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BREEDING CHRONOLOGY AND CLUTCH INFORMATION FOR THE WOOD STORK FROM MUSEUM COLLECTIONS

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Abstract.—Information on 203 museum tags that accompanied Wood Stork (*Mycteria americana*) clutches collected during 1875–1938 and 1967 were analyzed for breeding chronology and clutch size in Florida. Egg sets were collected in February–May in central Florida, significantly later than in south Florida where egg sets were collected in October and December–June. The mean ± SD clutch size for all Florida egg sets was 3.28 ± 0.74. Although the 1885–1894 period exhibited significantly larger clutches, no overall trend was detected in clutch size during 1875–1967. Modal and mean clutch sizes during the late 1800s and early 1900s were similar to the 1980s.

INFORMACIÓN SOBRE EL TAMAÑO DE LA CAMADA Y CRONOLOGÍA REPRODUCTIVA DE *MYCTERIA AMERICANA*, A BASE DE COLECCIONES DE MUSEOS

Sinopsis.—Se analizaron 203 marbetes de museos adjuntos a camadas de *Mycteria americana*, las cuales fueron coleccionadas entre 1875–1938 y 1967, para obtener información sobre el tamaño de la camada y la cronología reproductiva de la especie en Florida. Se encontró que en la parte central de Florida, los huevos fueron coleccionados entre febrero–mayo, significativamente más tarde que en la parte sur de Florida en donde las camadas fueron coleccionadas en octubre, y en diciembre–junio. El tamaño promedio de la camada ±DE resultó ser 3.28 ± 0.74. Aunque el periodo entre 1885–1894 mostró camadas significativamente mayores, no se observó ninguna tendencia particular en el tamaño de la camada entre 1875–1967. El promedio y el modo de las camadas durante la parte final del siglo pasado y principios de éste, resultó ser similar al de los años de la década de 1980.

The North American population of the Wood Stork (*Mycteria americana*) has received attention because of declining numbers (Kushlan and Frohring 1986, Ogden and Nesbitt 1979, Ogden and Patty 1981, Rodgers et al. 1987) and was recently listed as an endangered species by the U.S. Fish and Wildlife Service (USFWS 1984). I obtained oological data from museum collections to analyze historical temporal patterns of breeding and clutch size to contrast with my study on the breeding biology of the Wood Stork. My major purpose was to determine if a historical decrease in clutch size may have contributed to the decrease in the Wood Stork population in Florida.

METHODS

I obtained information on 203 Wood Stork egg sets from museum tags in 49 of 57 collections (see Kiff 1979 and Kiff and Hough 1985). Four sets were collected in Mexico, and 199 sets were collected in Florida during 1875–1967 (mean = 1913). I restricted my analyses to nest records collected in Florida. Of these 199 egg sets, three lacked a specific date, 11 were collected in 1967 (5.5%) and the remaining 185 (93.0%) were collected prior to 1939. The sample included only nest records with

unambiguous data on complete clutches. Egg sets were collected from two general regions (Fig. 1): the south and southwest coastal counties of Charlotte (1), Lee (11), Dade (1), and Monroe (76); and a nine-county cluster in central Florida: Volusia (21), Seminole (1), Orange (46), Brevard (7), Indian River (2), Osceola (21), Polk (8), Pasco (1), and Hillsborough (2). To minimize biases due to small sample sizes and uneven observer coverage with respect to the time of year and locality in my analysis of historical trends in clutch size, I combined clutch data by 10-yr periods. Clutch size data were tested for normality of distribution via the Kolmogorov-Smirnov one sample test. If the data were not normally distributed, the statistical analyses were performed on log-transformed (ln [clutch size + 1]) data.

Wood Storks exhibit a significant interyear variation in the mean hatch date within the same colony and much intercolony difference in the mean hatch date during the same year. Whereas most Wood Stork egg data slips contained information on incubation stage (e.g., "early," "late," "about 8 days"), the subjective assessments by oologists were too vague for me to confidently estimate a correction factor for date of egg-laying (see McNair 1987) for storks with a 28-day incubation period (Palmer 1962). Most years of egg set collection (77.4%) were represented by fewer than 10 observations and most individual colonies (78.3%) were represented by fewer than 10 observations. Thus, I combined the egg set data from different years and colonies and analyzed breeding chronology only by region (south and central Florida) and by month. I analyzed breeding chronology with a contingency table by region and month; some monthly (df) sample sizes were collapsed to ensure an adequate χ^2 test statistic.

Concurrent with this investigation, I studied the breeding biology of Wood Storks at 14 colonies in north and central Florida during 1981 through 1985. Data were collected on clutch size, fledging success and nest loss, and breeding chronology on a biweekly basis. See Rodgers et al. (1987) for the location of stork colonies and study methods. For comparison with the 1875–1967 data on breeding chronology in central Florida, I approximated the "fresh" collected condition of an egg set by subtracting the average 28-day incubation period (Palmer 1962) from the hatch date of clutches during the 1980s.

RESULTS AND DISCUSSION

Breeding chronology.—Egg sets of Wood Storks ($n = 76$) were collected in south Florida during October and December–June, whereas egg sets ($n = 106$) in central Florida were collected from February to May, a significant north–south temporal difference ($\chi^2 = 119.2$, df = 5, $P < 0.001$) in nests with complete clutches (Fig. 2). Within central Florida there was no significant difference ($\chi^2 = 7.2$, df = 3, $P > 0.05$) for the distribution of egg sets by month between the 1800s (1875–1899) and 1900s (1900–1938). However, within south Florida there was a significant difference ($\chi^2 = 9.6$, df = 3, $P < 0.05$). Egg dates from the 1800s were

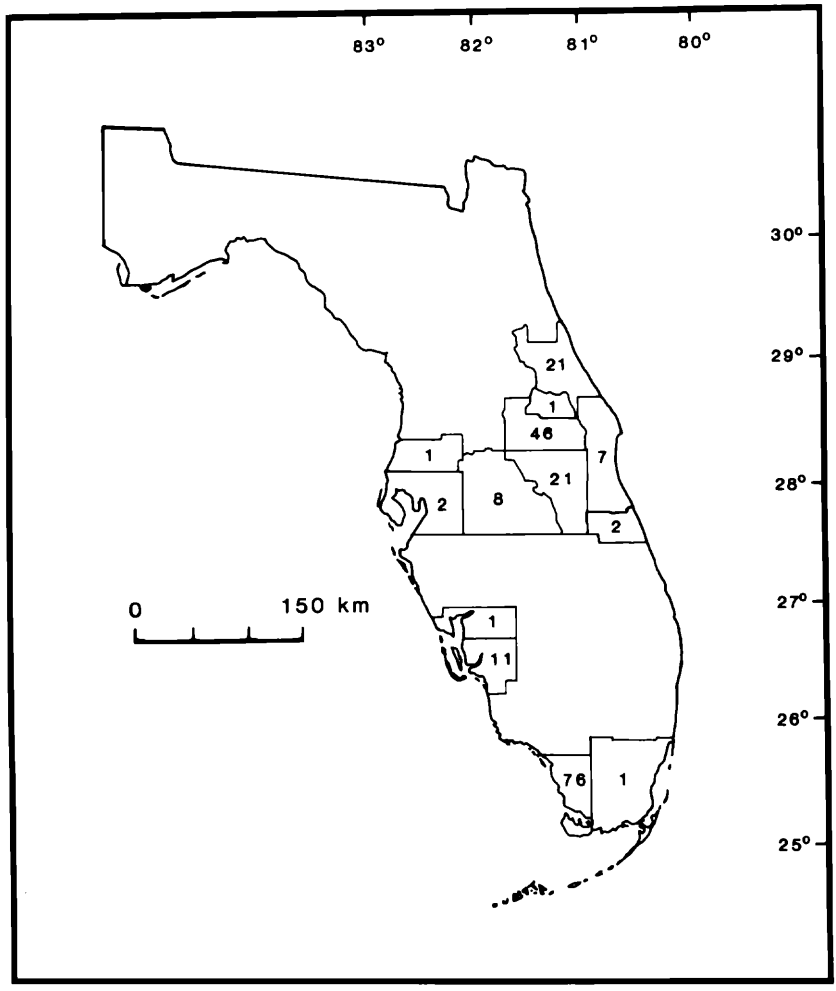

FIGURE 1. Geographic distribution in Florida of egg sets for Wood Storks. The number of egg sets collected within each county are indicated.

mostly from January (82.8%), whereas egg dates from the 1900s were less concentrated in a single month.

The effect of altered hydrocycles in south Florida has been correlated with changes in breeding cycles and decreases in the Wood Stork population in south Florida (Kushlan 1986, Ogden et al. 1987). Kushlan (1986:160) stated that storks historically nested in the southern Everglades from October to December, but after 1962 the start of nesting shifted to December through March (also see Kahl 1964:102). Egg sets from south Florida (including colonies in the Everglades National Park) only par-

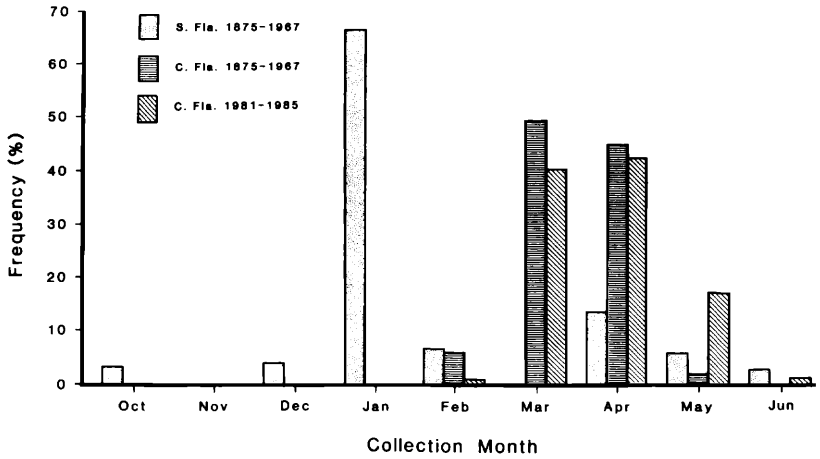

FIGURE 2. Proportion of egg sets collected by month from 1875–1967 and during nest monitoring studies from 1981–1985 for Wood Storks breeding in south and central Florida.

tially support this statement. Egg sets were collected in October and December–June during 1883 to 1937. The egg set dates from central Florida collected from 1875 to 1937 generally were similar or slightly earlier than my data collected during the 1980s in stork colonies located in the same central Florida counties (Fig. 2).

Clutch size.—The mean (±SD) clutch size for all Florida egg sets of Wood Storks was 3.28 ± 0.74 (range = 1–5, mode = 3, n = 199). The only significant difference detected among the time periods was for 1885–1894, when the modal clutch size was four eggs (Tukey's studentized range test, $P < 0.05$: Table 1). However, S. B. Ladd may have biased the clutch size data upward by collecting only 4-egg clutches (n = 21) at a Cape Sable, Monroe County colony on 5 and 9 Jan. 1892.

Oologists often put a premium on collecting larger clutch sizes in colonial waterbirds laying a variable number of eggs (McNair 1987:374, pers. comm.; L. F. Kiff, pers. comm.), thus potentially biasing the calculated mean clutch size upward. I believe that four-egg clutches of Wood Storks are slightly overrepresented and may be an artifact of collector bias. For example, J. C. Howell's (1941) comment (based on his 1933 visit to a Monroe County colony) "Exceptionally large clutches were the rule this season, for of the two hundred nests examined the majority contained four eggs and five nests held five eggs each" suggests a 3-egg clutch was the usual modal size during most years. Distribution of the 20th century egg sets is more normally distributed about the modal size of 3-eggs (68.9%) than the 19th century distribution of egg sets, whereas, the distribution of the 1800s clutches is unusually skewed toward four eggs (55.2%), though 5-egg sets are rare from 1875 to 1938 (4.4%), as

TABLE 1. Clutch data from egg set slips for Wood Storks grouped by time periods from 1875–1967.

Years	Number	Mode	Range	$\bar{x} \pm SD$
1875–1884	11	3	2–4	2.81 ± 0.60
1885–1894	27	4	2–5	3.96 ± 0.72
1895–1904	46	3	1–5	3.30 ± 0.78
1905–1914	27	3	2–4	3.07 ± 0.47
1915–1924	16	3	1–3	2.75 ± 0.58
1925–1938	58	3	2–5	3.31 ± 0.76
1967	11	3	3–4	3.18 ± 0.40

well as, during the 1980s (0.4%). Thus, I believe the modal clutch size for Wood Storks in Florida probably was three eggs during most years from both the late 1800s and early 1900s.

Though Ogden and Patty (1981:99) suggested that the frequency of 4-egg clutches was higher in the 1920s and 1930s compared to the 1970s based on egg set data from museum collections, early Audubon wardens, and their own observations, my data suggest otherwise. The calculated mean (±SD) clutch size in this study for the early 1900s (3.14 ± 0.67) is similar to my data for the 1980s (3.07 ± 0.55, $n = 3012$) in north and central Florida. A plot of the clutch sizes versus date of collection also failed to detect a historic trend during 1875–1967 ($r^2 = 0.007$, slope = −0.002) or 1875–1980s ($r^2 = 0.01$, slope = −0.01). Earlier, on an egg slip for a 4-egg set collected 15 Feb. 1930, J. C. Howell (1941) stated "Four is a large set for this species, altho [*sic*] I have taken one set of five." Thus, the clutch size of Wood Storks has not declined and cannot account for the population decrease in Florida. The effects of loss of foraging habitat, alteration of hydrocycles and rainfall on nestling survival are more probable parameters affecting stork population trends in Florida.

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bridge, Massachusetts; Illinois State Museum, Springfield, Illinois; James Ford Bell Museum of Natural History, University of Minnesota, Minneapolis, Minnesota; Museum of Natural History, University of Kansas, Lawrence, Kansas; Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana; Museum of Zoology, University of Massachusetts, Amherst, Massachusetts; University of Miami, Miami, Florida; Museum of Zoology, University of Michigan, Ann Arbor, Michigan; Milwaukee Public Museum, Milwaukee, Wisconsin; Monte L. Bean Museum, University of Utah, Provo, Utah; National Museum of Natural History, Smithsonian Institution, Washington, DC; State Museum, University of Nebraska, Lincoln, Nebraska; University of Nevada, Reno, Nevada; New York State Museum, Albany, New York; Ohio State University Museum of Zoology, Columbus, Ohio; N. D. Hoy, Media, Pennsylvania; Peabody Museum, Yale University, New Haven, Connecticut; William Penn Memorial Museum, Harrisburg, Pennsylvania; Philadelphia Academy of Natural Science, Philadelphia, Pennsylvania; Provincial Museum of Alberta, Edmonton, Alberta; Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington; Putnam Museum, Davenport, Iowa; Reading Public Museum, Reading, Pennsylvania; Rob and Bessie Welder Wildlife Foundation, Sinton, Texas; Royal Ontario Museum, Toronto, Ontario; San Bernandino County Museum, Redlands, California; Santa Barbara Museum of Natural History, Santa Barbara, California; Science Park Museum of Science, Boston, Massachusetts; Stoval Museum of Science and History, University of Oklahoma, Norman, Oklahoma; Strecker Museum, Baylor University, Waco, Texas; Tulsa Zoological Park, Tulsa, Oklahoma; Museum of Vertebrate Zoology, University of California, Berkeley, California; Western Foundation of Vertebrate Zoology, Los Angeles, California; and Zoological Museum, University of Wisconsin, Green Bay, Wisconsin. L. F. Kiff of the Western Foundation of Vertebrate Zoology and D. B. McNair offered helpful suggestions on the interpretation of egg set data on egg data slips. A. S. Wenner, S. T. Schwikert, and J. H. Hintermister assisted with field collection of data during 1981–1985. M. F. Delany, D. B. McNair, L. F. Kiff, K. Manci, and E. H. Burtt, Jr. provided helpful criticisms on earlier drafts of the manuscript. I thank T. L. Steele for typing the manuscript. This contribution is from the Wildlife Research Laboratory, Florida Game and Fresh Water Fish Commission.

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Association of Field Ornithologists–Wilson Ornithological Society Joint Annual Meeting 31 May–3 June 1990 (TENTATIVE SCHEDULE)

31 May Arrival
Council meetings
reception sponsored by Nuttall Club

1 June
0830 Welcome
0900 Symposium: Amateur in Ornithology
- *0900* Opening remarks
- *0910* From the pilgrims to the present: the contributions of amateur ornithologists—Mary Clench
- *0940* Current role of the amateur scientist—Harold Mayfield
- *1010* Coffee break
- *1030* Contributions amateur banders have made and can make—Robert Yunick
- *1100* View from the banding laboratory—John Tautin

0900 Banding at Manomet Bird Observatory
1130 WOS business meeting
1200 Picture, Lunch
1330 Workshop: Towards standardization of field techniques and data management among bird banders—Christopher Rimmer
1330 Contributed paper sessions 1 and 2
1800 Dinner
1930 Poster paper session, reception hosted by Manomet Bird Observatory

2 June
0830 AFO business meeting
0920 Banding at Manomet Bird Observatory
0920 Symposium: North American Avian Zoogeography
- *0920* Opening remarks
- *0930* Origins and development of North American avian zoogeography—Francois Vuillemier
- *1000* Use of BBS, BBC, and WBPS to track zoogeographic change—Chan Robbins
- *1030* Coffee break
- *1045* Current problems and answers in zoogeography—Russell Greenberg
- *1115* Global warming, deforestation and the future of avian zoogeography—Elliot Tramer

1200 Lunch
1315 WOS business meeting
1400 Workshop:
Conservation of coastal wetlands in the western hemisphere—Keith Bildstein
- *1400* Contributed paper sessions 3 and 4
- *1700* Cash Bar (?)
- *1800* Banquet—Speaker: Frank Gill

3 June Field trips

Program chairs:

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