

THE CONDOR

VOLUME 66

JANUARY-FEBRUARY, 1964

NUMBER 1

BREEDING BEHAVIOR OF THE WHITE PELICAN AT YELLOWSTONE LAKE, WYOMING

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The White Pelican (*Pelecanus erythrorhynchos*) breeds in widely scattered colonies in western North America from the Great Slave Lake in Canada (Bailey, 1935) southward to the Salton Sea in California (Grinnell, 1908) and the coast of Texas (Carroll, 1930). No intensive studies of the breeding behavior of this large and uncommon bird have been made. The scanty literature on the subject is summarized by Bent (1922) and Palmer (1962). The observations on which this report is based were made between June 3 and August 22, 1962, on a small rookery of pelicans in Yellowstone Lake, Yellowstone National Park, Wyoming.

ACKNOWLEDGMENTS

I am greatly indebted to the Jackson Hole Biological Research Station of the University of Wyoming for providing living facilities and to Dr. L. F. Clarke and other personnel of the Station for help in various ways. The New York Zoological Society granted financial assistance. I am grateful to Superintendent L. Garrison and Chief Naturalist R. McIntyre of Yellowstone National Park for permission to work in the park and for logistic support throughout the study. The Yellowstone Museum Association was generous in its loan of equipment. Dr. K. Diem, my wife K. Schaller, Miss M. Meagher, and Messrs. J. Reuter, D. Cross, A. Haines, L. Thompson, R. Hite, R. Ellis, G. Davis, and R. Wood helped in various ways. Drs. J. T. Emlen, K. Diem, K. R. L. Hall and G. van Tets read the manuscript critically. This paper was prepared while the author was a Fellow at the Center for Advanced Study in the Behavioral Sciences, Stanford, California, in 1962-1963.

DESCRIPTION OF THE STUDY AREA

Yellowstone National Park in northwestern Wyoming comprises a vast mountainous region covered with extensive forests of lodgepole pine (*Pinus contorta*). Of the numerous lakes found in the park and surrounding areas, Yellowstone Lake (44° 30' N, 110° 25' W) is the largest, covering some 139 square miles. Two arms of the lake, the South and Southeast arms, jut southward into the foothills of the Absaroka Mountains. In the southern tip of the Southeast Arm lie two small islands, known collectively as the Molly Islands (figs. 1, 2), which constitute the only sites in Wyoming where the White Pelican is known to have bred successfully in the present century.

The Molly Islands lie about 600 feet apart and are roughly one-quarter mile from the nearest mainland. Sandy Island, the most westerly and larger of the two, is flat and rises barely five feet above the water line. Its primary vegetation consists of willows (*Salix scouleriana*) less than eight feet high on the water's edge, and patches of *Urtica gracilis*, *Polemonium pulcherrimum*, and *Potentilla* sp. in the center of the island. Rocky Island has a central hump, about nine feet high, which is heavily covered with boulders of breccia. Vegetation is almost absent except for a stand of willows on the western sandy tip of the island.

The nesting pelicans were divided into eight distinct aggregations or colonies, six on Sandy Island and two on Rocky Island (fig. 1). This distribution is not consistent, however, for it was noted by Yeagher (1929) in 1928 and Diem and Condon (in press) in 1949 that the majority of the pelicans nested on Rocky Island. The main breeding associates of the pelican in 1962 were the California Gull (*Larus californicus*) with about 600 nests on Rocky Island, the Double-crested Cormorant (*Phalacrocorax auritus*) with eight nests, and the Caspian Tern (*Hydroprogne caspia*) with 17 nests (see fig. 1).

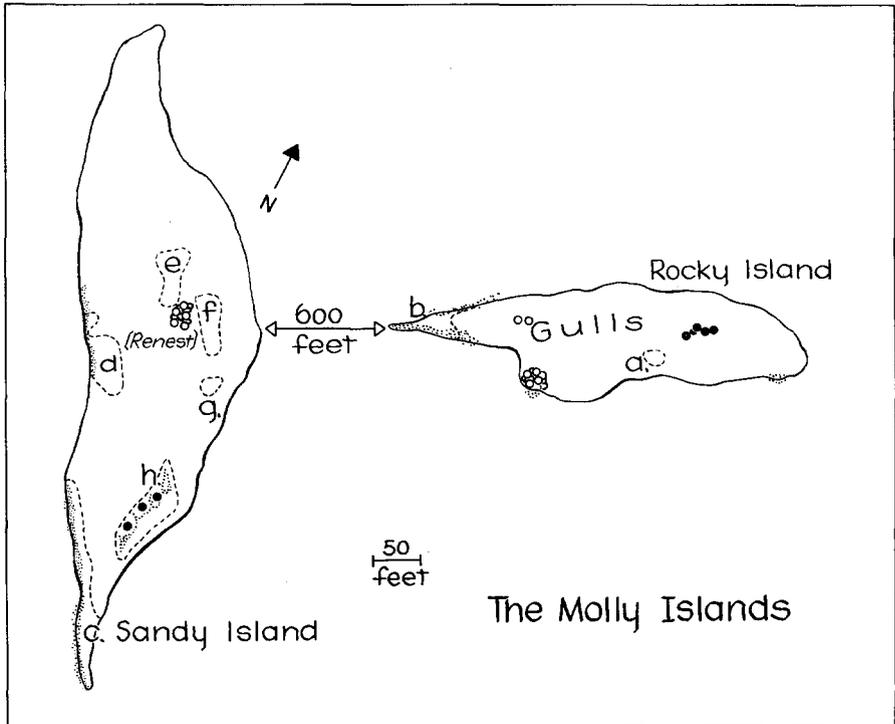


Fig. 1. Approximate configuration of the Molly Islands. The lettered areas enclosed with a dashed line represent eight pelican colonies; circles indicate the locations of tern nests during both nesting attempts; dots signify cormorant nests; and stippled patches are willow thickets.

The breeding birds are subjected to a rugged mountain climate. Yellowstone Lake, at an altitude of 7733 feet, remains frozen from mid-December to mid-May or later, and snow may fall during any month of the year. In 1962 the lowest temperature between May and September was 13° F., the highest 78° F., and freezing temperatures occurred in every month. Precipitation is not heavy, the yearly total being generally 15 to 25 inches.

HISTORY OF THE PELICAN ROOKERY

The first pelican taken in Yellowstone Park is that reported by Davis (1884) who, as a member of the Stuart party in 1863, shot a pelican at the mouth of what is now Pelican Creek. In 1869, Cook (1870) noted "thousands of wild ducks, geese, pelicans, and swans" on Yellowstone Lake. The breeding site was discovered on July 10, 1890,

by Linton (1891:354), who observed "at least five hundred pelicans, young and old, on the island." He collected four pelicans and discovered that this bird is the adult host of the tapeworm *Dibothrium cordiceps* which in its larval stage infests the cutthroat trout (*Salmo clarkii*). Further parasitological work was done by M. Hall, J. Stewart and J. Scott (unpublished manuscripts in Yellowstone National Park library), who collected 27 specimens between 1920 and 1933. Behavioral observations on the pelicans have been of a sporadic and cursory nature. Between 1898 and 1922, Skinner (1917, 1925) took some general notes. Seventy-five young were banded by Ward (1924) in



Fig. 2. The southern tip of the Southeast Arm, Yellowstone Lake, Wyoming. The Yellowstone River delta lies in the distance. In the center are the Molly Islands, Rocky Island on the left, Sandy Island on the right, June 9, 1962.

1922, and between 1932 and 1959 some 1853 additional young were banded by various investigators (Diem and Condon, in press). Counts of eggs and young by Skinner (1917), Yeagher (1929), J. Murphy (1960), and others indicate that the size of the pelican population has remained relatively stable over the past 70 years.

Human disturbance on the islands has in the past been fairly heavy. In 1926 all eggs were destroyed, and in 1927 and 1928 about 214 young were killed (H. Lick in letter to G. Miller, January 22, 1932), because the pelicans were blamed for the supposed decline in the number of cutthroat trout, which, together with sucker (*Catostomus*) and chub (*Gila*), is a major food fish of the birds in the area. Although unauthorized visits to the islands were prohibited in 1932 (Thompson, 1932), motorboat traffic and landings by tourists increased to such an extent after 1950 that the breeding birds were greatly disturbed (J. Murphy, 1960). In 1960 much of the Southeast Arm was closed to motorized craft, a ruling which has enabled the birds to nest without continuous interference for the past three seasons.

METHODS

Camp was established and occupied for 58 days at a point of land one-quarter mile from the Molly Islands. I observed the behavior of the birds for a total of 367 hours, usually with binoculars from a canoe anchored 50 to 150 feet from the colony. This technique permitted detailed observation without noticeably disturbing the birds. Four of the colonies (A, B, C, D), easily visible on the sloping banks of the islands, were chosen for detailed study, and in each of these colonies about a dozen nests were selected for intensive observations. In August, when the large young fled into the water even at the distant approach of a boat, I watched the birds from the mainland with a spotting scope.

The park service wisely forbids all landings on the islands until the latter part of the breeding season. Hence, detailed censuses of all colonies, especially those in the center of Sandy Island were not feasible. However, the contents of nests near the water's edge could readily be tallied from the canoe. In late July and August counts of all young were made by landing on the islands (table 1).

TABLE 1

CENSUSES OF WHITE PELICAN EGGS AND YOUNG ON THE MOLLY ISLANDS IN 1962*

Census date Colony	June 6-7		June 22		July 4		July 20	Aug. 11	Aug. 21
	Number nests	Number eggs	Number nests	Number eggs	Number young	Number eggs	Number young	Number young	Number young
A	8	....	0	0	0	0	0	0	0
B	28	45	1	0	1	0	0	0	0
C	66	115	37	8	44	0	20	} 143	} 117
D	66	109	44	8	63	2	45		
E	27	....	28	....	....	....	19±		
F	38	....	25	....	....	....	24±		
G	13	....	10	7	11	2	10		
H	52	89	36	14	42	4	44	} 117	

* I counted 298 incubating birds on June 6-7. If each nest contained an average of 1.7 eggs (see table 2), the total number of eggs present would have been about 507. Only 117 young survived on August 21. Thus the mortality (including infertile eggs) during this 2½-month period was 77 per cent, due mostly to destruction of the nests by high water, gull predation, abandonment of some nests, and starvation of small young when in the same nest with a larger sibling.

Eight downy young were marked from a distance by spraying them with ink. During the two weeks that the color remained discernible, I traced the interactions between these young and certain adults.

Eleven days were spent in observing the behavior of pelicans at their feeding and loafing areas away from the rookery. This led to the discovery of an abandoned breeding site at Heart Lake, which lies 12 miles west of the Molly Islands. At least 175 nests had been built and some 30 eggs laid along a beach on the western shore of the lake, but the colony had apparently been destroyed by a mammalian predator. Fireguard R. Hite saw no pelicans on Heart Lake when he arrived on June 16, suggesting that the site was used sometime in May or early June. It could not be determined whether these birds renested on the Molly Islands or whether they represented another flock.

DATE OF ARRIVAL AT THE BREEDING GROUNDS

The pelicans are reported to arrive in Yellowstone Park during late April or May when most of the lakes are still frozen and snow covers the ground. Twelve first sightings in the park between 1914 and 1961 give a mean date of May 11 with a variation

from April 28 to May 23 (Ward, 1924; Skinner, 1925; Anonymous, 1930; Wood, pers. comm.). In 1962, the pelicans apparently arrived in late April or in early May.

It appears that only adult birds return to and remain at the breeding grounds. On May 28, I saw one bird near Jackson Lake, 35 miles south of the Molly Islands, which lacked the ornamental plumes on the crown and retained the somewhat dusky hue of the juvenal plumage; on June 5, I counted a flock of ten such birds on Sandy Island. However, no nonbreeders remained near the rookery after June 5.

COURTSHIP DISPLAYS

A group of adults, varying in size from four to 20 and apparently representing a courting party, milled around Sandy Island on June 10, 11, and 12. These birds displayed four prominent behavior patterns.

(1) *The head-up* (fig. 3A, B, C).—The bird stood very erect with neck stretched skyward and with bill usually raised above the horizontal. The gular sac or pouch was extended or inflated, displaying its orange color vividly, especially when the pelican slowly turned its head from side to side. Frequently four or five birds in the group responded to this display by assuming similar attitudes while facing each other.

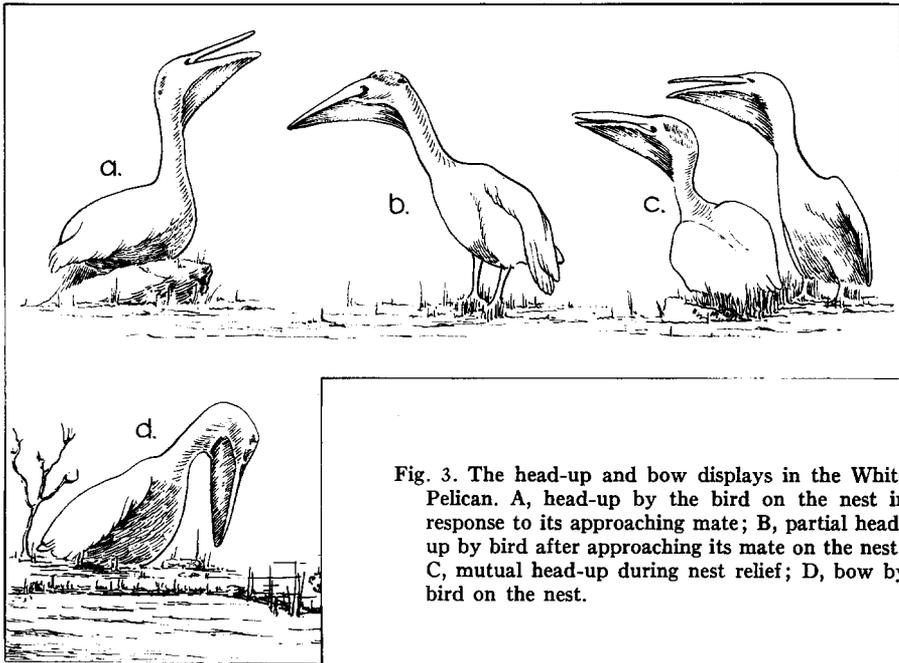


Fig. 3. The head-up and bow displays in the White Pelican. A, head-up by the bird on the nest in response to its approaching mate; B, partial head-up by bird after approaching its mate on the nest; C, mutual head-up during nest relief; D, bow by bird on the nest.

The head-up is also given during nest reliefs, before and after copulation, and when two birds meet each other—the gesture apparently serves as a greeting. Meischner (1959) described a similar posture in pelicans (*P. onocrotalus*, *P. rufescens*, *P. crispus*) in the Leipzig zoo but interpreted it as a threat. The head-up somewhat resembles the “stretch” given by the Brandt Cormorant (*Phalacrocorax penicillatus*) as a mutual display during pair formation (Williams, 1942).

(2) *The bow* (fig. 3D).—A pelican in the courting party occasionally arched its neck and pointed its bill toward its feet. The pouch was usually extended as the bird

slowly waved its head from side to side. The display is also given in situations similar to those of the head-up and serves perhaps as an appeasement gesture.

(3) *The courtship flight*.—From four to 14 birds took to the air intermittently and in a compact group circled the rookery. They resumed the head-up and bow displays after landing.



Fig. 4. Two adult pelicans on their nests. Note the horn on the bill of each bird and the closeness of the nests. The young is about 12 days old, June 22, 1962.

(4) *The strutting walk*.—Two birds sometimes broke away from the courting party, one following the other with rapid, rather strutting, steps. The males are somewhat larger than the females (Palmer, 1962), and in all instances when I could discern a difference in size, the larger bird followed the smaller one. The body of both birds was held erect, the yellow-colored chest projected forward, and the neck arched backward with the bill resting on it in such a way that the horn was prominent. The narrow plumes on the crown stood erect, a very conspicuous feature when the bird was seen from the front. Some birds assumed to be males occasionally strutted alone. A similar posture was described by Bent (1922) in the Brown Pelican, *P. occidentalis*.

The function of the horn.—The deciduous, convex, keel-like plate or horn on the distal half of the upper mandible is found in both sexes (fig. 4). Thirty-three horns, collected at random, averaged 50.8 mm. in length at the base (range, 17 to 85 mm.; S.D., 12.84), 41.1 mm. in height (range, 26 to 57 mm.; S.D., 8.12), and 10.0 gm. in weight (range, 2.9 to 24.3 gm.; S.D., 4.99). Although Chapman (1908) and others have noted that the horn appears prior to nesting and falls off after the eggs have been laid, no plausible use has been suggested for it. Lawrence (*in* Baird, 1858) thought that it had offensive and defensive functions, but I was unable to confirm this.

As noted earlier, the horn is prominent during the strutting walk, a display assumed by both males and females. This suggests that the function of the horn is to make the

courting birds more conspicuous. In this respect, the horn is analogous to the striking feathers displayed by some other bird species. That the horn may function in courtship finds some corroboration in the time at which it is shed. About 70 per cent of the horns of both sexes fell off during June, and no courting was seen after June 22.

Date	Total number birds checked	Per cent of birds with horns
May 29	71	86.0
June 18	72	38.9
July 3	86	13.9
August 8	104	0

COPULATORY BEHAVIOR

The invitation.—On eight occasions, birds in the courting party were seen to lower their bodies, open their quivering wings slightly, hunching them up, and arch their necks forward with the bill pointing to the ground, pouch not extended. Twice a male started to climb onto the back of the crouched bird; once a pelican took the neck of the displaying one between its mandibles; and five times the posture elicited no response.

Copulation.—The female was typically squatting or lying during copulation and the male stood on her back with beating wings, holding her neck between his mandibles. Both birds emitted loud, harsh grunts. On one occasion the male grasped the bill of the female while balancing on her shoulders. However, this copulation was not successful, and the birds parted after a mutual head-up display. Two of the six attempts at copulation observed apparently reached completion.

NESTS AND NEST BUILDING

Selection of the nest site.—On June 5, I observed behavior which suggested a nest site was being selected. A female, judging by her size, landed near colony A. She walked slowly to within three feet of an incubating bird, bowed once briefly, and lay down. She remained there for at least four hours, occasionally picking up sand with her bill and placing it close to her body. The following morning she was gone.

Nest locations and materials.—Published records indicate that the White Pelican nests only on the ground, usually on islands in lakes. In this the species differs from *P. onocrotalus* and *P. rufescens* in Africa (Mackworth-Praed and Grant, 1952) and *P. occidentalis* in America (Chapman, 1908), which are known to nest both on the ground and in trees.

In constructing its nest, the White Pelican has been known to use shells (Carroll, 1930), sticks and weeds (Pearson, 1921), fallen reeds (Chapman, 1908), and sand, dirt, and stones (Hall, 1925; Behle, 1958). On the Molly Islands, birds nesting in sandy areas built their nests of sand and pebbles, and those occupying the rather hard-packed soil on top of Sandy Island built no nests, making merely shallow scrapes. At Heart Lake, many nests were again built of sand, but birds which nested beneath trees used sticks and pine needles as well.

Pelicans tend to construct a nest mound in sandy areas. Such mounds may reach a height of 8 to 11 inches (Grinnell, 1908; Hall, 1925) and have a diameter of 2½ feet at the base. The diameter at the top of 12 mounds on Sandy Island measured 13 to 22 (mean 16.5) inches at the end of the nesting season. The central depression was relatively shallow, two inches or less deep.

Behavior during nest construction.—In building a mound, the bird characteristically sits on the nest site and with its bill hauls in materials from all directions. No

pelican was seen to carry sticks or other matter to the nest, nor was the sand scraped onto the mound with the feet as suggested by Behle (1958). A bird of either sex merely extended its neck, picked up a twig or some sand with the tip or side of the bill, and deposited the material in front of its chest or along the side of its body.

In colony A, a bird had laid an egg on the sand without constructing a mound. When observed on June 5 and 6, this bird actively hauled in nest materials, suggesting that egg laying occasionally precedes mound construction. Adults added materials to the mound as long as the young remained in the nest.

Yellowstone Lake rose 2.3 feet during June, and at least 80 nests were washed out by the unusually high water. No bird attempted to build its nest mound higher or otherwise stem the flow of water into the nest cup.

Faithfulness to nest site after destruction of nest contents.—Observations of nine nests in which the eggs or young had been destroyed showed that the adults tend to remain at the site for at least one day. For example, the two eggs in one nest were washed out on June 14. The following morning the adults stood near, then upon the submerged nest. Nest relief occurred at this submerged nest, and the relieving bird remained standing on the nest for one hour. An adult pelican stayed with the nest on June 16 but was gone the next day. In another instance, a ten-day-old young pelican drowned in its nest on June 19. A gull fed on it on June 20 without eliciting a response from the parent standing three feet away. Nest reliefs occurred on June 20 and 21. Either parent was on the nest for a few minutes daily until June 23.

After abandoning the nest, adults leave the rookery and seldom, if ever, return for the rest of the season. Consequently, the number of adults on the islands decreases steadily during the summer. It is probable that most of these unoccupied birds left the area. I noted no instances of reneesting, although it may have occurred before my arrival.

EGGS AND EGG LAYING

Time of egg laying.—Since the first young hatched on June 8, incubation probably began on about May 9 (see incubation period), and the first eggs may have been laid by May 7 or earlier, a month before my arrival. There is, however, some yearly variation in the date on which eggs are laid. On June 26, 1932, for example, G. Baggley (MS, in Yellowstone National Park library) found that three-fourths of the young had hatched. The following year, on June 25, only eggs were present, suggesting that incubation did not begin until late May. Skinner (1925) stated that egg laying usually commenced on May 25.

Number of eggs laid.—The average clutch size is two (Behle, 1958; Palmer, 1962), but as many as six eggs have been recorded in one nest (Bent, 1922). I found that 66.5 per cent of the nests checked contained two eggs, 32.5 per cent contained one egg, and one per cent contained three and four eggs (table 2). These observations are similar to

TABLE 2
NUMBER OF EGGS PER NEST IN THE FOUR CENSUSED COLONIES ON THE MOLLY ISLANDS, JUNE 6-7

Colony	Total nests	Number of nests with:				Total eggs	Average number eggs per nest
		1 egg	2 eggs	3 eggs	4 eggs		
B	28	11	17	0	0	45	1.60
C	66	17	49	0	0	115	1.74
D	66	23	43	0	0	109	1.65
H	52	18	32	1	1	89	1.71
Totals	212	69	141	1	1	358	1.67
Percentages		32.5	66.5	0.5	0.5	100	

those of Ward (1924) and G. Miller (MS, in Yellowstone National Park library). However, my census was made when most birds had been incubating for at least two weeks, thus the figures give no indication of the total number of eggs laid.

Incubation period.—The two eggs of known laying date were destroyed before hatching. Eggs placed under a domestic hen hatched in 29 days (Bendire, *in* Bent, 1922:286). Bent (1922) stated that incubation lasts about one month.

DIFFERENCES IN BREEDING SCHEDULES BETWEEN COLONIES OF THE SAME ROOKERY

Chapman (1908), Hall (1925), Behle (1958), and others have noted that the breeding schedule of pelicans at a given location shows considerable variation, with eggs and large young being present at the same time. Furthermore, each colony usually has eggs or young of approximately the same age. My data from the Molly Islands confirm these observations. Table 3 shows that the various colonies are quite well synchronized in

TABLE 3
NEST CENSUS ON THE MOLLY ISLANDS, JUNE 22, SHOWING DISPARITY IN THE BREEDING SCHEDULE BETWEEN COLONIES OF WHITE PELICANS

Colony	Total nests	Total eggs	Total number of young		
			0 to 5 days	6 to 10 days	11+ days
A	0	0	0	0	0
B	1	1	0	1	0
C	37	8	10	16	18
D	44	8	50	13	0
E	28	many	few	0	0
F	25	all	0	0	0
G	10	7	11	0	0
H	36	14	8	14	20

their breeding schedule. Pelicans in colonies C and H began to incubate over a week before those of colonies B, D, E, and G, and over two weeks before pelicans in colonies F and probably A.

Ward (1924) and Behle (1958) suggested that this disparity between colonies may occur because different groups of birds arrive at their breeding grounds at different times. It is also possible that the birds arrive at approximately the same time, but that the behavior of those that are physiologically ready to breed is synchronized by the stimulating effect of group courtship and egg laying as suggested by Darling (1938). Synchronized birds crowd together, creating colonies.

BEHAVIOR OF INCUBATING AND BROODING ADULTS

This section describes the behavior patterns of adults which are incubating eggs or are brooding young less than two weeks old. To obtain some idea of the frequency with which certain patterns were performed, I counted them over a definite time span in a sample of 9 to 14 birds. I did not discern differences in behavior between males and females.

THE DAILY ACTIVITY CYCLE

Birds on the nest are active only during the daylight hours in contrast to those away from the rookery that commonly fish during the period of darkness. In the course of one night spent in a canoe within 100 feet of Sandy Island, and on three moonlight nights when it was bright enough to see the birds from the mainland, I noted no activity after 9:00 p.m. and before 3:00 a.m. A few birds not occupied on nests, sometimes circled

the islands with the first glimmer of dawn, and some left the rookery within an hour after daylight. However, the incubating and brooding pelicans remained inactive on the nest, each bird averaging only about four periods of activity (stretching or adding sand to the nest, for example) per hour before 7:00 a.m. Between 7:00 and 9:00 a.m., the birds shifted their positions on the nest frequently and preening was prolonged. Many pelicans rested for about one hour after this active period, only to resume preening and other behavior. Toward noon additional birds arrived singly and in small flocks from the feeding grounds and relieved their mates on the nest. Of 4326 arriving birds counted, mean flock size was 4.8 birds per flock; the largest flock consisted of 90 birds. Between 1:00 and 3:00 p.m. there was a general rest period, followed by a spell of somewhat greater activity until 6:00 p.m. After 6:00 p.m. and before dusk, preening was prominent, but the duration of the activity was short compared to that in the morning. Most birds were asleep by 8:00 p.m.

DESCRIPTION OF ACTIVITIES

Resting and sleeping.—A bird on the nest averaged about 70 periods of activity between dawn and dusk, a figure which includes all the patterns listed below, as well as the feeding of young, and a few miscellaneous activities. Each pelican was active for perhaps 1 to 1½ hours per day, spending the rest of the time resting quietly or sleeping. When resting the neck was folded back with the bill lying on the chest and lower part of the neck. The webbed feet frequently covered the eggs. The birds faced in any direction from the nest even when the wind blew strongly and ruffled their feathers. Skinner (1917) and Behle (1958) stated that adults are silent. I found that resting pelicans commonly emitted a series of murmuring grunts. A bird settling to sleep placed its bill along the back and hunched its wings slightly.

Scratching.—A pelican on the nest scratched on the average of 1.5 times per day. To scratch the neck or head, the bird shifted its weight onto one leg, partly opened one wing, extended the neck, and brought the other leg directly forward. A similar posture was employed to scratch the pouch except that the neck was retracted and the bill pointed toward the ground.

Shaking.—A pelican shook on the average of 1.1 times per day, especially after a rain or snowstorm. One kind of shake consisted of ruffling the feathers as the partly opened wings were jerked several times up and down at the shoulder joint. The bird also extended its neck, pointed the bill obliquely skyward, hunched its wings slightly, and briefly shook the whole body.

Stretching.—Each bird stretched about 3.1 times during the daylight hours by the following means: (1) raising the wings, wholly or partly opened, and with neck sometimes extended horizontally, (2) extending one leg and one wing on the same side caudally, (3) stretching the pouch by opening the bill and lowering the rami of the lower mandible astride the upward curved neck, and (4) rearing in the nest and beating the wings two or three times.

Preening.—By far the most prevalent self-care behavior of pelicans was preening, which each bird did on the average of 28.5 times per day. Ninety-eight preening periods timed with a stopwatch, primarily between 8:00 and 10:00 a.m., were of a mean duration of 63.6 seconds (range, 1.2 to 708.6 sec.; S.D., 106.57), indicating that a pelican on the nest spent at least 30 minutes per day in caring for its feathers. Preening was contagious in that the behavior in one bird often elicited a similar response in its neighbors.

Most adults preened while sitting on the nest, placing the main emphasis on the wings, back, sides, and chest; the rump and tail were rarely preened. The preening be-

havior of pelicans resembled that of most birds in that the large flight feathers were drawn through the bill and the contour feathers were arranged by vigorous nibbling, pulling, and shifting with the tip of the bill. Occasionally a bird preened its chest by biting at the feathers with the whole side of the bill.

Yawning.—I did not quantify yawning because it was difficult to distinguish from a self-advertisement display termed the pouch spread (see beyond). In a typical yawn of low intensity, the head was tipped slightly as the bird opened its bill with the pouch hanging loosely. During a yawn of high intensity, the open bill was pointed skyward and the rami of the lower mandible were flexed laterally so that the pouch was stretched like the skin on a drum. The joints of the mandible or the whole head were sometimes moved from side to side at the peak of the yawn.

Wing drying.—After a heavy rain, pelicans occasionally sat on their nests with wings partly opened and held away from the body.

The alert posture.—A sudden noise, close approach by man, and other potentially dangerous situations elicited a posture, which, if given by one bird, was rapidly transmitted through the colony. Birds on the nest merely sat erect and looked around with wings slightly lifted and necks stretched stiffly in a vertical position.

Pouch shaking.—When shaking its pouch, an activity which occurred on the average of 3.3 times per bird per day, the pelican pointed its open bill toward the ground and moved its head up and down 5 to 10 times so rapidly that the pouch flew back and forth with a flapping sound. Meischner (1959) suggested that the behavior rids the pouch of debris after preening. I have also seen it given after hauling in nest material, and after feeding young, indicating that the shaking may indeed serve to dislodge objects from the pouch. However, shaking also occurs before and after aggressive encounters, during nest relief, after the alert posture, and during courtship, all situations which tend to create tension in the bird. The pouch shake may well be a displacement activity in many instances, and I suspect that the behavior has become ritualized to some extent, thus functioning as a self-advertisement display, especially if given in conjunction with the pouch spread.

Pouch spreading.—A bird on the nest spreads its pouch about 0.9 times a day, sometimes immediately preceding or following the pouch shake. The pouch spread, described earlier under yawning, was given in situations similar to those eliciting pouch shaking. The flashing of the orange pouch skin is so prominent a gesture that it probably functions as a self-advertisement display, representing perhaps ritualized displacement yawning.

Nest constructing.—This activity occurred on the average of 9.2 times per bird per day during June. However, the frequency declined as the young grew and building finally ceased when they left the nest. Between July 4 and 10, a sample of birds in colony D hauled in material at the rate of 2.9 times per bird per day, only one-third as often as in mid-June. The parents built no new nest when young were displaced by high water.

Nest cleaning.—When over three inches of snow fell on the Molly Islands on June 4 and 5, some birds pushed the snow away from their bodies with the tip of the upper mandible. Pebbles, egg shells, and other materials were thrown from the nest cup by holding them in the tip of the bill and flicking them out with an upward jerk of the head.

Egg turning and shifting of small young.—Eggs or small young were shifted on the average of 3.1 times per day. The adult usually poked its bill between its legs and pushed the nest contents around. When turning the egg, the pelican stood in the nest, pushed the tip of the lower mandible under the egg, and raised the bill slightly, thereby

rolling the egg toward the feet. Of 21 egg turnings observed, 15 occurred between 4:00 and 7:00 p.m.

AGGRESSIVE BEHAVIOR

Each pelican behaved aggressively toward another pelican or another bird species on the average of 6.7 times per day, chasing away any intruder that wandered within reach of its nest. In the order of increasing intensity, aggressive behavior consisted of the following gestures: (1) a slight jerk of the head in the direction of the other animal, (2) facing the offender with raised head and horizontal bill, pouch not extended, (3) facing the other bird with open bill, (4) clapping the bill rapidly, (5) jabbing once and closing the bill with a snap, and (6) repeated hard jabs directed usually at the head of the other bird. The other pelican sometimes reciprocated with jabs, resulting in sparring birds audibly clanking their bills together. Occasionally one grabbed the bill of the other and the two pelicans pulled and shook, while emitting harsh nasal growls.

Aggression toward other pelicans.—Birds walking through the colony to join their mates on the nest and wandering loafers elicited roughly 50 per cent of the aggressive acts observed. Such birds had to run a gantlet of jabs through the crowded colony. Some attempted to circumvent this by jumping with extended wings over the birds on the nest or by running past them. Young pelicans were also driven from the vicinity of nests, although jabs directed at them appeared to be less vigorous than those directed at adults. However, on one occasion, a young, about 20 days old, crawled from its nest into an adjoining one. The adult grabbed the wing of the intruder and jerked the head up as if trying to throw it from the nest. As the young scuttled away, the adult pecked it so hard on the head that it stumbled and seemed dazed.

About 50 per cent of the aggressive acts were directed at other birds on the nest, sometimes because of their close proximity, and frequently when they were stealing sand and other materials from a neighboring mound.

Aggression toward other birds.—A pelican behaved aggressively toward any bird that approached its nest. California Gulls, which commonly wandered among the colonies feeding on unattended eggs and small young, were frequently attacked. When a gull was within five feet but out of reach, the pelican either opened its bill or snapped with horizontally extended neck. I have also seen similar behavior directed at a cormorant, a Caspian Tern, a Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), and Ravens (*Corvus corax*). In only one instance was a pelican seen to hit a gull.

Occasionally a pelican tolerated the close proximity of a gull. One gull fed on a dead young within one foot of a brooding adult without eliciting a response. Two gulls nested within two feet of incubating pelicans in colony A, yet were not attacked.

Distance between nests and its effect on aggressive behavior.—Grinnell (1908) and Behle (1958) noted that, on the whole, the spacing of pelican nests was equal to the combined lengths of two birds' necks, a frequent condition among colonial nesters. On the Molly Islands, however, some nests were so close to each other that the bills and bodies of adjoining birds almost touched when the birds were at rest (fig. 4). Such close proximity frequently caused strife, for simple movement by one bird was sometimes enough to elicit a jab from a neighbor.

The combined neck and head lengths of six dead adults averaged 30 inches. The radiating grooves around the nest, made with the bill when the bird hauls in nest material, gave a further indication of the pelican's reach. At eight nests the farthest average point reached from the center of the nest was 29 inches. Thus to avoid aggressive contacts with a neighbor, birds must build nests about 60 inches apart. The average

distance between the centers of 172 nests, measured at random on the Molly Islands and at Heart Lake, was 41.7 inches (range, 29 to 73 inches; S.D., 7.83), showing that most birds were within reach of one another. Much unused and apparently suitable space was available for nesting.

In the Common Murre (*Uria aalge*) crowding may be a necessity for reproduction, with fights intensifying the urge to incubate (Johnson, 1941). Although this is perhaps a contributing factor in pelicans, several of my observations suggest another advantage in crowding. Occasionally incubating or brooding pelicans stepped off the nest and preened, a trait noted particularly in colonies A and B during early June. Adult gulls immediately devoured the contents of such unattended nests unless chased away by either the returning parent or by a pelican on a neighboring nest. A nest out of reach of a neighbor, either at the periphery or in the center of a colony, is thus more vulnerable than one closely surrounded by other nests. In colony A, where nests were widely spaced, all eggs were destroyed by gulls. As the number of nests declined, the remaining birds became noticeably shyer. They stepped off the nest at the slightest disturbance, and this exposed their eggs to further predation. It is possible that the birds need the social stimulation of many neighbors to nest successfully. In colony B, on the other hand, only peripheral nests were taken by gulls. One abandoned nest with two eggs in the center of the colony remained untouched for three days. On two occasions I saw a gull approach the eggs, but it was prevented from eating them by the jabs of nearby pelicans. Thus selection would tend to favor the larger colonies.

NEST RELIEF

Nest relief ceremony.—The nest relief ceremony consisted of the head-up and bow displays (fig. 3) given by both pelicans, often several times without definite sequence. The bird on the nest often responded to the arriving mate when the latter was as far away as 20 feet, indicating that visual recognition was acute. Both pelicans frequently emitted a series of loud, nasal *ho-ho-hos* while displaying. The ceremony was sometimes interrupted as the bird on the nest hauled in some nest material, or as both birds stopped to preen. When ready to be relieved, the bird on the nest stood up and walked off with beating wings, and the other bird got on the nest. Chapman (1908) described a similar sequence of events for *P. occidentalis*. Two typical examples from my field notes describe this behavior:

June 7, 11:00 a.m. One bird, probably a male, lands at the edge of the colony and walks toward his nest 10 feet away. The incubating bird looks up, then grunts while bowing, waving her head from side to side, bill pointed obliquely downward and wings slightly hunched. She ceases to bow, and hauls in one beak tip full of sand before shaking her pouch. The male now stands before his mate, grunts once in the head-up posture then bows. She too bows as he scratches his head and preens. Suddenly both birds stand facing each other and give 4 consecutive head-ups. She finally walks 6 feet off the nest, beats her wings, preens, and shakes, whereas the male, standing on the nest rim, gently pokes at the egg, lies down, and hauls in some sand.

During June, I timed 160 nest reliefs from the time of arrival of the relieving bird at the nest until it settled down on the nest. The duration of reliefs, rounded to the nearest half minute, varied from 0 to 65 minutes (mean, 8.4 minutes; S.D., 12.08). Reliefs were sometimes prolonged because one adult refused to leave the nest, even when nudged by its mate. If a bird was unable to get on the nest, it usually rested nearby for a few minutes before attempting again. In one case, however, the bird left the rookery and returned the following day. Forty-five relieved birds remained near the nest for an average of 4.4 minutes (range, 0 to 17 minutes; S.D., 4.05) before departing for their feeding and loafing areas along many of the streams and lakes within about a 40-mile radius of the rookery.

Occasionally birds tried to get back on the nest after having been relieved earlier in the day. The incubating or brooding bird sometimes jabbed at its mate, permitting no relief, but at other times it departed.

As the young grew older, the ceremony, if any, became more cursory and relief was more rapid. Two examples illustrate this:

June 24, 10:22 a.m. A pelican walks to its nest and head-ups once. Thirty seconds later the brooding bird simply walks away and the new one feeds the large young.

July 9, 1:09 p.m. A pelican ambles toward its mate. When still 6 feet from the nest, the brooding bird simply flies away without ceremony. The former goes to the mound and feeds its young.

Relieved birds departed from the rookery alone or joined others from the same or different colonies in a flock. Mean flock size of 4416 departing birds counted was 2.8, and the largest flock consisted of 46 birds. However, single pelicans and small flocks frequently united with others within a mile of the rookery, and as many as 200 birds were at times seen together in the air.

Frequencies of nest relief.—Nest relief occurred at any time between dawn and dusk, but it usually occurred between mid-morning and mid-afternoon. About 65 per cent of all birds arrived at the rookery between 11:00 a.m. and 1:00 p.m. in June, about 26 per cent in July, and about 95 per cent in August. Nest relief during incubation occurred on the average of once every two days, with a variation of one to three days. Two consecutive reliefs at the same nest were noted nine times and the interval between them varied for 23 to 75½ hours with an average of 54 hours. That nests were relieved about every two days was corroborated by counts of the number of birds arriving at the rookery in the daylight hours. Between June 4 and 10, when most of the 298 nests contained eggs (see table 1), an average of only 146 pelicans landed each day. Table 4A presents relief times at one nest during a sample week.

TABLE 4
TIMES OF NEST RELIEF AT THREE SAMPLE NESTS IN COLONY C

Date	A	B	C
	2 eggs Time of relief	2 small young Time of relief	1 small young Time of relief
June 13	Noon	....	....
June 14	11:01 a.m.	....	10:55 a.m.
June 15	none	10:42 a.m.	10:11
June 16	11:09	12:04 p.m.	1:08 p.m.
June 17	none	11:09 a.m.	11:05 a.m.
			3:30 p.m.
June 18	11:32	9:55	none
June 19	none	10:33	10:34 a.m.
June 20	10:35	10:26	1:00 p.m.
June 21	none	11:20	....

After the young had hatched and until they left the nest, relief occurred on the average of once a day, occasionally twice a day, and rarely once every two days. Two consecutive reliefs at the same nest were recorded 50 times. These showed an average interval of 22½ hours (range, 3 to 43 hours) between reliefs. Nest relief times at two typical nests are shown in table 4B and C.

THE BEHAVIOR OF THE YOUNG

Physical and behavioral development.—During the first month of its life the young developed from a naked, uncoordinated creature, barely able to lift its head, to a down-covered, chicken-sized bird, able to run around and leave the nest. Thereafter, develop-

ment appeared slower as the young grew in size, acquired its plumage, and finally took to the air at the age of about 10 to 11 weeks. In this period, too, the behavior of the adult changed considerably. After brooding the young almost continuously during the first two weeks of its life, the parents left it more and more unattended until, at the age of about one month, it was left unattended day and night. The ages at which I first noted various stages in the physical and behavioral development of the young are summarized in table 5.

The formation of the pod.—Young began to congregate into groups or pods after they were able to crawl and were not brooded continuously by the adults. Occasionally young ventured into an adjoining nest by the age of three weeks. Such visits seemed to

TABLE 5

THE PHYSICAL AND BEHAVIORAL DEVELOPMENT OF YOUNG WHITE PELICANS

Approximate age in days	Behavior
0	The naked, orange-colored young open their eyes at or soon after hatching. They are barely able to raise the head in a shaky fashion. Their only vocalization is a sharp <i>kek-kek</i> .
6	The squab-sized young occasionally peer out from beneath the brooding adult.
10	The body covering of white down has grown prominent and the neck movements are well coordinated.
13	The adult stands in the nest while preening, leaving its young exposed to the sun for as long as 10 minutes. The young is able to sit up supported by its belly and tarsi.
15	The young is visible in the nest beneath the brooding adult. One young picked up something from the nest rim and swallowed with an upward jerk of the head.
16	One young lies in the sun beside its parent. It stretches with wings lifted skyward and neck extended horizontally; it preens its side with rapid nibbling movements of the bill tip, then picks up some sand and shakes its head. One young vibrates its pouch rapidly.
17	One young crawls 2 feet uphill, thus escaping its flooded nest. Some adults leave the young unattended as they loaf 3 to 5 feet from the nest.
20	The young take their first wobbly steps, with the body raised off the ground and with wingtips propped on the ground for support. When a sudden strong wind blows, the young face it and beat their wings briefly. Young preen themselves commonly; one stretches its pouch; another shakes its pouch; two open their bills aggressively at each other. One young walks to a neighboring young and lies down. Some young sleep with bills tucked along the back.
22	Young are brooded only intermittently during the day, but they remain by or under the adult all night.
26	The young can stand and walk quite well. They form small groups of 2 to 6 birds. When approached closely by man they take to the water and swim away without seeming hesitation.
27	One young wanders across the rookery over 100 feet from its colony.
28	The young are sometimes left uncovered throughout the night. One young gives a head-up display to a passing adult.
30	Two young give the head-up display to each other; one young yawns in a manner resembling the pouch spread; one young, caught between two fighting adults, bows. A young follows its parent to the water's edge but does not enter.
33	One young, primaries erupted $1\frac{1}{2}$ inches from the sheath, jabs at a gull.
50-60	All young on the island join into one large pod. Some young swim within 50 feet of shore in typical adult fashion, with wings slightly hunched.
62	Nineteen young, about $\frac{2}{3}$ the size of adults, swim 200 feet from the rookery. One young bathes like an adult—dips head under water, beats wings, ruffles feathers. When a strong wind blows most young hop or run with beating but uncoordinated wings.
69	One young glides about 3 feet down a slope.
71	One young rises 4 feet into the air and glides 10 feet. Hall (1925) observed that two young flew for the first time at the age of 62 and 64 days.
72	Ten young swim $\frac{1}{2}$ mile from the rookery before returning.

be prompted either by a need for warmth or for shade. Even downy young shivered on cool days, and some crawled out of their nests and beneath their parent if one stood within a few feet. Panting young sought shade under standing adults on hot days. However, no adult was seen to shade its young by moving to a position between it and the sun as has been observed by Bartholomew, Dawson, and O'Neill (1953) and Behle (1958) in other areas. Visits of young to other nests were at first of brief duration, half an hour or less, for adults tended to jab at strange young. As the adults spent less time on the nest site, the wandering young came into more frequent and prolonged contact with each other. Groups of two to six young frequently rested together during the day. Occasionally an adult approached its young in a small group, pecked away the other young and brooded its offspring for a few minutes on the spot. At night the small groups usually broke up as each young lay by or under its parent, either on or near the nest.

By the age of one month, when the young were left alone all day and usually all night, except at feeding time, the small pods aggregated into large ones. At first all young in a given colony tended to remain together, but frequent mixing occurred, and by the time the oldest young were 50 days old all of the young on Sandy Island had joined into one large pod.

The formation of the pod had a highly disruptive influence on those adults of a colony which were still brooding or incubating. Such adults tended to leave their nests unguarded as they joined other loafing adults around the rookery. Consequently only young two weeks or older survived, the others usually being exposed and eaten by gulls. Under such conditions greater synchronization of the breeding schedule of a colony would favor the survival of more young.

Behavior of young in large pods.—Young in pods were highly gregarious and certain behavior by one bird frequently elicited a similar response in the others. For example, when one bird left the pod and walked to the shade of a clump of willows 20 feet away, some 30 others followed. On another occasion, two low-flying Ravens, which regularly scavenged in the rookery, caused one young to run toward the water, and over 100 others joined the stampede.

The daily routine of the young in August was fairly consistent. During the night all huddled together in one or two pods, and they remained there until 7:00 a.m. and as late as 8:30 on rainy mornings, after which the pod usually dispersed as the young stretched, preened, and wandered around. By 10:00 a.m. many began to drift singly and in small groups back to their nest area where they were fed by one parent, usually between 11:00 a.m. and 1:00 p.m. Preening, sleeping, and standing around in scattered groups of various sizes was the main activity during the afternoon. Occasionally two young grappled with each other, seemingly in play. If a strong wind blew, some young pelicans beat their wings; if rain or hail fell they crouched tightly in a cluster, heads toward the center. By 6:00 p.m. many of the young were again assembled in a few large pods, and by 7:00 p.m. most were sleeping.

FEEDING OF YOUNG

Feeding behavior.—When the young bird was less than one week old, the adult pointed its slightly open bill into the nest, either on its own accord or in response to the raised head of the young. With a series of rhythmical neck movements the adult regurgitated small, mushy bits of fish into the partly spread pouch and held its bill near the head of its offspring. The young fed from the tip of the lower mandible. At the age of about one week, the young pecked at the bill of its parent, emitting a harsh *kek-kek*, as it attempted to insert its head into the pouch. By the age of 10 days a feeding young

supported its chest hammock-like in the pouch of the adult and stretched its neck so far upward that the food barely left the gullet before being grabbed. Large young, aged about two weeks, demanded their food vigorously, begging on the belly with beating wings and emitting nasal *waaa-o*, *waaaa-o*. When the adult presented its closed bill, the young bird either pecked at it or slid its bill up and down the lateral margin of the adult's bill until admitted. Large young took the food directly from the gullet of the standing parent, sometimes lying down while doing so.

To remove feeding young from their pouches, adults either raised their heads or twisted them sideways. Some large young were, however, so persistent and difficult to reject that the adults first attempted to back away and finally shook their heads violently with the result that the young were literally thrown off their feet.

Because they sometimes hatched two to three days apart, there was often a great disparity in size between the two young in a nest. Since the young were fed on a "first come, first served" basis, the larger and stronger one fed until satiated before the other had the opportunity to reach the pouch. Because the smaller bird received consistently less food than its nest mate, it grew progressively weaker and finally seemed to die of starvation. I noted only one instance in which an adult ignored the begging of a large young and fed the small one first. Only one young tended to feed at a time, although I saw five instances in which two young had their heads in the pouch together.

Most feeding periods were short, one minute or less. In August, adults characteristically landed in the rookery, fed the young, and departed usually within five minutes. Small young, however, may be fed off and on for as long as 20 minutes.

Ströh (1959:275) observed that in *P. onocrotalus* "the adult would throw up the fish and let the young scramble for it." Such behavior was not seen in the course of this study. Once an adult inadvertently let a fish slip from its pouch and thereby lost it to two other adults and a gull. On another occasion an adult pelican snatched a fish dropped by a young bird.

Mere movement by a young sometimes seemed to release feeding behavior in a nest mate. Occasionally a young bird enclosed the head of another in its open bill and made swallowing gestures with head and neck. This sometimes resulted in a struggle between the two young, with one attempting to free itself, and the other trying to hold on.

All young were still fed daily at the age of two and one-half months, when they were beginning to fly. Hall (1925) noted that adults still fed fully fledged young away from the rookery. I obtained no evidence to support R. Murphy (1961), who stated that young pelicans are abandoned by their parents before they learn to fly and must live on their own fat.

Begging behavior.—Young, ten or more days old, often begged vigorously for their food. Usually a young pelican sat very upright in front of its parent, with neck stretched high and wings beating, until it was admitted to the pouch. Sometimes, however, a young bird ran to an adult, threw itself on the ground and beat its wings wildly, all the while swinging its head from side to side. Occasionally the young lay on its side, beat one wing, suddenly jumped up, ran at and pecked several young in the vicinity, driving them away, only to continue begging. It also grabbed, shook, and bit its own wing with the bill as it turned its body around and around, growling all the time. In the words of Chapman (1908:102) the young "acts like a bird demented." Such begging often continued for one minute, with the young usually facing the adult. Young frequently continued to beg after they were fed and occasionally were fed a second time.

When the young were unsure on their feet, adults could elude their begging by rapidly walking away. However, large young often ran after the adults for 40 or more

feet. Some adults then climbed out of reach onto boulders, others took to the water. A young sometimes swam after its parent, begging with quivering wings and laying its head sideways on the water.

Begging probably has several functions. The waving head bears a striking resemblance to the bow display. Thus intense begging by the approaching young may inhibit attack in the adult. The begging may also draw attention to the young, give the adult the opportunity to recognize its young, and stimulate the adult to regurgitate food.

Time and frequencies of feeding young.—When the young were three weeks or less old, they were fed at various times throughout the daylight hours, especially in the early morning and toward evening. Observations of 14 nests between June 13 and 23 in colony C showed the following average number of feedings per observation period.

4:00 to 8:00 a.m.	20.5
8:00 a.m. to noon	11.3
Noon to 4:00 p.m.	13.5
4:00 to 8:00 p.m.	18.4

Small young received food at least four times a day. Because of the intermittent way in which some young were fed, I counted a feeding only if 15 or more minutes had elapsed since a previous one. For instance, one young, aged five days, was fed four times between 8:00 a.m. and 5:00 p.m., three times by one parent and once by the other. At the age of 11 days, the same young was fed twice between 4:00 and 8:00 a.m. and once between 5:00 and 8:00 p.m. As the young grew older, the frequency of feeding declined. The young were fed only once a day in August, each parent returning to the rookery every two days. That only one member of a pair tended to arrive daily was corroborated by the fact that between August 7 and 21 the average number of adults arriving daily at the rookery was 135, a total which only slightly exceeded the 117 young present. On August 9, I watched the rookery from 5:00 a.m. to 8:00 p.m. In this period 131 pelicans arrived, but one flock of 19 birds merely landed briefly without feeding any young.

Individual recognition between parents and young.—R. Murphy (1936) noted that the young of *P. occidentalis* are recognized by their parents, perhaps by voice. Hall (1925) marked three young of *P. erythrorhynchos* and found that these were fed only by certain adults. On the other hand, Behle (1958) doubted that the young of *P. erythrorhynchos* can recognize their parents; and Ströh (1959:275) observed in *P. onocrotalus* that "the parents seemed unable to distinguish their young in the 'school', and feeding became a communal effort."

I marked eight young in July and found that each was fed only by two specific adults. An adult usually landed near the pod or pods in the vicinity of its former nesting site and approached the young at a slow walk. It then stood silently at the edge of the pod, as if looking for its young. If none reacted, the adult sometimes nibbled several young lightly until they moved, behavior which seemed to draw attention to the adult. On several occasions a sleeping young, awakened by the actions of the adult, subsequently begged. If still no bird reacted, the adult checked another pod. Often a young popped from a pod, and ran to its parent, begging wildly. Before feeding the young, the adult sometimes jabbed at other young in the vicinity until a space was cleared. Some young responded to approaching adults from as far as 10 feet.

Occasionally a young begged from an adult which was not its parent. Such begging was usually of low intensity, and, in some cases, appeared to be due to mistaken identity. In one typical example, four young stood up in the pod begging lightly as an adult

approached, but only one of these left the pod begging vigorously as the adult drew nearer. When young solicited strangers intensively, I had the impression that they were so hungry that the appearance of any adult released begging behavior. Adults either ignored such young, walked away from them, or jabbed them lightly.

The evidence suggests that recognition between parents and their young is mutual, based primarily, perhaps exclusively, on visual cues. The young usually recognizes and responds to its parent before the latter can distinguish it in the dense mass of the pod. Final judgment by the adult is passed on the young after it has left the pod. Again recognition seems to be primarily visual, although the vocalizations of begging young may be a further aid. The recognition system of the White Pelican thus seems to differ from that of the Adélie Penguin (*Pygoscelis adélieae*), where the young in the pod recognize and respond to the food call of the returning parent (Penney, 1962).

SEXUAL ASSAULTS OF YOUNG BY ADULTS

Between July 4 and 18, a period when many young were leaving the nest, I observed 23 attempted copulations by adults on young. Typically an adult approached a lying or standing young from behind, grasped it by the neck with the bill, and stepped up to tread on its back, grunting loudly. The young usually struggled with the result that the adult slipped off. Occasionally another adult, presumably the parent of the young, ran up and drove the copulator away. No adult was seen to mount its own young. One adult was brooding its offspring when suddenly it walked to an unattended young in a nest six feet away, tried to mount, then returned to its own nest. One young, after having been mounted, shook itself and preened in the manner of an adult female following successful copulation.

It is possible that the wobbly movements of the young resemble a female presenting herself for copulation and that the posture releases sexual behavior in the adult. One young, for instance, approached an adult and begged with waving head. The adult in turn bowed, then grabbed the young by the neck and mounted.

DATE OF DEPARTURE FROM THE BREEDING GROUNDS

The pelicans usually leave the rookery in September. Skinner (1925) saw no pelicans in Yellowstone National Park after September 17. On September 18, 1949, Ericson (1950) observed only one pelican on the Molly Islands. A few stragglers may, however, remain in the park until late autumn. Wood (pers. comm.) recorded a pelican on Yellowstone Lake on October 9, 1961, and McLaughlin (1929) noted a few birds in early November. Most of the pelicans winter along the coast from Los Angeles southward to the Gulf of California, and a few frequent the Gulf of Mexico (Diem and Condon, in press).

SUMMARY

The breeding behavior of the White Pelican (*Pelecanus erythrorhynchos*) was studied between June 3 and August 22, 1962, at a rookery containing about 300 nests in Yellowstone Lake, Yellowstone National Park, Wyoming.

The birds arrived at the breeding grounds in late April or early May. The courtship ceremony consisted of the head-up and bow displays, and a strutting walk, which emphasized the nuptial plumage and the horn on the bill. During copulation the male grasped the neck of the female with his bill. Nest mounds were constructed of sand, which the bird hauled toward its body from all directions with its bill. The first eggs were probably laid by May 7. The average clutch size in early June was 1.7. Each of the eight colonies in the rookery had its own breeding schedule, with over two weeks difference between the extremes.

Birds on the nest were inactive during the night and for much of the day. Scratching, stretching, shaking, and preening were the principal self-care activities. Two gestures, the pouch shake and pouch spread, appeared to be self-advertisement displays. Aggressive behavior toward other nesting pelicans and loafing adults was relatively frequent in the crowded colonies. It is suggested that crowding, although it increases intra-specific strife, has selective advantage in that it reduces predation of eggs and young by gulls through mutual nest protection. The nest relief ceremony combined the head-up and bow displays. Incubating birds relieved each other once every two days, and brooding birds every day, on the average.

The young were born naked, but down covered their bodies within 10 days. By the age of three weeks they could stand up, and by 10 weeks they took the first brief flight. Adults brooded the young for the first two weeks after hatching. Thereafter, the adults spent progressively less time near the young, which by the age of one month were left unattended all day and congregated into groups or pods.

Adults regurgitated food into the tip of the lower mandible to feed small young; large young took the fish directly from the gullet of the parent, occasionally begging wildly with beating wings and waving head before feeding. Small young were fed at least four times per day by both parents; large young, one month and older, received food only about once a day. Adults fed only their own young. Recognition between parents and young appeared to be mutual and based on visual cues. Twenty-three adults were seen to assault young sexually.

The pelicans usually leave the rookery in September and winter on the Gulf of California and the Gulf of Mexico.

LITERATURE CITED

Anonymous

1930. Brevities. *Yellowstone Nature Notes*, 7(7):46.

Bailey, A. M.

1935. The white pelican. *Bird-Lore*, 37:329-336.

Baird, S. F.

1858. General report upon the zoology. *In* U.S. Pac. RR. Surv. Vol. IX, pt. II. Birds (Washington).

Bartholomew, G. A., Dawson, W. R., and O'Neill, E. J.

1953. A field study of temperature regulation in young white pelicans, *Pelecanus erythrorhynchos*. *Ecology*, 34:554-560.

Behle, W. H.

1958. The bird life of Great Salt Lake (Univ. Utah Press, Salt Lake City).

Bent, A. C.

1922. Life histories of North American petrels and pelicans and their allies. U.S. Nat. Mus. Bull. 121.

Carroll, J. J.

1930. Breeding of the American white pelican on the Texas coast. *Condor*, 32:202-204.

Chapman, F. M.

1908. Camps and cruises of an ornithologist (D. Appleton and Co., New York).

Cook, C.

1870. The valley of the Upper Yellowstone. *Western Monthly*, 4:60-67.

Darling, F. F.

1938. Bird flocks and the breeding cycle (University Press, Cambridge [Eng.]).

Davis, J.

1884. Yellowstone Park. *The Courier-Journal* (Louisville, Kentucky). Sunday, April 18, p. 12.

Diem, K., and Condon, D.

In press. Banding studies of water birds on the Molly Islands, Yellowstone Lake, Wyoming.

Ericson, M.

1950. Birds nest unmolested at rookery in Yellowstone Lake. *Yellowstone Nature Notes*, 24(4):39-42.

Grinnell, J.

1908. Birds of a voyage on the Salton Sea. *Condor*, 10:185-191.

Hall, E. R.

1925. Pelicans versus fishes in Pyramid Lake. *Condor*, 27:147-160.

Johnson, R. A.

1941. Nesting behavior of the Atlantic murre. *Auk*, 58:153-163.

Linton, E.

1891. A contribution to the life history of *Dibothrium cordiceps* Leidy, a parasite infesting the trout of the Yellowstone Lake. *Bull. U. S. Fish Comm.*, vol. 9 for 1889:337-358.

Mackworth-Praed, C., and Grant, C.

1952. Birds of eastern and northeastern Africa. Vol. I (London).

McLaughlin, J.

1929. Waterfowl on Yellowstone Lake and River. *Yellowstone Nature Notes*, 6(12):4-5.

Meischner, I.

1959. Verhaltensstudien an Pelikanen. *Zool. Gart.*, 25:104-126.

Murphy, J.

1960. The Molly Island nesting colonies of Yellowstone Lake. *In* National Park Service hearings before a subcommittee of the committee on appropriations, United States Senate (Washington), pp. 11-16.

Murphy, R. C.

1936. Oceanic birds of South America. Vol. 2 (Amer. Mus. Nat. Hist., New York).

1961. A continental waterbird. *Nat. Hist.*, 70(9):28-31.

Palmer, R. S., ed.

1962. Handbook of North American birds. Vol. 1 (Yale Univ. Press, New Haven).

Pearson, T. G.

1921. Notes on the bird-life of southeastern Texas. *Auk*, 38:513-523.

Penny, R. L.

1962. Voices of the Adélie. *Nat. Hist.*, 71(8):16-25.

Skinner, M. P.

1917. The birds of Molly Island, Yellowstone National Park. *Condor*, 14:177-182.

1925. The birds of the Yellowstone National Park. *Roosevelt Wildl. Bull.*, 3:1-192.

Ströh, H.

1959. A colony of white pelicans in the Rukwa Valley, Tanganyika. *African Wildl.*, 13:273-278.

Thompson, B. H.

1932. History and present status of the breeding colonies of the white pelican (*Pelecanus erythrorhynchos*) in the United States. *U. S. Dept. Int., Nat. Park Serv., Contr. Wild Life Div., Occas. Pap. No. 1.*

Ward, H. B.

1924. Banding white pelicans. *Condor*, 26:136-140.

Williams, L.

1942. Display and sexual behavior of the Brandt cormorant. *Condor*, 44:85-104.

Yeagher, D.

1929. A trip to pelican island. *Yellowstone Nature Notes*, 6(7):3-4.

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