# CLAM DROPPING BEHAVIOR OF THE GLAUCOUS-WINGED GULL (*LARUS GLAUCESCENS*)

David P. Barash, Patrick Donovan and Rinda Myrick

Tinbergen (1961) and Oldham (1930) have reported that Herring Gulls (*Larus argentatus*) commonly drop whelks (*Baccinum undatum*) and other hard-shelled molluscs in order to break them open, but that their selection of substrate appears to be random, with the birds as likely to drop potential food objects on soft surfaces (sand) as on hard (rocks). The European Gull (*Larus canus*) also shows this same apparently non-adaptive behavior with regard to cockles (*Cardium edule*, Oldham 1930). This curious failure of such adaptive food generalists to make maximal use of a foraging technique is surprising. Our own observations of Glaucous-winged Gulls (*Larus glaucescens*) in northwestern Washington suggested that this species also commonly feeds on marine shellfish, which it opens by dropping. We therefore attempted to investigate substrate selection and other behaviors related to this clam dropping habit.

## METHODS AND RESULTS

We conducted this study on Center Island, one of the San Juan Islands, and at Golden Gardens Park, Washington, between 5 November 1973 and 22 May 1974. Results for the two study areas were comparable and are combined for the following report. A large population of Glaucous-winged Gulls was commonly present. Although it was not possible to recognize most individuals, 3 adults and 3 two-year-olds were identified by feather peculiarities. In addition, 4 adults and 2 yearlings were live-trapped and marked with distinctive dye patterns. Both areas contained a variety of substrates: rock, cement, wood, sand, and water. A minimum of 20 $m^2$ of each substrate was present within ¼ km of each study site. During each set of observations, a small pile of 3–15 butter clams (*Sacidonus giganteus*) was exposed to the gulls, and detailed records were made of their feeding behavior. The substrate upon which the clams were placed was determined each time by use of a random numbers table, so as not to consistently predispose subsequent behavior toward any particular substrate.

The gulls used either standing or flying drops to open the clams. During standing drops the clams were released while the gull remained on the ground. There was considerable variation in this behavior, especially with regard to the position of the head when the clam was released. Head position during standing drops varied from maximum vertical extension to just a few

TABLE 1

SUBSTRATES UPON WHICH CLAMS WERE DROPPED

| | Rock | Wood | Cement | Sand | Water | Total |
|---|---|---|---|---|---|---|
| Flying Drops | 79 | 38 | 12 | 11 | 6 | 146 |
| Standing Drops | 420 | 159 | 21 | 20 | 0 | 620 |
| Totals | 499 | 197 | 33 | 31 | 6 | 766 |

centimeters above the substrate. With successive standing drops there was often an incremental lowering of the head until the clam appeared to be deposited almost directly upon the substrate. Flying drops occurred at altitudes ranging from 0.5 to 15 m and appeared to be most commonly 4 to 7 m. They characteristically involved a horizontal flight of varying length followed by a brief, almost vertical ascent, a hover of about 0.5 sec, and then the drop itself. The substrates upon which all observed clams were dropped are presented in Table 1.

Combining rock, wood, and cement as "hard" substrates as opposed to the "soft" substrates of sand and water, gulls used the former significantly more often (binomial test; Siegel 1956, $p < .001$). Standing drops were also used significantly more often than were flying drops ($p < .001$). Although this trend is apparent for both hard and soft substrates, the preference for standing drops appears greater on the hard substrates (82% standing vs 18% flying) than on the soft ones (54% standing vs 46% flying); however, because of the small number of soft-substrate drops, this possible trend cannot reliably be evaluated.

Predictably, flying drops are more effective than standing drops: the former averaged 1.72 drops per clam (SD .63) the latter, 3.91 (SD 1.19). The difference is significant (t-test, $p < .001$). Similarly, hard-substrate drops are more effective than their soft counterparts: hard substrate flying drops were always successful the first time (one drop per clam), while soft-substrate flying drops averaged 1.96 (SD .70; t-test, $p < .01$). Hard-substrate standing drops averaged 2.54 drops per clam (SD .48), while soft-substrate standing drops averaged 4.23 (SD .69; t-test, $p < .01$).

We also attempted to identify the factors involved in the selection of dropping techniques, standing vs flying. Time of day, height of the tide and age of the animals provided no significant correlations. However, the technique employed was correlated with the abundance of gulls in the immediate area. We estimated the gull density within 50 m of the clam-dropping animal on 80 arbitrarily selected observations: flying drops averaged 11.6 animals within 50 m (SD 7.3) and standing drops averaged 26.4 (SD 10.9). These data produced a point biserial correlation coefficient of 0.31 (Walker and Lev 1953), indicating a significant ($p < .01$) correlation of flying drops with low density of nearby animals and of standing drops with high density.

Clearly, gulls do not drop all prospective food items; a simple experiment investigated the cues involved. Soft clay models of butter clams were interspersed with the real ones on five occasions: the models were probed with the bill but never dropped. Kiln-hardened models, however, were dropped and treated the same as real clams, suggesting that hardness, perhaps combined with visual properties, identifies the object as one worthy of being dropped.

Our observations also indicate an age-related progression of increased clam-slamming efficiency in this species. Thus, yearling gulls accounted for 6% of the 729 hard-substrate drops, and 78% of the 37 soft-substrate drops ($p < .01$). Two-year-olds accounted for 13% of the hard-substrate drops and 14% of the soft-substrate drops, while adults performed 81% of the hard-substrate drops and only 8% of the soft ($p < .01$). In addition to substrate selection, learning may also be reflected in the actual techniques of clam dropping, both standing and flying. Thus, yearlings fumbled their clams (dropping them when attempting to fly) on 29% of their attempts; this occurred in only 7% of adult attempts. Furthermore, yearlings accounted for all of the flying drops made from less than 1 m (9) and greater than 10 m (11). The unusually low-altitude drops appeared to be less successful than those in the more normal range and probably constitute inefficient use of the energy expended in performing a flying drop. Correspondingly, 6 (55%) of the very high altitude drops resulted in the clam being appropriated by other gulls before the original bombardier was able to descend. By contrast, only 8% of normal altitude drops were consumed by animals other than the one performing the drop.

Yearlings also appeared to be less efficient at standing drops. Thus, they accounted for 64% (111 of 174) of the standing drops estimated to have been less than 10 cm as opposed to 22% (98 of 446) of those exceeding 10 cm in height. The biserial correlation coefficient relating height of standing drops (above or below 10 cm) with number of drops required was .36, indicating that greater height required significantly fewer drops ($p < .05$). On the other hand there was no suggestion that the choice of clam dropping technique (standing vs flying) correlated with age. Dichotomizing the data into adults vs juveniles and standing vs flying drops produced a tetrachoric correlation coefficient of .13 (Walker and Lev 1953) indicating no significant correlations.

Finally, certain dropping sites appeared to be preferred by certain individuals and in some cases, even partially defended. Four individually recognized adults each used different rock areas during a two-month period for all their flying drops and 63% of their standing drops. There was no discernible tendency for juveniles to similarly concentrate their activities at particular places. On seven occasions a juvenile flying with a clam was chased away from one of these rock areas by the adult proprietor. No adults with clams were seen to intrude onto these four areas; however, when they were not carrying clams, both adults and juveniles often congregated on these rocks and were not attacked.

## DISCUSSION

Flying drops are more efficient in terms of the number of such drops required for success but presumably are more expensive metabolically than are standing drops and also carry a greater risk of the food being pirated by other animals. The precise circumstances that render one strategy more efficient than the other are not known, but local density of potential competitors may be important, with lower density favoring flying drops and higher density favoring standing drops. In either case, use of a hard substrate seems maximally efficient.

As suggested by the relative inefficiency of juveniles, clam dropping bebehavior may well involve learning. The relatively well-developed flying ability of juveniles strongly suggests that the disparity between their performance and that of adults is not caused by maturational factors. However, this situation could be clarified by observations of newly-released captive animals who had been deprived of the opportunity to feed in this manner. In addition, further field studies in other geographic regions may be worthwhile in determining the extent to which clam dropping is a locally learned tradition, possibly analogous to other food-gathering techniques already documented for birds (Hinde and Fisher 1952) and primates (Itani 1958).

Brown (1964) has emphasized that territorial behavior requires resources that are economically defensible. Rocks that are particularly suitable for breaking clams would appear to fall within this category. If clam dropping rocks are selectively defended only against gulls that are themselves carrying clams, this would introduce a novel aspect to the literature on territorial behavior. We might expect that such defense is actually somewhat nonadaptive, since the resource itself (the rocks) is not diminished by another animals' use, and indeed, the proprietor may benefit by frequent use of his property assuming that he occasionally can pirate a clam dropped by another bird. In this sense, his apparent defense may simply represent an aggressive attempt to steal the clam from another bird, behavior which may be more likely for an animal whose social dominance is enhanced by proximity to a familiar area. On the other hand, defense of a suitable clam dropping area may itself be adaptive if it reduces the local population density around these rocks, thereby decreasing the probability that the proprietor will himself suffer piracy when breaking open his own clams.

In the present study, juveniles were never seen to defend any clam dropping area and their generally reduced use of hard over soft substrates may reflect their lower social status as much as inadequate learning. Thus, juvenile Glaucous-winged Gulls feeding on spawned salmon in Alaska are relegated to less desirable feeding areas (Moyle 1966).

Finally, it remains to be pointed out that the Greek poet, Aeschylus, is reputed to have been killed by a falling tortoise that had been dropped onto his (hard substrate) bald head by a passing bird. Although the culprit species remains unidentified, the present study suggests that further investigation of clam-dropping behavior in gulls may be a hazardous activity, especially for ornithologists with receding hairlines!

## SUMMARY

Glaucous-winged Gulls break open clams by dropping them, using either standing or flying drops. Both techniques preferentially utilize hard substrates, in distinction to previous reports for several European species. The relative efficiency of hard vs soft substrates, and high vs low standing and flying drops was investigated. Adults are more efficient clam droppers than are juveniles, and certain clam dropping areas may be actively defended.

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DEPTS. OF PSYCHOLOGY AND ZOOLOGY, UNIV. OF WASHINGTON, SEATTLE, WA 98195. ACCEPTED 2 AUG. 1974.