



FIGURE 1. Nest of *Columbigallina minuta*.

*C. minuta* feeds on the ground, it perches freely in bushes and low trees or shrubs, and thus behaves much more like *C. talpacoti* than like *C. passerina*.

In its breeding habits *C. minuta* also resembles *C.*

*talpacoti*, for it nests in low shrubbery. I have found six nests, all built among creepers, well hidden among the thick foliage, at heights of 30–150 cm above the ground. All nests and eggs were found between 25 October and 8 November, during the long dry season. The nests were small, sometimes compact, structures of fine roots and sticks (fig. 1). I never found any feathers in them, unlike those observed by Young (*Ibis* 12th Ser. 4:759, 1928) in Guyana and by Belcher and Smooker (*Ibis* 13th Ser. 6:4, 1936) on Trinidad.

The first nest I found was on 25 October, with the bird sitting tightly on the still empty nest, a common habit among doves. On the afternoon of 28 October, I found another nest, with a bird sitting on one egg; on the following afternoon there were two eggs. On 9 November at 17.00 there were still two eggs, but on the next afternoon one nestling apparently had just hatched, as it was still wet. The second egg did not hatch and proved infertile. Assuming that the eggs were laid on consecutive days and that incubation started with the first egg, I conclude that the incubation period was 12 days. This is shorter than the period of 14 days established from birds in captivity in Europe (Goodwin 1967).

The weight of 11 specimens that I collected in Surinam was: eight males 27–38 g (av. 31 g) and three females 27–34 g (av. 29 g).

Accepted for publication 7 February 1974.

## SCHEDULE OF PRESUPPLEMENTAL MOLT OF WHITE PELICANS WITH NOTES ON THE BILL HORN<sup>1</sup>

F. L. KNOPF

Department of Wildlife Science  
Utah State University  
and  
Utah Cooperative Wildlife Research Unit  
Logan, Utah 84322

During the breeding season, the White Pelican (*Pelecanus erythrorhynchos*) undergoes a presupplemental molt (Traylor, in Palmer 1962). The molt is restricted to the head and neck regions and involves replacement of the white nuptial crest by short, dark gray-black plumes (fig. 1). The bill horn associated with the nuptial plumage is shed contemporaneously.

Many field investigators have observed the presupplemental molt of White Pelicans, and some have speculated about the function of the bill horn (Hall 1925, Behle 1958, Schaller 1964). During recent studies of the species in Utah, I documented the progression of the molt and the time of bill horn shedding. These events were related to concurrent reproductive activities of the pelicans.

### STUDY AREA AND METHODS

I observed White Pelicans between 6 April and 28 July 1973, on Gunnison Island, Great Salt Lake, Utah. In 1973, approximately 5,200 pelicans nested on the island in 18 spatially and temporally separate colonies of 4 to 633 nests each. As is characteristic of the species, reproductive activities were synchronized

within, but not between, colonies (Low et al. 1950, Schaller 1964).

Because White Pelicans readily abandon nesting sites when disturbed, I did not capture or inspect birds for plumage information but made most observations using a 20× spotting scope from points overlooking the colonies.

At three colonies with different reproductive chronologies I surveyed birds for plumage characteristics four times between egg laying and the time the young were a few days old (about a 40-day interval). I obtained additional information periodically through the breeding season from similar plumage surveys of prenesting, courting birds. For each bird I recorded the date, number of days since the first egg appeared in the colony, and presence or absence of a horn, crest plumes, and gray or black feathers on the crown or nape. These data enabled me to determine the frequency of each plumage character in the sampled colony relative to the reproductive stage of the colony.

### RESULTS

In 1973, migrant pelicans were first sighted in northern Utah on 9 March (William Zimmerman, pers. comm.) at the Bear River Migratory Bird Refuge. The first eggs were laid on Gunnison Island about 1 April, and the last nesting colony was established there on 13 June. A few nests were established peripherally to existing colonies after that date.

During early April, all pelicans on Gunnison Island were in the alternate (nuptial) plumage. Each bird possessed the horny protuberance on the maxilla and the prominent crest plumes.

Within colonies selected for intensive observations, the first eggs were laid about 1 April, 11 April, and 20 April, respectively. All birds displayed the al-

<sup>1</sup> Contribution No. 166 of The Welder Wildlife Foundation, Sinton, Texas 78387.



FIGURE 1. Definitive alternate (nuptial) and supplemental plumages of the head region of the White Pelican. Extent and intensity of the darkened crown in the supplemental plumage are highly variable among individuals (Drawn from photographs).

ternate plumage at the time of laying and through the initial stages of incubation (fig. 2). Approximately two weeks after incubation began, a few pelicans in each colony lost the horn and showed signs of graying especially on the lateral, supraorbital region of the head. At hatching (two weeks later) 81–100% of the pelicans in each colony had shed the horn, and some birds had lost all crest plumes. The percentage of pelicans with crest plumes decreased rapidly after the eggs hatched. Thus, for birds nesting during April, presupplemental molt appeared synchronized with the reproductive activities within the nesting colony.

Beginning in early May, an occasional pelican initiated presupplemental molt before breeding. On 16 May four of 45 courting birds surveyed had shed the horn and/or showed initial graying of the crown. On 13 June seven of 16 birds had lost the horn and 15 of those had gray-black crown feathers. Horns of these latter birds were noticeably smaller or inconspicuous. In addition, six of the 16 pelicans had completely darkened crowns and lacked all crest plumes. This increased incidence late in the season

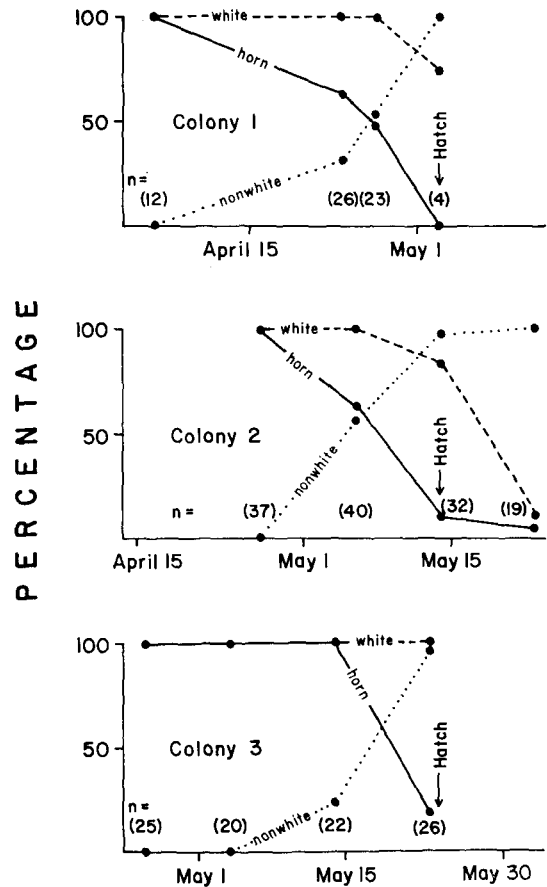


FIGURE 2. Percentage of nesting White Pelicans possessing a horn, white (or pale yellow) crest plumes, and nonwhite (gray-black) crown feathers, relative to hatching date of eggs.

of molting by prebreeding pelicans may reflect the presence of reneaters in the samples.

#### DISCUSSION

*Timing of molt.* Molting places a significant energetic demand on birds, owing to the simultaneous "costs" of generating new tissues and compensating for decreased insulating properties of the plumage (Payne 1972). As a result, molt usually is temporally separated from other major events of the annual cycle such as reproduction and migration (Kendeigh 1949, Payne 1972), although overlap of prebasic (postnuptial) molt and reproduction has been reported for some species (Pitelka 1958, Holmes 1966, Verbeek 1973).

Presupplemental molt in the White Pelican population strongly overlapped late incubation and the nesting stage of reproduction. However, inasmuch as the molt involved only a limited portion of the plumage, this overlap probably did not represent a significant stress to the pelicans. Further, the molt occurred at a time when competing energy demands seemed reduced. Incubation, especially in its later stages, may not represent an energetic demand beyond that of basal metabolic processes (King 1973). In the White Pelican incubation may even be passive since the birds do not develop incubation patches but cover the eggs with their feet. Once the eggs hatch,

energy demands probably increase as the parents commence feeding the young.

Physiologically, onset of presupplemental molt midway through incubation may reflect a shift in the hormonal balance of birds. The action of prolactin is implied since this hormone is responsible for brood patch development and brooding behavior in many birds and acts upon the feather papillae and molt schedules of some species (Riddle 1963). Prolactin inhibits molt in other species, however, and the impact of this and other hormones upon molt schedule is highly variable among species (Payne 1972). For this reason, further studies are necessary to elucidate the relationship between changing hormone levels and presupplemental molt in White Pelicans.

*Functional aspects of molt.* By definition, supplemental plumages are specialized, occurring in addition to the basic and alternate plumages (Humphrey and Parkes 1959). This definition implies functional relevance of plumage characters to the major event in the annual cycle with which the plumage is associated. Among White Pelicans, synchronization of presupplemental molt with specific reproductive activities implies relevance of altered characters to subsequent breeding events.

The functions of the nuptial crest and its replacement, the gray-black crown, remain obscure. I failed to observe any postures or movements by the pelicans that drew specific attention to the crest or crown regions. However, one possible function of the darkened crown was suggested by the timing of its appearance. Replacement of the crest by the dark crown was completed in most birds about the third week after the young hatched. At this time, the young were left alone on the island as both parents went to the feeding grounds simultaneously. Thereafter the adult pelicans returned to the island only to feed the young. Once left alone, young pelicans abandoned the nest site and joined other juveniles in loose social aggregations that moved about the island. Within these aggregations, individuals from one colony mixed freely with chicks from other colonies. Thus, following completion of presupplemental molt, the primary reproductive activity of adult pelicans on the island was to locate and feed the young.

When adults return to feed young, individual recognition between parent and chick appears mutual and dependent upon visual cues (Schaller 1964). At this time variation in the intensity and extent of the darkened crown may assist pelican chicks in recognizing their parents. At Gunnison Island, the adults returned to the vicinity of the colony in which they nested and loitered there until approached by the juvenile. I never observed an adult approach a juvenile and solicit it to feed. This does not imply, however, that an adult does not recognize its own young since returning adults were often approached by, but refused to feed, chicks other than their own.

*The bill horn.* The maxillary horn is unique among the Pelecanidae. Schaller (1964) presented measurements of horns and inferred that the horn may serve some signaling function during the strutting walk display of courting birds.

The horn was present on most birds during courting, nest site selection, and early incubation. Once paired, birds aggressively defended potential nest sites within an establishing colony. Agonistic behavior was intense and involved frequent physical contact. In 37 of 46 encounters the aggressive jabs and snappings of the bill made contact. A subsequent survey indicated that 95 of 100 aggressive jabs were

oriented at the distal portion of the maxilla near the horn. Thus, the horn appeared to function as a "target" structure at which jabs were directed. Without this orientation, jabs could inflict serious injury to the fleshy pouch essential to successful foraging.

Structures with target functions also occur on the turkey, *Meleagris gallopavo*, and the Ring-necked Pheasant, *Phasianus colchicus* (Schleit 1967, Williams, in press). In addition the Great White Pelican, *Pelecanus onocrotalus*, displays a forehead "knob" during mating and incubation (Brown and Urban 1969) that may function similar to the horn of the New World species. The wattles of the pheasant also serve as releasers of aggressive behavior (Williams, in press), a function not observed for the horn of White Pelicans.

Most pelicans shed the bill horn during the fourth week of incubation. As with presupplemental molt, this rather precise timing may reflect a shift in the hormonal balance of the birds. Functionally, the horn may not be necessary once territorial conflicts are resolved.

These observations were conducted incidental to a study of spatial and temporal aspects of colonial nesting in White Pelicans. The larger study is currently funded by the Bureau of Sport Fisheries and Wildlife and a predoctoral scholarship from the Welder Wildlife Foundation. I am grateful to Keith L. Dixon for his comments during the initial phase of these observations and his review of an early draft of the manuscript. The manuscript also was reviewed at various stages by William H. Behle, Clarence Cottam, Jessop B. Low, and H. Warrington Williams. Debbie Ruggiero prepared the illustration for Figure 1.

I thank the Utah Division of Wildlife Resources for access privileges to Gunnison Island.

#### LITERATURE CITED

- BEHLE, W. H. 1958. The bird life of Great Salt Lake. Univ. of Utah Press, Salt Lake City.
- BROWN, L. H., AND E. K. URBAN. 1969. The breeding biology of the Great White Pelican *Pelecanus onocrotalus roseus* at Lake Shala, Ethiopia. *Ibis* 111:199-237.
- HALL, E. R. 1925. Pelicans versus fishes in Pyramid Lake. *Condor* 27:147-160.
- HOLMES, R. T. 1966. Molt cycle of the Red-backed Sandpiper (*Calidris alpina*) in western North America. *Auk* 83:517-533.
- HUMPHREY, P. S., AND K. C. PARKES. 1959. An approach to the study of molts and plumages. *Auk* 76:1-31.
- KENDEIGH, S. C. 1949. Effect of temperature and season on the energy resources of the English Sparrow. *Auk* 66:113-127.
- KING, J. R. 1973. Energetics of reproduction in birds, p. 78-107. In D. S. Farner [ed.] *Breeding biology of birds*. Natl. Acad. Sci., Wash., D.C.
- LOW, J. B., L. KAY, AND D. I. RASMUSSEN. 1950. Recent observations on the White Pelican on Gunnison Island, Great Salt Lake, Utah. *Auk* 67:345-356.
- PALMER, R. S. 1962. *Handbook of North American birds*, vol. 1. Yale Univ. Press, New Haven, Conn.
- PAYNE, R. B. 1972. Mechanisms and control of molt, p. 104-157. In D. S. Farner and J. R. King [eds.] *Avian biology*, vol. 2. Academic Press, New York.
- PITELKA, F. A. 1958. Timing of molt in Steller

- Jays of the Queen Charlotte Islands, British Columbia. *Condor* 60:38-49.
- RIDDLE, O. 1963. Prolactin in vertebrates. Function and organization. *J. Natl. Cancer Inst.* 31: 1039-1110.
- SCHALLER, G. B. 1964. Breeding behavior of the White Pelican at Yellowstone Lake, Wyoming. *Condor* 66:3-23.
- SCHLEIDT, W. 1967. Turkey signals, p. 130-133. *In* D. Burkhardt, W. Schleidt, and H. Altner [eds.] Signals in the animal world. McGraw-Hill, New York.
- VERBEEK, N. A. M. 1973. Pterylosis and timing of molt of the Water Pipit. *Condor* 75:287-292.
- WILLIAMS, H. W. In press. Behavior and social organization, Chap. 3. *In* R. F. Labisky [ed.] Pheasant symposium. Proc. Midwest Fish and Wildl. Conf. (St. Louis) 2-5 Dec. 1973.

Accepted for publication 6 June 1974.

## PREDATOR-PREY INTERACTIONS OF ADULT AND PREFLEDGLING BANK SWALLOWS AND AMERICAN KESTRELS

DONALD WINDSOR<sup>1</sup>

AND

STEPHEN T. EMLEN

Division of Biological Sciences  
Section of Neurobiology and Behavior  
Cornell University  
Ithaca, New York 14850

Predation is believed to be an important selective pressure shaping the breeding biology of many avian species (Crook 1965, Tinbergen 1965, Lack 1968, Ricklefs 1969). For hole nesters, losses of eggs and nestlings to predators are greatly reduced and various changes in breeding behavior have been considered as resulting from the easing of this selective force (von Haartman 1957).

Many species of swallows increase the security of their nest locations by either building protective mud walls around the nest chamber or by digging nests deep into vertical cliffs of dirt or sand. Bank Swallows (*Riparia riparia*) use the second method. Studies show it to be quite effective; repeated observations on over 500 nests indicated that losses of eggs or nestlings to non-aerial predators amounted to less than 13% of the total eggs laid (Emlen and Demong, unpubl. data).

Young Bank Swallows are also subject to aerial predation. Freer (1973) recently documented that American Kestrels (*Falco sparverius*) will attack swallows both in flight and at their burrows. Observations that we have made at a number of colonies 50 miles N of Freer's colony support her contention that kestrels are frequent aerial predators on these birds. We describe below the hunting strategies of the kestrels and the "anti-predator" behavior of Bank Swallows, and discuss their possible adaptive significance.

We made observations at 16 colonies of Bank Swallows in sand and gravel pits within a 40 mile radius of Ithaca, New York, during May, June, and July 1969 through 1972. In the latter two seasons, observers were in the field almost continuously. Kestrels were seen 67 times; in 27 instances, the bird flew directly over the colonies without stopping, while on 40 occasions the kestrels perched on or near the edge of a colony. In these latter cases, kestrels flew to the burrow opening of swallow nests in pur-

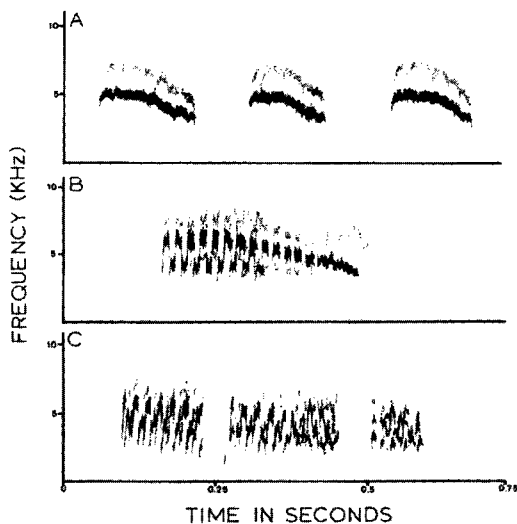


FIGURE 1. Spectrograms of Bank Swallow vocalizations. A. High intensity alarm call. B. Low intensity alarm call. C. "Social" (nonalarm) call notes.

suit of young on 25 instances and succeeded in capturing a total of 9 nestling swallows. Successful predation of this sort was observed at three different colonies. Additionally, one swallow (age unknown) was captured on the wing and a nestling was taken after it had fallen from its burrow. On several occasions, swallows in mist nets were also attacked.

Most predation attempts were seen in the middle and last weeks of June, when many colonies had broods near to or actually fledging. In fact, kestrels first appeared at colonies when the majority of the swallow young were approximately 14-16 days old. At the age of 14 days, swallows shift their diurnal position from the nest chamber—located at the rear of the 3-ft burrow—to a resting point at the burrow entrance. One of the presumed advantages of this shift is in decreasing the time needed for transferring food from adults to young. One of the disadvantages is an increased vulnerability to aerial predators.

We never observed more than two kestrels working a colony. In three instances where the kestrels were followed, their nests with young were found close to the swallow colony. We believe that the kestrels were opportunistically taking advantage of a food resource located within their normal feeding territories. We found no evidence that the kestrels increased their foraging range to concentrate at *Riparia* colonies, regardless of the size of the colony.

<sup>1</sup> Present address: Smithsonian Tropical Research Institute, P. O. Box 2072, Balboa, Canal Zone.