW1 had higher blood Hg concentrations compared to all other colonies, with the exception of Frog City South (ANCOVA, $F = 5.53$, $df = 6$, $p = 0.0001$) (Fig. 4A). In addition, for 1994, first-hatched great egret chicks from JW1 had higher feather Hg concentrations than did first-hatched chicks from all other colonies (ANCOVA, $F = 10.18$, $df = 5$, $p = 0.0001$) (Fig. 4B). Similarly, during 1995, first-hatched chicks from JW1 and L67 colonies had a significantly higher Hg concentration in their feathers when compared to birds from all other colonies (ANCOVA, $F = 12.97$, $df = 5$, $p = 0.0001$) (Fig. 4).

We found no evidence of differences in blood or feather Hg concentration among nestlings of different hatch order. For nests with two nestlings, neither Hg in blood nor feathers differed between A and B chicks (ANCOVAS, $F = 0.59$, $df = 1$, $p = 0.4462$ and $F = 0.57$, $df = 1$, $p = 0.4551$, respectively). Similarly, for nests with three chicks, no differences were found between blood and feather Hg concentrations of A, B, and C chicks (ANCOVAS, $F = 0.14$, $df = 2$, $p = 0.8674$ and $F = 1.52$, $df = 2$, $p = 0.3221$, respectively).

DISCUSSION

There are few reports on Hg concentrations in blood from nestlings of fish-eating birds. The concentration of Hg in blood of great egrets from southern Florida reported here is higher than that reported in great blue herons (*Ardea herodias*) from California [10], common terns (*Sterna hirundo*) from New York [11], common loons (*Gavia immer*) from Ontario [12], and bald eagles (*Haliaeetus leucocephalus*) from Oregon, Washington, and Florida [13–15] (Table 2).

When comparing feather Hg concentrations from this study and others in south Florida [16] with those published on other species of young birds, egrets from southern Florida had the highest concentration of Hg. Reports of Hg in feathers of nestling wading birds sampled elsewhere averaged between 1.4 μg/g wet weight and 2.2 μg/g dry weight, approximately six times lower than the values reported in this study (Table 2). Similarly, feathers from nestling piscivorous marine birds contained less Hg compared with great egrets from southern Florida. Young raptors had feather Hg concentrations that were closer to, but still lower than, those reported in the present study (Table 2). Thus, it appears that great egret nestlings in the WCAs of the Everglades have high Hg exposure compared with other birds.

Differences in Hg concentrations between young great egrets from southern Florida and young birds sampled elsewhere could be related to several factors. One such factor could be the type and growth stage of the feathers sampled. In general, higher Hg concentrations have been documented from abdominal and down feathers compared with other contour and wing feathers [17–21]. The studies in Table 2 represent samplings of almost every type of feather, which could explain at least part of the observed differences. In addition, and in contrast to this study, most authors report Hg concentrations from mature feathers. In a study of Hg in mature wing feathers from free-ranging common terns, Burger and Gochfeld [22] found higher concentrations of Hg in the distal portion compared to the proximal portion of these feathers. These findings are important because they suggest that it might not be appropriate to compare Hg concentrations across studies if different types and/or maturity stages of feathers are used.

Differences in Hg concentrations between different species of nestlings could be related also to differences in prey size and type (larger and piscivorous fish usually contain higher concentrations of Hg compared with smaller fish or invertebrates) [7,23,24], to physiological differences in sequestration or distribution rates to various tissues, and/or to geographic differences in the concentration of Hg in prey items.

Mercury concentrations in growing feathers of great egret nestlings were related to Hg concentrations in blood. We conclude that, when monitoring large numbers of free-ranging great egret nestlings (or other wading birds) for Hg concentrations, the collection of blood can be avoided and replaced by the collection of a few growing feathers, which is much less intrusive and is safer and faster.

Great egret nestlings are useful indicators of local contamination because the parents feed their chicks foods collected close to the breeding colonies. In this respect, Frederick [25] reported that, during the time when adult great egrets were feeding their young in colonies located in WCA 3, birds flew an average distance of 6.21 km during 1994 and 8.50 km during 1995. Similarly, Bancroft et al. [2] reported that, during 1983 and from 1986 to 1989, adult breeding great egrets flew to forage an average distance of 6.3 km from their colonies located in the WCAs of the Everglades.

Mercury concentration in blood of great egrets increased during the first month of age. Interestingly, this increase occurred despite the fact that large amounts of Hg were being excreted through growing feathers. In fact, the average blood Hg concentration in great egret chicks (all ages combined) was approximately 12 times lower than in growing feathers during 1994 (1.2 vs 15 μg/g) and 13 times lower during 1995 (0.8 vs 9.6 μg/g). Honda et al. [26] reported a similar finding in

eastern great white egret (*Egretta alba modesta*) nestlings. In these birds, whole-body concentrations of Hg increased until the 45th day of age (which corresponds to fledging time) and decreased thereafter. The authors concluded that this decrease was due to the fact that relatively high amounts of Hg were being excreted via molting.

Because the primary mode of Hg contamination in great egret nestlings is through the ingestion of contaminated prey, differences in tissue Hg concentrations between years might be explained by differences in the amount of Hg that these birds were being exposed to through their diets. Higher Hg concentrations in great egrets during 1994 might be explained because of an increased availability of larger prey during that year. It is possible that lower water levels and more rapid drying during 1994 [25] might have increased the availability of larger fish for adult egrets during this year. Since larger fish tend to be older and be higher in the trophic level, these fish usually contain higher concentrations of contaminants compared with smaller fish.

In general, we conclude that, for both years, chicks sampled from JW1 and L67 had the highest concentrations of Hg. These two colonies are located along a northwest/southeast line at the center of WCA 3 (see Fig. 1). For both years, chicks from Hidden/L28, Mud Canal, and Alley North, together with Deer Island colony in 1994 and Tamiami East colony in 1995, had the lowest concentrations of Hg. Except for Hidden/L28, all these colonies are situated close to the eastern border of WCA 3. At this time, it remains unknown if the observed differences in Hg concentrations between colonies are due to differences in the type of foods consumed by the breeding egrets, differences in Hg contamination of the selected food items, or a combination of both. The differences in Hg concentrations between colonies, with nestlings from JW1 having approximately twice as much Hg when compared with other colonies, may be due to the presence of a local, but yet unidentified, source of Hg.

No differences in Hg tissue concentration were detected between siblings despite the fact that a representative sample of nests with two (n = 44) and three (n = 15) great egret chicks were analyzed for differences. Similarly, Stendell et al. [27] found no differences in egg Hg concentrations within clutches of great egrets nesting in Lake St. Clair and the Detroit River. In contrast, in herring gulls (*Larus argentatus*) and common terns, egg Hg concentrations have been shown to decline with laying sequence [28]. In addition, first-hatched herring gulls and common terns have significantly higher Hg in down than their younger siblings (20 and 31% higher Hg concentrations, respectively) [21]. Fully grown back feathers from these birds, however, showed no significant differences in Hg contamination between siblings. These results indicate that differences in Hg concentrations between siblings, if any, are more likely to be detected at very early stages of development (embryo, downy stage). The fact that great egret chicks in this study were sampled for Hg at a later age could explain the absence of a similar pattern.

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