PREY DROPPED BY HERRING GULLS (*LARUS ARGENTATUS*) ON SOFT SEDIMENTS

BRETTON W. KENT

Department of Zoology, University of Maryland, College Park, Maryland 20742 USA

ABSTRACT.—The prey dropped by Herring Gulls (*Larus argentatus*) on soft sediment substrates in northwest Florida were examined between January and April 1979. Bivalves were the dominant prey, with the scallop (*Argopecten irradians*) accounting for over half of the prey dropped. Only the largest available prey were dropped. Gastropods were abundant but were not dropped due to greater resistence to breakage than bivalves. *Received 10 June 1980, accepted 2 December 1980.*

GULLS are well known for their ability to open shelled invertebrates by dropping them on hard substrates (Tinbergen 1953, Harris 1965, Barash et al. 1975). In this paper I examine the prey dropped by wintering Herring Gulls (*Larus argentatus*) on soft substrates in the Turkey Point region of Franklin County, Florida. This area has a diverse fauna of large, hard-shelled invertebrates that potentially could be utilized by gulls, but hard substrates for drop sites are absent. Most of the intertidal zone consists of grassflats of muddy sand interrupted by occasional bars of firmly packed sand. The objectives of this study were to examine the diet of Herring Gulls using sandbar drop sites and to correlate this diet with the relative vulnerability of different prey to being opened on sandbars.

METHODS

Gull drop sites were examined on three sandbars near the Florida State University Marine Laboratory at Turkey Point between January and April 1979. All three sandbars are bordered by seagrass beds composed of shoal grass (*Halodule wrightii*) and turtle grass (*Thalassia testudinum*). Gulls forage on these grass flats during low tides and take prey to the nearest sandbar for dropping. When the gulls reach the bar, they make a vertical ascent to about 10–15 m, hover briefly before releasing the prey, and then, following the release, make a short spiral descent to the sandbar to examine the prey.

Gulls were observed dropping prey items during low tides. In order to examine the prey eaten during each observation period, I walked along sandbars just before they were covered by the incoming tide. The species and size of each prey item was recorded. The maximum anteior-posterior dimension of bivalves and gastropods, the carapace width of crabs, and the test diameter of urchins were recorded. Some prey were too badly broken to be measured. The size distributions of the major prey species available to gulls were obtained by systematically searching the grass beds exposed at low tide where the gulls normally foraged. These prey were replaced after being measured.

The vulnerability of prey was examined by dropping prey from known heights onto firmly packed sandy soil. This substrate was similar to, but slightly softer than, the sandbars normally used by gulls. Prey were dropped initially from 10.0 m, and the number of each species stunned or broken was recorded. Unopened prey were then dropped from 12.5 m, and the procedure repeated at 2.5-m intervals to a height of 22.5 m.

RESULTS

The prey dropped by Herring Gulls are listed in Table 1. Because no systematic differences occurred between the three sites, the data were pooled. Bivalves were the major prey, with the scallop (*Argopecten irradians*) accounting for over half of the observed feedings. Three species, the cockle (*Trachycardium egmontianum*), the spider crab (*Libinia dubia*), and the urchin (*Lytechinus variegatus*), were moderately important. The remaining species were only infrequently eaten. No gastropods were

TABLE 1. Prey dropped on sandbars by Herring Gulls between January and April 1979.

Prey species	Size range eaten (mm)	Number eaten	Percentage of diet	Percentage broken
Bivalves				
Argopecten irradians	41–87	186	56.0	24.0
Dinocardium robustum	55–85	8	2.4	87.5
Trachycardium egmontianum	32–53	52	15.7	78.8
Lucina floridana	36	1	0.3	100.0
Macrocallista nimbosa	87–148	6	1.8	66.7
Mercenaria campechensis	67–95	3	0.9	100.0
Decapod crustaceans				
Libinia dubia	23–87	44	13.3	100.0
Callinectes sapidus	87–90	2	0.6	100.0
Echinoids				
Lytechinus variegatus	49–58	30	9.0	100.0

dropped and eaten. Several times during the study I observed gulls turning over gastropods (*Busycon spiratum, B. contrarium,* and *Fasciolaria lilium*), but they were not carried to sandbars and dropped. The gulls did peck at the foot of each overturned snail. These snails were collected and held in a tank of circulating seawater, and all survived, with only minor damage to the opercula.

Not all prey had to be broken to be eaten (Table 1). *Argopecten* when dropped were frequently only stunned, but not broken. Gulls inserted their beaks between the gaping valves and removed the soft parts. All other prey usually had to be broken in order to be eaten. Observations with binoculars during the drops showed that bivalves broke most readily when one valve received the full impact of being dropped. Bivalves that landed on the commissure between the valves rarely broke. Crabs broke most readily when they landed upside down so that the carapace was smashed. Urchins broke at all points of impact and were usually broken further by short drops made while the gull was standing.

Comparisons of the size distributions in the grass beds and at drop sites of *Argopecten, Libinia,* and *Trachycardium* all show a consistent pattern (Fig. 1). Within a prey species, Herring Gulls show a decided preference for the largest available prey. For all three species, gulls were able to find and eat prey larger than those I could find living in grass beds. This absence of large *Argopecten, Libinia,* and *Trachycardium* in grass beds suggests that these individuals are rapidly located and consumed by gulls.

No comparison between living and dropped *Lytechinus* was possible because most urchins dropped by gulls were too badly broken to be measured. The other prey items were eaten too infrequently to allow any definitive conclusions about size selection, although several qualitative comparisons can be made. The largest *Lucina floridana* and *Macrocallista nimbosa* eaten are very similar to the maximum sizes I have observed in the grass beds. For *Dinocardium robustum, Mercenaria campechensis,* and *Callinectes sapidus,* the largest size eaten (Table 1) is considerably smaller than the largest available (106, 153, and 151 mm respectively). Despite the small sample sizes for these species, it can be concluded that the largest individuals eaten are probably very close to the largest the gulls are capable of handling, because they closely approximate the sizes of the largest prey of a similar type eaten (Table

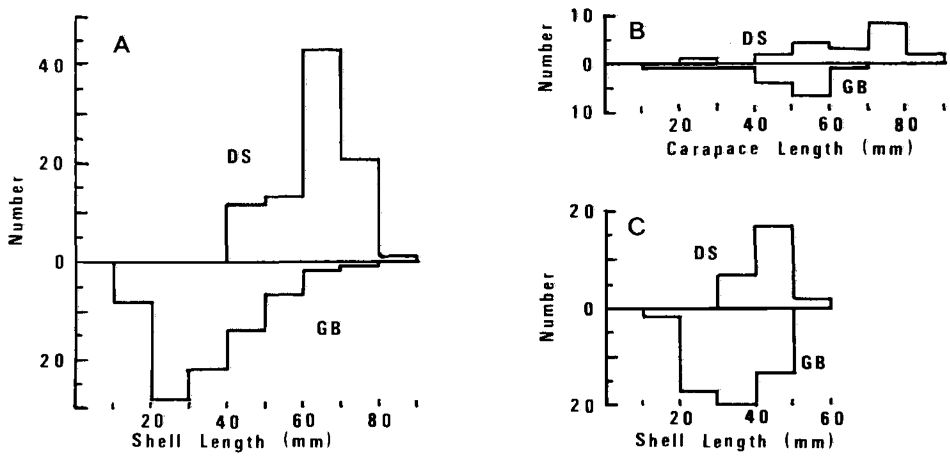

Fig. 1. Size distributions for Herring Gull prey from drop sites (DS) and grass beds (GB). A = *Argopecten irradians,* B = *Libina dubia,* and C = *Trachycardium egmontianum.*

1). The only apparent exception is *Macrocallista,* but, because of its elongate, flattened shape, it is comparatively light for its length.

Gastropods, which are very common in the grass beds but are not dropped by gulls, are much more resistant to being opened by dropping than bivalves (Table 2). The two most frequently eaten bivalves, *Argopecten* and *Trachycardium,* were readily stunned or broken, while the gastropods, *Busycon spiratum, B. contrarium,* and *Fasciolaria lilium,* were not. Stunned bivalves gaped widely and did not respond when touched. Such prey could be readily eaten by gulls.

None of the gastropods sustained any shell damage or showed a response analogous to gaping in bivalves. Snails remained deeply withdrawn into their shells throughout the experiment. After the experiment the snails were placed in a tank of circulating seawater to see if any had been stunned or killed. After 24 h, 2 *Fasciolaria,* 2 *B. spiratum,* and 3 *B. contrarium* were dead. All of the dead snails were so deeply withdrawn into their shells that they would have been unavailable to gulls. The surviving snails showed no ill effects from having been dropped.

TABLE 2. Number of prey stunned or broken when dropped on firm, sandy soil. Each prey item was dropped from progressively greater heights (10.0–22.5 m by 2.5-m increments) until it was either stunned or broken.

Prey species	*n*	Size range (mm)	Number stunned	Number broken	Percentage opened	Mean height when opened (m)
Bivalves						
Argopecten irradians	5	64–68	5	0	100.0	10.5
Trachycardium egmontianum	4[a]	44–49	2	2	100.0	16.8
Gastropods						
Busycon spiratum	5	85–93	0	0	0.0	—
Busycon contrarium	5	88–112	0	0	0.0	—
Fasciolaria lilium	5	65–78	0	0	0.0	—

[a] A fifth *Trachycardium* was broken when a *B. spiratum* was inadvertently dropped on it from 17.5 m. The *B. spiratum* was not damaged.

Discussion

In order to be profitable, prey selected for dropping must be easily broken or stunned and large enough to offset the energy required to find, carry off, and drop them. Such constraints must be particularly important for gulls in areas lacking hard substrates, because prey break less readily on soft substrates than on hard ones (Barash et al. 1975). The absence of gastropods as dropped prey and the selection of the largest prey that could be handled reflect these constraints.

Gastropods, either alive or as the abode of hermit crabs, have been dropped successfully by gulls in other areas (Colton 1916, Oldham 1930, Magalhaes 1948, Harris 1965, Spight 1976). In almost all these cases snails were dropped on hard substrates. Where only soft substrate drop sites are available, snails are much less desirable prey items than bivalves because of their greater resistance to breakage (Table 2). Furthermore, bivalves need only be dropped until either stunned or broken, while gastropods may need to be dropped and broken more than once in order to extract the tissues completely (Zach 1978).

The greater durability of gastropods is not caused by differences in shell thickness. Thick-shelled *Trachycardium* (valves 1.4–1.9 mm thick) could be readily broken, while the thinner-shelled gastropods *B. spiratum* and *Fasciolaria* (0.6–1.0 mm) could not (Table 2). This difference was particularly obvious when a *B. spiratum* was accidentally dropped on a *Trachycardium* from 17.5 m. The *Trachycardium* was badly fractured, while the *B. spiratum* was undamaged.

One important difference between bivalve and gastropod shells is the internal reinforcement of the shell spire caused by the helical growth form in gastropods. Because snails deeply withdraw into their shells when handled and dropped, they tend to land on the strengthened spire, which should increase durability. Differences in the crystalline structure of the shell can also affect shell strength (Vermeij and Curry 1980), but I have not investigated this possibility.

Selection for the largest prey that can be handled for dropping has been observed previously in gulls (Siegfried 1977) and crows (Zach 1978). Large prey not only yield a larger reward than that obtained from small prey but also break more readily (Siegfried 1977, Zach 1979). Selection for the largest prey should be particularly important when prey is dropped over soft substrates. The mean number of drops needed to open a prey is greater on soft substrates than it is on hard substrates (Barash et al. 1975), causing a concomitantly higher energetic investment in each prey. The selection of the largest and most easily broken prey by the gulls in this study (Fig. 1) therefore is not surprising. Although it appears that energetic and structural constraints prevent the effective use of small prey by dropping, the data should not be construed to show that small prey are not eaten. Small prey may be swallowed whole and the empty shell later regurgitated (Colton 1916, Harris 1965). This tactic reduces the energetic investment in each prey item and allows gulls to consume small prey profitably.

Soft substrate dropping sites impose severe constraints on the prey items selected for dropping. Some prey, such as gastropods, cannot be readily broken and must be ignored. More susceptible prey can apparently only be dropped in the larger, more energetically profitable, and more easily broken sizes.

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