

THE GALÁPAGOS SWALLOW-TAILED GULL IS NOCTURNAL

JACK P. HAILMAN

GULLS (Larinae) are thought to be diurnal birds. This paper reports the nocturnal habits of the Galápagos Swallow-tailed Gull, *Larus* (*Creagrus*, *Xema*) *furcatus*, and discusses briefly its adaptations to, and the selective advantage of, its nocturnal behavior.

The Swallow-tail is unusual among gulls because of its cliff-nesting habits and pelagic tendencies, in which it is surpassed only by the Kittiwakes, *Larus* (*Rissa*) *tridactylus* and *brevirostris*. Unique is the Swallow-tail's diet of squid, known from regurgitation by captured birds, which led Gifford (1913:76) to write "I have never for a certainty seen them feeding, and rather suspect that as a rule they do so at night." This suggestion went virtually unnoticed (e.g., Murphy, 1936; Alexander, 1954), although Moynihan (1962:101) noted that the species' unusually large eyes could be adapted to life in low light intensities (see Fig. 1). Bailey (1961), who reviewed the Swallow-tail's habits from the literature and his own field observations, failed to mention the possibility of nocturnal existence. Previous authors seem to have been influenced strongly by the report of Streets (1912) that *furcatus* at sea flew "always in the direction of the islands—in the evening going to and in the morning going away from them." [However, Bailey (1961) misquotes Streets as having said that the gulls always go *towards* the islands.]

In hopes of getting new evidence relating to this unsettled question, I studied the habits of *L. furcatus* during a research trip to the Galápagos Islands in November–December 1962.

CONFIRMATION OF NOCTURNAL HABITS

Possible effects of dark nest cavities.—At Plaza Island to the east of Santa Cruz (Indefatigable) Island I noted that some nests of *L. furcatus* were placed well back in dark crevices below rock ledges. It was hypothesized that such cavities provided the dark environment in which large eyes would be particularly advantageous. In a census of 38 nests there, 27 were on open ledges, 6 partly covered by a rock overhang above, and only 5 truly placed under ledges. Subsequent observations on Tower Island indicated an even lower proportion of nests in cavities there. Thus, the suggestion of adaptation to dark nest cavities seemed unlikely.

Observations on the daily cycle.—Observations of the undisturbed colony during the day demonstrated that adults ordinarily have but two activities: sleeping and preening. No adults (and but a few young at the base of the



FIG. 1. Profile of an adult *Larus furcatus* showing the light markings on the tip and at the base of the bill. Note the enormous eye.

cliff) could be seen on or over the sea during the day. Therefore, I placed my sleeping bag at the side of the cliff on the nights of 13–14 and 14–15 November, and repeatedly set an alarm clock throughout the night so that I would awaken at least at the beginning of each hour in order to sample activity of the colony. A nearly full moon for much of both nights allowed general observation when skies were clear; activity at certain nests was checked by flashlight.

The results of these night observations were clear cut. At dusk the gulls begin flying upward in groups of 2 to 20 and circling above the cliffs. As it grows darker, they leave the island and fly to sea, usually to the east of Plazas, but occasionally southward. By the time it is fully dark the only individuals remaining in the colony are birds incubating eggs, brooding young chicks, or (only occasionally) “guarding” chicks too old to be brooded. At these nests, a mate may return between midnight and 0300 to relieve the bird on duty; the bird that has been sitting apparently goes immediately to sea. Prior to first light in the morning, birds begin returning. By the time the dawn provides enough light for a human observer to distinguish colors, all birds have returned.

Displaying, both between mates and to members of other pairs, begins upon arrival in the morning and may last up to 1 or 1.5 hours after sunrise.

[Notes on specific displays will be communicated separately; see Moynihan (1962) for a preliminary description.] Occasionally, birds display briefly during the day. I observed one pair copulating in the evening just prior to sunset on Tower Island on 23 November. The feeding of young birds is done from shortly after midnight until an hour or so after sunrise by the returning parent. All these activities confirm that nesting adult *L. furcatus* are fully nocturnal in habits while they are on the breeding grounds.

POSSIBLE ADAPTATIONS TO NOCTURNAL EXISTENCE

Some of the peculiarities of *L. furcatus* appear to be related to its nocturnal habits.

White colors in plumage and soft parts.—Several areas of white on *L. furcatus* may have evolved because they render the gull or its movements more conspicuous at night. Large white triangles on the upper surfaces of the wings are evident when the bird lands, and could be useful as a social attractant during nocturnal feeding. The white ventral surface may be useful in reflecting light into the nest (say, during nocturnal feeding of the chicks), but as it is found throughout the gulls it cannot be considered a special adaptation to nocturnal feeding.

The head has two white areas. The grayish white tip of the dark bill (Fig. 1) elicits and directs the pecking response of the young chick (a more complete discussion of this in a comparative context is in Hailman, 1964*b*). A unique white tuft of feathers at the base of the bill (Fig. 1) accentuates head movements during displays. The relative position of the gray bill tip to the white basal tuft signifies the position of the bird's head, even in such low light intensities that the rest of the head is not visible.

Finally, the young birds prior to fledging possess a white plumage (Fig. 2) unique among gulls. The white head, in particular, is conspicuous at night when the young bird is giving its "head tilting *cum* begging call" to the parent. (Newly hatched chicks, although colored a cryptic gray, are nevertheless easy to find since they do not leave the nest.)

The eye.—The eye of *L. furcatus* is extraordinarily large, both absolutely and relative to body size, when compared with eyes of other gulls. The functional advantage of large eyes in nocturnal animals is a rather complicated story (Walls, 1942:210–212), but no less important for that.

The dissected eye (of a newly hatched chick) contains a reduced pecten, with few folds and very little pigmentation. Although the function(s) of the avian pecten is a matter of dispute, nocturnal birds typically have small ones (Walls, 1942:365, 657). Adults, however, have well-developed pectens, so that the species may be in the process of losing the pecten through retarded development rates (Hailman, 1964*b*).



FIG. 2. An immature Swallow-tailed Gull. In diurnal gull species, birds of this age are usually dark brown over most of the plumage.

When the beam of a flashlight is directed into the eye of a Swallow-tailed Gull, the eye shines brightly, similarly to the way in which a cat's eye shines. Similar experiments on the diurnal Laughing Gull (*Larus atricilla*) failed to elicit eyeshine. Eyeshine usually indicates that the eye has a special structure which reflects instead of absorbs light behind the retina, although the structure itself differs widely in various vertebrates (Walls, 1942:288 ff.). Eyeshine is a typical trait of nocturnal animals where it functions to "lengthen the exposure" of the retina to a dimly lit object.

The eye of a newly hatched *furcatus* chick shows a bluish tinge in the interior of the eye. This blue is evident in live or dead chicks and adults, whereas night eyeshine appears yellowish or white. I dissected the eyes of several chicks and found that a blue layer coats the eye between the retina and the chorioid. Similar coatings in many vertebrates are well-differentiated tapeta, which may be retinal or chorioidal (as in *furcatus*). However, I did not know at the time of my dissections that no tapetum has been found in birds' eyes (Walls, 1942:230), and so did not make extensive examinations of the bluish coat. Eyeshine in birds has been attributed to the lamina vitrea layer between the pigment epithelium and the chorioid. Without more complete histologic data it is impossible to state the origin and exact nature of this

reflecting coat in the eye of *furcatus*. It is certainly functionally similar to the chorioidal tapetum in many mammals.

Miscellaneous.—The Swallow-tail's diet of squid, which rise to the sea's surface at night, was confirmed by Dr. A. Brosset on Tower Island during our trip there in November. All of the 17 birds that regurgitated when caught in a net for banding brought up squid. These captured birds included adults and young at about the fledging age. One time I did see a whole fish being fed to a younger bird on Plaza Island, but this may be exceptional. J. Hatch found shells of a marine gastropod about the nests of *furcatus* on Hood Island; the shells were identified by Dr. Harald A. Rehder of the U. S. National Museum as the floating planktonic species *Janthina ianthina*. However, nocturnal squid seem to be by far the main staple.

The calls of the Swallow-tailed Gull are unique among gulls, several involving clicking sounds that reminded me of a rapidly creaking door. The superficial resemblance of features of these calls to those given by other animals living in low light intensities (e.g., bats and porpoises) suggests a possible special function such as echo location. Sonograms of recordings (made by J. J. Hatch) of the calls revealed no energy in very high frequencies, such as might be expected if the call were used for echo location.

DISCUSSION

Possible selective advantage of nocturnal habits.—Why has such an "ungull-like" habit as nocturnal activity been evolved? Perhaps the abundance of squid at night provided an open ecological niche near the Galápagos Islands. There are certainly a number of fish-eating, diurnal species present with which a "typical" gull would have to compete (an albatross; several storm-petrels, shearwaters, boobies, terns; etc.), and several species, including a gull, apparently compete for refuse as scavengers (Hailman, 1963). Certain observations lead me to propose another possibility. Man-o-war Birds (*Fregata magnificens* and *minor*) constantly sail above the colonies of *L. furcatus*: at Tower, where all three species nest, and at Plazas, where only the gull nests. Gifford (1913:36) notes that Man-o-wars chase adults, making them disgorge food. I saw such an incident at sea about 300 miles east of the Galápagos on 5 November. Gifford (loc. cit.) further reports that the diurnal Galápagos Hawks (*Buteo galapagoensis*) take young birds, as I believe Man-o-wars try to do. It is interesting that the gathering of Swallow-tailed Gulls in the evening on Plazas begins just after the last Man-o-war departs for its nesting islands (the closest one is Daphne, about 25 miles to the northwest). Furthermore, nearly every *furcatus* has returned in the morning by the time the first Man-o-war is observed. My suggestion, then, is that the Swallow-

tailed Gull has evolved habits which allow both members of the pair to stand continual guard against predators at the nest during the day, and to feed unmolested at night.

Comments on the observations of Streets.—My observations appear to contradict those of Streets (1912), in that mine predict that gulls at sea should be heading *toward* the islands at dawn and *away* at dusk, not the converse. En route from Peru to Mexico by boat in 1885, Streets passed within sight of Chatham, the easternmost island of the Galápagos. He noted “gulls with a forked tail” apparently only when the boat was 300–400 miles away from the islands, although coordinates of his position are not given. Streets observed the gulls morning and evening for 3 days. He was not able to collect the birds, but noted that they had “a forked-tail, a black head, the entire under part of the body white, the back of a darker color . . . and with streaks of black and white on the wings.” The dates are not given.

One possible explanation of Streets’ observations is that he observed Malpelo Island individuals. Smith (see Bond and de Schauensee, 1938) found a small colony of *furcatus* nesting on a rock called Malpelo Island, located about 800 miles northeast of the Galápagos Archipelago. Streets may well have been closer to Malpelo than to the Galápagos at the time of his observations taken northeast of the Galápagos. Thus, birds flying southwest at dusk would be coming from Malpelo, those going northeast at dawn, returning to the rock. If such an explanation is correct, it is consistent with the observations on the gull’s nocturnal habits reported here. However, this explanation fails to explain Streets’ observations made southeast of the Galápagos Islands.

Another explanation might be that Streets saw nonbreeding individuals, and that these birds are diurnal, not nocturnal. A further assumption would have to be made that such diurnal individuals congregate somewhere other than in breeding colonies which I visited in the Galápagos, since I never saw birds arriving at dusk or leaving at dawn. However, even nonbreeding birds are probably nocturnal (see below).

Furthermore, Streets fails to mention the diagnostic field mark of *L. furcatus*, the white tuft of feathers at the base of the beak. The morphologically similar Sabine’s Gull, *L. (Xema) sabini*, which lacks the white tuft, migrates to the South American coast during the winter (Alexander, 1954:101), although its status at sea is poorly known. Thus the possibility of misidentification may exist.

Finally, assuming Streets’ identifications were correct, is it not possible that during the 27 years which elapsed between his observations and their publication that some errors were incorporated? It seems wisest to accept Streets’ (1912) published report only with caution until further observations can be made or the details of his original notes can be found.

Behavior outside the breeding season.—My observations refer to breeding individuals only. *L. furcatus* is known to visit the Humbolt current off the coast of South America (Murphy, 1936). Moynihan (1962:104) watched them in Paracas Bay, Peru, in the mornings where “they were probably just resting in the calm waters of the bay after periods of active feeding.” This report suggests, then, that even outside of the breeding season—for individual gulls, since the species breeds year-round in the Galápagos (Hailman, 1964a)—*furcatus* is still nocturnal.

SUMMARY

Larus furcatus is the only nocturnal gull. Nesting adults fly to sea at night, only returning to feed young or guard and incubate at the nest. They display mostly at dawn and dusk.

Possible adaptations to nocturnal existence include: white plumage prominent in displays, including a white “releaser” on the bill for the chick’s pecking; large eyes with a tapetum-like coating and reduced pecten; the primary diet of squid (which surface only at night); and, possibly, the unique clicking calls.

Nocturnal habits may have evolved to allow adults to stand guard at the nest during the day when the diurnal Frigate Birds (*Fregata*) patrol the colonies.

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DEPARTMENT OF ZOOLOGY, DUKE UNIVERSITY, DURHAM, NORTH CAROLINA
(PRESENT ADDRESS: INSTITUTE OF ANIMAL BEHAVIOR, 31 FULTON STREET,
NEWARK, NEW JERSEY), 9 MARCH 1964

NEW LIFE MEMBER



A recent addition to the list of Life Members of the Society is Dr. Jack P. Hailman of the Institute of Animal Research of Rutgers University at Newark, New Jersey. Dr. Hailman holds a baccalaureate degree from Harvard University and a doctorate from Duke University, and recently completed postdoctoral studies at the University of Tübingen, Germany. While at Duke he participated in an expedition to the Galápagos Islands and the picture shows him holding a chick of the Swallow-tailed Gull and the model used to check pecking responses of chicks. A by-product of this expedition was the paper on the Swallow-tailed Gull published in this issue of the *Bulletin*. Dr. Hailman's principal ornithological interests are in the ontogenetic, physiological, and cybernetic aspects of avian behavior and he has published several papers on these and other subjects. He is married and has one child.



Hailman, Jack P. 1964. "The Galápagos Swallow-Tailed Gull Is Nocturnal." *The Wilson bulletin* 76(4), 347–354.

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