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BREEDING ECOLOGY OF THE LITTLE BLUE HERON ON THE WEST COAST OF FLORIDA

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ABSTRACT.—Little Blue Herons (*Florida caerulea*) nest most often in association with the *Schinus-Sabal* community on the Alafia Banks, Florida. The number of active nests reaches two peaks during the breeding cycle; breeding time seems unaffected by cooler temperatures in the winter or spring. Peaks probably result from two different breeding populations and not from renesting. Mean clutch size is 2.91 ± 0.09, hatching success is 92.1%, and nestling survivorship to two weeks of age is 53.0%. Egg loss and nestling mortality can be attributed to nestling starvation, nest collapse and predation. Little Blue Herons on the Alafia Banks lay smaller clutches and fledge fewer young compared to most populations studied in other areas.

The Little Blue Heron (*Florida caerulea*) is listed as a "species of special concern" in Florida (Kale 1978), and it has also declined elsewhere in most of its range (Ogden 1978). The main reason for this situation appears to be drainage of wetlands but the mechanism can only be learned from studying breeding success and ecological requirements of the species in a variety of habitats. The breeding ecology of Little Blue Herons has mostly been studied in freshwater habitats (Meanley 1955, Jenni 1969, Summerour 1971, Werschkul 1977, Wiese 1977); few data are available from the coast (e.g. Maxwell and Kale 1977). I report here on the breeding success and nesting ecology of this species on a dredged-material island off the west coast of Florida.

STUDY AREA AND METHODS

I conducted field studies from 1976 to 1978 on the Alafia Banks, Hillsborough Bay, Hillsborough County, Florida. The Alafia Banks consist of two dredged-material islands (Bird and Sunken islands) where Little Blue Herons breed most often in Brazilian pepper (*Schinus terebinthifolius*), cabbage palm (*Sabal palmetto*) and black mangrove (*Avicennia germinans*). These herons also nest in red mangrove (*Rhizophora mangle*) on Bird Island, but this population was not studied. Within the regions used by Little Blue Herons on the Alafia Banks, 125 pairs of Snowy Egrets (*Egretta thula*), 175 pairs of Louisiana Herons (*Hydranassa tricolor*), 75 pairs of Black-crowned Night Herons (*Nycticorax nycticorax*), 75 pairs of Yellow-crowned Night Herons (*N. violacea*), 75 pairs of Glossy Ibis (*Plegadis falcinellus*) and 4,500 pairs of White Ibis (*Eudocimus albus*) also nested.

Bird and Sunken islands were created in 1931 and 1961, respectively, and differ in their geology, bird populations, and flora. Data for the relative frequency of plants in the study area (Table 1) were derived from Lewis and Lewis (1978). The history and habitat of the Alafia Banks have been described by Schreiber and Schreiber (1978) and Lewis and Lewis (1978).

Nestling Little Blue Herons were banded with U.S.F.W.S. aluminum bands and with individually numbered, colored leg-streamers to aid in identification. Nests were marked and data collected twice weekly on nest failure, clutch size and nestling survivorship. Nests were checked during early daylight hours from March to August of each year. Nests and eggs of Little Blue Herons were indistinguishable from those of other intermediate sized day-herons, but nests were identified by observing their adult and/or nestling occupants.

RESULTS

HABITAT AND VEGETATION USED

In 1974, Little Blue Herons began moving from the *Sabal* community on Bird Island (>75 pairs) into a mixed *Schinus-Sabal* community on Sunken Island (F. Dunstan, pers. comm.). A yearling Little Blue Heron banded on Bird Island in 1975 was found nesting on Sunken Island in 1976. By 1977 fewer than 15 pairs nested in the Bird Island *Sabal* community.

Little Blue Herons bred in a variety of vegetation on the Alafia Banks (Table 1). The percent total plant species used for nesting differed significantly ($\chi^2 = 29.72$, d.f. = 6; $P < 0.01$) from the relative frequency of the plant species in the study area. Brazilian pepper was used more often than expected, whereas cabbage palm, marsh elder, and white mangrove were used less often than expected. Nests in cabbage palms were erected at the junction of the fronds with the trunk, usually across two fronds, and at the first level of intact fronds. The closest distance between two active nests was 0.81 m.

Table 1 also includes the frequency of nest loss for nests built in each plant species. Nest loss was 2.4 times greater than expected (percent nests destroyed/percent total nests) in mulberry; nests were not lost significantly more than expected in other

TABLE 1. Nesting vegetation used by Little Blue Herons on the Alafia Banks.[1]

Species	Nest height			Percent total nests	Relative frequency[2]	Percent total nests destroyed
	N	$\bar{x}$	Range			
Brazilian Pepper (*Schinus terebinthifolius*)	183	2.65 m	1.14–2.92 m	70.3	42.6	63.2 (24)[3]
Cabbage Palm (*Sabal palmetto*)	34	2.24 m	1.12–3.02 m	13.1	29.4	13.2 (5)
Black Mangrove (*Avicennia germinans*)	18	3.45 m	2.62–3.20 m	7.0	8.6	5.3 (2)
Mulberry (*Morus rubra*)	14	2.99 m	1.66–3.29 m	5.4	1.6	13.1 (5)
Gray Nicker (*Caesalpina crista*)	6	1.14 m	1.01–1.28 m	2.3	0.1	2.6 (1)
Marsh Elder (*Iva frutescens*)	4	1.55 m	1.14–1.82 m	1.5	9.1	0
White Mangrove (*Laguncularia racemosa*)	1	2.54 m	2.54 m	0.4	8.6	2.6 (1)

[1] Data lumped for 1976 and 1977; do not include nesting in red mangrove on Bird Island.
[2] Frequency of a species/sum of frequencies of all species within the study area ×100; data from Lewis and Lewis (1978).
[3] Numbers in parentheses are the number of nests.

plants (χ^2 = 5.46, d.f. = 5). Thirty-eight nests were destroyed before nestlings were two weeks old.

Nests from previous years did not remain intact and early breeders constructed new nests. However, as the seasons progressed nests were emptied, resulting in an 11.2% (N = 260 nests) rate of re-use by Little Blue Herons (contra Meanley 1955). Twenty-eight nests were re-used from various day-herons and one had been abandoned by White Ibis; nests of nearby night herons were not used.

TIMING OF BREEDING

In the Tampa Bay region, the 1976 winter–spring period was slightly warmer (January, +2.9°C; February, +3.1°C; March, −0.6°C) than in 1977 (data from the National Weather Service, Climatic Center, Asheville, N. C.). However, timing of first eggs hatched per nest did not differ between years (Fig. 1). The only apparent difference between the breeding cycles of 1976 and 1977 was the higher bimodal peaks in 1976.

CLUTCH SIZE

Clutch size did not differ significantly between 1976 and 1977 (Table 2) or between phases 1 ($\bar{x}$ = 2.74) and 2 ($\bar{x}$ = 2.76) for 1976. In 1977, phase 1 clutches ($\bar{x}$ = 3.07, SE = 0.58; N = 56 nests) were significantly larger than phase 2 clutches ($\bar{x}$ = 2.58, SE = 0.25; N = 26 nests; t-test, $P < 0.01$).

EGG LOSS AND NESTLING SURVIVORSHIP

The greatest cause of egg loss was nest collapse (38 nests, 76%), followed by Fish Crow (*Corvus ossifragus*) predation (five nests, 10%), abandoned nests (five nests, 10%) and nesting interrupted by fecal droppings from White Ibis nests above (two nests, 4%). Two nests were abandoned owing to subadult male infidelity during the incubation period (see Rodgers 1978a, 1980), resulting in the loss of seven eggs.

Four of seven subadult pairs raised at least one nestling to two weeks of age (Table 2; $\bar{x}$ = 1.40, range 0–3). Survival rates to two weeks did not differ significantly between phase 1 and 2 herons in 1976 (t-test). However, survival rate to two weeks was significantly greater in 1977 (55.9%, $\bar{x}$ = 1.64 young/nest; N = 72 nests) than in 1976 (49.5%, $\bar{x}$ = 1.35 young/nest; N = 74 nests), and it was significantly greater for phase 1 (59.2%, $\bar{x}$ = 1.82 young/nest; N = 56 nests) than for phase 2 nests (54.2%, $\bar{x}$ = 1.42 young/nest; N = 26 nests) in 1977 (t-tests; $P < 0.01$).

The success of a nest (egg to two-week old young) varied with clutch size. Two-egg clutches (N = 35) produced a mean of 1.34 chicks (67.1% survival rate), three-egg clutches (N = 92) produced a mean of 1.89 chicks (63.0% survival rate), four-egg clutches (N = 18) produced a mean of 2.05 chicks (51.3% survival rate) and a five-egg clutch produced three two-week old chicks (60.0% survival rate).

Seventy-six percent of nestling deaths were attributed to starvation (N = 76 chicks in 146 nests during 1976 and 1977); 62% of the deaths involved the youngest nestlings. Nest collapse (19%), nestlings falling from

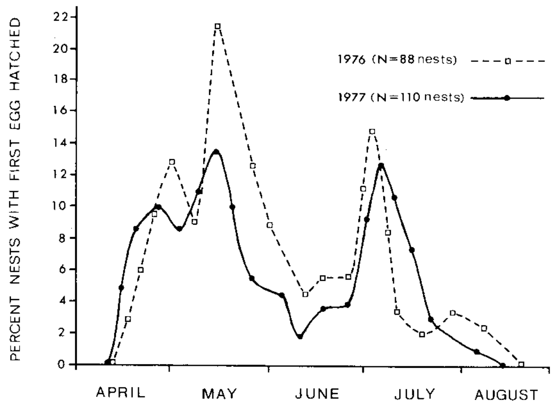

FIGURE 1. Percent of Little Blue Heron nests with first egg hatched, on Sunken Island. Nests with chicks appearing before 11 June are first phase, after 11 June are second phase.

nests (4%) and accidental injury (1%) were other known causes of death.

DISCUSSION

Cold weather is reported to delay the onset of breeding in some birds (Snow 1955), including the Great Egret (*Casmerodius albus*; Simmons 1959). Winter-spring temperatures in the Tampa Bay region in 1976 were near normal, while 1977 was below normal. However, I detected no great difference in the frequency distribution of nests according to the date when the first egg hatched between the two years (Fig. 1). Ogden et al. (in press) detected some impact of temperature on the breeding cycle of Great Blue Herons (*Ardea herodias*) but could not differentiate between the effects of temperature and rainfall.

I believe the low number of Little Blue Heron chicks hatching around 11 June (Fig. 1) resulted from a previous lull in the initiation of new nests, which occurred when the area became fully occupied with the territories of numerous species of herons and ibises. These birds prevented male Little Blue Herons from setting up the large territories typical of courtship (Meyerriecks 1960, 1962, Rodgers 1978b). A time-lag occurred between the peak in fledging (which makes habitat available for new territory formation) and initiation of courtship by newly arriving males and females. The minor decrease in the number of nests in which the first egg hatched during early May probably was a result of the temporary saturation of the area with large courtship territories, followed by shrinking of the territory to that around the nest consequent with pair formation by the early-nesting waders. This newly available space allowed additional herons and ibises to enter, and the available nesting habitat was completely occupied in late May.

TABLE 2. Clutch size, hatching success, number of young per nest, and nestling survival rates of Little Blue Herons on the Alafia Banks.

Character	Data set	No. nests	No. eggs	No. young
Clutch size				
$\bar{x} \pm$ SE	2.91 ± 0.09	219	637	—
mode	3			
range	1–5			
No. eggs hatching/nest				
$\bar{x} \pm$ SE	2.67 ± 0.11	167	484	446
mode	3			
range	0–5			
No. one-week old young/nest				
$\bar{x} \pm$ SE	2.19 ± 0.11	146	—	320
mode	2			
range	0–5			
No. two-week old young/nest				
$\bar{x} \pm$ SE	1.49 ± 0.13	146	—	218
mode	2			
range	0–4			
Survival rates				
percent eggs hatched	92.1%	167	484	446
egg to one week	77.4%	146	413	320
egg to two weeks	53.0%	146	411	218
hatched to one week	84.0%	146	—	320
hatched to two weeks	57.2%	146	—	218
one week to two weeks	68.1%	146	—	218

TABLE 3. Comparative breeding success of Little Blue Herons.

Clutch size	Mortality	Habitat	Latitude	Source
4.4 ± 0.71	—	freshwater	33°10′N	Summerour 1971
4.04	28.8%[a]	freshwater	34°N	Meanley 1955
4.0 ± 0.79	—	freshwater	33°10′N	Werschkul 1977
3.9	31.1%[a]	estuarine	29°35′N	Wiese 1977
3.83 ± 0.6	—	marine	39°2′N	Burger 1978
3.7 ± 0.10	37.7%[a]	freshwater	29°N	Jenni 1969
3.3 ± 0.16	15.9%[b]	estuarine	27°35′N	Maxwell and Kale 1977
2.91	—	freshwater	31°N	Taylor and Michael 1971
2.91 ± 0.09	47.0%[a]	marine	27°5′N	This paper
2.3	—	freshwater	31°–32°N	Hopkins and Murton 1969

[a] Egg laying to two weeks.
[b] Egg laying to 10 days.

I suspect that the bimodal peaks in nesting resulted from two groups of Little Blue Herons entering the breeding cycle during different parts of the breeding season. They probably were not the result of renesting attempts, because breeding color of the soft parts fades shortly after pair formation and the pair bond terminates when the young leave the nest (Rodgers 1980, in press a). For renesting to occur, the endocrine system must again prime the reproductive cycle. Little Blue Herons in nonbreeding soft-part coloration were common after the middle of May, indicating that most birds did not undergo a second hormonal cycle. The phase-2 herons may have come from inland sites that failed, as the severity of the drought during 1976 and 1977 (see below) increased during the year (Ogden et al., in press).

While the Sunken Island colony of Little Blue Herons showed yearly breeding synchrony for the two years of my study, the birds did not breed simultaneously within the year. Burger (1979) found that colony synchrony decreases above 100–200 pairs in Herring Gulls (*Larus argentatus*). Perhaps the large number of several wading bird species and saturation of the habitat with territories prevented Little Blue Heron synchrony on Sunken Island within the year. In contrast, McCrimmon (1978) found only a single nesting peak for Little Blue Herons in North Carolina, possibly the result of a more synchronized cycle facilitated by a shorter breeding season or fewer nests (N = 33). Mock (1978) found two peaks in pairing and nesting activities among Great Egrets in Texas; he suggested that the second phase may have been the result of subadults entering the breeding cycle.

The mean clutch size for Little Blue Herons on the Alafia Banks (Table 2) was relatively low compared to data from most other studies (Table 3). These data indicate that clutches are larger among Little Blue Herons nesting in freshwater swamps (the exception being the data of Hopkins and Murton 1969) and smaller in more southerly colonies. The smaller clutches on the Alafia Banks as compared with those from colonies in freshwater swamps are hard to explain but may relate to food supply. My studies disclosed that adult Little Blue Herons prey chiefly on freshwater animals. The central-west coast of Florida received below-average rainfall during 1976 (−18.0 cm) and 1977 (−45.5 cm), a situation that might have resulted in less foraging habitat and fewer prey. Hence, if the body reserves of female Little Blue Herons were reduced they might have laid fewer eggs.

The hatching success of 484 eggs on the Alafia Banks was 92.1% (combined total for 1976 and 1977). Summerour (1971) reported 74%; Werschkul (1977), 82%; and Maxwell and Kale (1977), 87%.

Nestling mortality for Little Blue Herons on the Alafia Banks is the highest reported to date (Table 3), yet the reason for this is unclear. The low survival rate to two weeks of age was caused in part by egg loss from nest collapse. Possibly *Morus* and *Schinus* trees are particularly unstable nesting sites. Still, starvation was the greatest cause of nestling death. Below normal rainfall may have affected the predominantly freshwater foraging of the Little Blue Herons. Many freshwater marshes in Hillsborough County have been drained, further affecting heron breeding success through loss of foraging habitat. On several occasions, nestling Little Blue Herons regurgitated non-native fishes while I was banding them. The area east of the Alafia Banks contains several tropical fish farms and the proprietors probably kill fish-eating birds that feed at their ponds. Possibly the loss of one or both parents by illegal killing contributed to the high loss of nestlings from starvation.

In my colony, more nestlings died between one and two weeks of age than in earlier periods (Table 2). Cattle Egrets (*Bubulcus ibis*) in Africa also suffered higher nestling mortality during the second week (Siegfried 1972). I detected differences in the success of a nest (number of two-week old young/nest and survival rate) in relation to the clutch size for the Little Blue Heron. Both St. Clair Raye and Burger (1979) and Rodgers (in press b) found little difference in survival rates between different size broods among several species of herons.

Phase-1 Little Blue Herons laid significantly larger clutches, with greater nestling survivorship, than did phase-2 birds for 1977. Possibly the severe 1977 drought hurt the phase-2 breeding population more. Jenni (1969) also reported significantly larger Little Blue Heron clutches earlier in the season. Gaston and Johnson (1977) found that clutch sizes and nestling mortality rates varied for Louisiana Herons and Cattle Egrets through the breeding season. If inexperienced subadult herons enter the breeding cycle later in the season (Mock 1978, Rodgers 1978a), they may account for the lower reproductive success of the phase-2 group.

Causes of egg loss and nestling mortality in this study were similar to those in other studies. Werschkul (1979) reported that most nestlings died because late-hatching chicks starved, a result of their failure to compete with older siblings.

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RECENT PUBLICATIONS

A Manual for Bird Watching in the Americas.—Donald S. Heintzelman. 1979. Universe Books, New York. 255 p. $17.95. This book offers elementary advice on equipment, references, ornithological organizations (but omits the C.O.S.), lists and counts, techniques for finding and identifying certain kinds of birds, and birding localities in the Western Hemisphere. The treatment is generally superficial, yet sound as far as it goes, being based on the author's wide experience. The book is over-illustrated: many of the photographs, although good, are superfluous or too large. Possibly a useful reference for novice birders. Lists of additional reading; index.

Birds of the Grand Canyon Region: An Annotated Checklist.—Bryan T. Brown et al. 1978. Grand Canyon Natural History Association, Monograph No. 1. unnumbered pages. Paper cover. $2.00. Source: G.C.N.H.A., P.O. Box 399, Grand Canyon, AZ 86023. This checklist is the latest in a series which began with C. Hart Merriam in 1890. The annotated list summarizes the status of every species known from the region and gives unusual records. Bar charts repeat the information on seasonal occurrence and add dates. List of references.

A Birdwatcher's Guide to the Eastern United States.—Alice M. Geffen. 1978. Barron's, Woodbury, N.Y. 346 p. Paper cover. $6.95. Here is yet another guide to public birding places. Each chapter (state) has a simple overall map, a general introduction, and description of any national parks, forests, wildlife refuges, etc. These are followed by brief accounts of nature centers, Audubon sanctuaries, and Nature Conservancy preserves. "Each write-up includes the full name of the sanctuary, address, and telephone number; traveling directions; hours of operation; available educational programs; a general description of the terrain; primary species sighted; nesting species; and the availability of a checklist." Illustrated with attractive drawings by Peter Hayman. Bibliography; list of ornithological and nature periodicals; index. Compare this guide with that by Pettingill (noted in Condor 79:286); devoted birders will find that both have their advantages. The books by Kitching (1976. Arco, New York) and Heintzelman aren't in the same league.