HAZARDS OF TAIL-FIRST FISH-SWALLOWING BY YOUNG TERNS

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Young Common Terns (*Sterna hirundo*) are fed small fish by their parents during the pre-flying or pre-fledging period, and thereafter until they have mastered the skills involved in fishing for themselves (e.g., LeCroy 1972). Observers such as Jones (1906), the Marples (1934), and Palmer (1941) have commented that almost invariably the young birds swallow the fish head-first. The head undoubtedly provides a firm wedge that facilitates swallowing, while the broad caudal fin would serve instead as an obstacle. Direct observations on feeding of young terns by adults at Jones Beach (Long Island, New York) tern colonies in 1972 revealed only one certain case of tail-first swallowing compared with over 430 cases of head-first swallowing, although in many other cases swallowing was so quick that the orientation of the fish could not be determined. Palmer (1941) stated that head-first swallowing was the only kind he had observed. In the laboratory, however, I have found it possible to cause young terns to swallow fish tail-first by presenting them a fish with the tail toward their beak.

An additional observation (fig. 1) illustrates one hazard of tail-first swallowing. On 10 July 1972, at Cedar Beach (Suffolk County, New York) in a colony of some 1000 pairs of Common Terns, I found a young tern, estimated at 10–12 days old on the basis of size and plumage, that had swallowed a fish (apparently a young Bluefish, *Pomatomus saltatrix*) tail-first. The chick's upper mandible had entered the gill and emerged through the mouth of the fish so that the fish was impaled on the upper mandible. I removed the fish and found that the caudal half of the body had been digested, indicating that it had probably been in place for more than an hour (based on my observations of digestion rates in other chicks). It is impossible to determine what would have happened to this bird without intervention, but even though it would probably have rid itself of the half-digested fish, it would probably have missed several feedings while so encumbered. This is the only such case I have found among about 10,000 young Common Terns handled in six seasons, but it raises the question of why tail-first swallowing is so rare and of how the chicks learn to perfect head-first swallowing.

Feeding experiments, involving 26 wild-hatched tern chicks aged 3–4 days, have revealed other disadvantages associated with tail-first fish-swallowing, even though no accident comparable to that shown in figure 1 occurred. Chicks were kept in captivity and fed at 4–5-hr intervals. The results reported here are limited to the first four feeding periods, because chicks became experienced and changed their behavior with each subsequent feeding period. Therefore, data from later tests are not considered here, and even in the first four periods bias from experience probably exists.

The fish used were Silversides or Spearing (*Menidia menidia* and *M. americanus*) measuring 50–55 mm (snout to base of caudal fin) and weighing about 1.0 to 1.5 g (wet weight). These fish are slender enough to be swallowed tail-first by young tern chicks. Each fish was held crossways in a forceps, either at the gills (= head presentation) or at the caudal peduncle (= tail presentation), and was offered with the forceps pointed toward, and coaxial with the bill. The chicks usually seized the fish close to the forceps, held it crossways in their beaks, and manipulated it with a series of quick vertical tosses of the head, accompanied by slight opening of the bill. When an end was reached, a chick would turn the fish with more tosses and attempt to swallow it. These young chicks usually moved the fish initially toward the shorter end (head on head-first presentation), since gravity acting on the body of the fish would pull the long end downward on each head-toss. This also resulted in frequent loss of the fish as it dropped out of the beak. Older chicks do not have such difficulty, and can easily manipulate a fish against gravity; even 3-day-old chicks can accomplish this with obvious difficulty and many tosses of the head.

For each feeding I recorded the amount of time elapsed between seizure of the fish from the forceps and successful swallowing (= manipulation and swallowing time), and also the number of attempts required. A chick was charged with a failed attempt every time it dropped a fish, whether the bird picked up the fish itself or had to have it presented again with the forceps. Each feeding period or trial for each chick consisted of up to seven attempts, and if the chick failed to swallow the fish after the seventh presentation and attempt, the entire trial was eliminated. This occurred in three cases, apparently when the chicks were not hungry, because all three chicks ate on subsequent trials. Thus for 26 birds and four feeding periods, there was a total of 104 trials of which three were eliminated.

For each trial all of the presentations were made the same way, either head-first or tail-first. The first 15 trials were tail-first, but thereafter the trials were randomized. Table 1 summarizes results for the total of 62 tail-first and 39 head-first trials. Of the head-

TABLE 1. Results of head- vs. tail-first presentation experiments with 3 to 4-day-old Common Tern chicks. *P* values are probabilities based on Mann-Whitney U tests.

Presentation	Swallow	Mean ± S.D. attempts	Mean ± S.D. time (sec)
Head (n = 39)	Head (n = 37)	1.46 ± 0.730	5.27 ± 0.546
		$P < 0.001$	$P < 0.001$
	Tail (n = 2)	5.50	24.50
Tail (n = 62)	Head (n = 33)	2.54 ± 1.325	12.88 ± 0.388
		$P < 0.003$	$P < 0.001$
	Tail (n = 29)	3.34 ± 1.470	21.60 ± 0.349

FIGURE 1. Common Tern chick with fish (probably Bluefish) impaled on upper mandible after tail-first swallowing.

trials, 2 of 39 were swallowed tail-first on the fourth and seventh attempts. By contrast, 33 of 62 tail-trials resulted in fish being swallowed head-first. This difference, tested by a Chi Square on a 2×2 contingency table is highly significant ($P < 0.0001$).

Four possible outcomes were considered: head-first presentations swallowed head-first vs. tail-first, and tail-first presentations swallowed head-first vs. tail-first. The mean elapsed time and the number of attempts required for swallowing a fish are given for each of the four response categories. For head-presentations (with only two tail-first swallows and no ties), the Mann-Whitney U test was used and the probabilities associated with the differences were $P < 0.001$ for both attempts and time. For tail-presentations with many ties, the Median Test and Fisher Exact Probability tests were used. The differences between head-first and tail-first swallowing with respect to time ($P < 0.001$) and number of attempts ($P = 0.003$) were again significant.

For all trials there was a total of 246 attempts. Of tail-first attempts 31 of 143 (21.7%) were successful, compared with 70 of 103 head-first attempts (68%). The difference is significant ($\chi^2 = 53$; $P < 0.0001$). However, as mentioned earlier, these trials are not strictly independent, and will be repeated with randomization for each attempt. Additional observations made on chicks of various ages that were fed in a holding pen with other chicks revealed that of 76 head-first swallowing attempts, fish were stolen only twice, compared with five thefts in 21 tail-first attempts ($\chi^2 = 11$; $P < 0.001$).

The results indicate that tail-first swallowing attempts usually failed. Moreover, even when successful, tail-first attempts required more time and effort on the part of the chick and increased the possibility of having a fish stolen by another bird. Thus even if the "accident" shown in figure 1 is evolutionarily trivial, the disadvantages observed in the feeding experiments are adequate to explain the rarity of tail-first swallowing in nature. They also indicate why chicks learn to swallow fish head-first, almost without errors, by the time they are about a week old.

The cues involved in this learing process remain to be determined. Presumably, success associated with head-first attempts condition chicks to repeat the process, while failures would inhibit future tail-first attempts. My initial results suggest that the manner in which the fish is presented plays a role, since the chicks usually seize the fish close to the forceps in experiments and close to the adult bill in nature. Field observations show that adults usually grip the fish just behind the head (pers. observ.). Also, I have noted that chicks will frequently seize a fish near the eye, as if this contrasting spot elicited pecking, much as for Herring Gulls (*Larus argentatus*) (Tinbergen 1960). Both of these factors increase the likelihood that chicks will attempt to swallow a fish head-first (Gochfeld, unpubl. data).

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PELAGIC GULLS IN WINTER OFF SOUTHERN CALIFORNIA

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The species and age distribution of certain gulls in southern California were reported by Devillers et al. (1971), but few sightings at sea were included. Indeed, except for the work of Sanger (1970, 1973) in the north Pacific, few studies of the movements and ranges of gulls consider pelagic populations (cf. Woodbury and Knight 1951, Kadlec and Drury 1968). This article presents winter observations on age, distribution, density, and species of gulls at sea off southern California.

Most observations were made more than 50 but less than 400 miles offshore, by me or other personnel of the Pacific Ocean Biological Survey Program (POBSP), Smithsonian Institution, during 436 hr of daytime observations, 19 January to 9 April 1967. Observations in pelagic areas between 30°10′ and 35°00′ N and 121°20′ to 126°40′ W, an area of approximately 350 by 300 statute miles (fig. 1), were made from ships usually traveling at about 10 knots.