Hermit Crabs in the Diet of Pigeon Guillemots at Kachemak Bay, Alaska

MICHAEL A. LITZOW, JOHN F. PIATT AND JARED D. FIGURSKI

Alaska Biological Science Center, U.S. Geological Survey, Biological Resources Division, 1011 E. Tudor Rd., Anchorage, Alaska 99503 USA
Internet: litzow@cats.ucsc.edu

Abstract.—Guillemots *(Cepphus* spp.) feed their chicks a diet that is almost exclusively fish. We observed Pigeon Guillemots (*C. columba)* at two colonies in Alaska where hermit crabs (Crustacea: Anomura) were a major part of the diet for some nestlings. Hermit crabs were delivered to three of five observed nests at one colony, comprised between 2% and 22% of the items delivered at those nests, and were the second most common food type at one nest. Hermit crabs may be an attractive prey item when lipid-rich forage fish are scarce, and crabs living in gastropod shells that have been softened by encrustations of *Suberites* sponges may be vulnerable to guillemot predation. *Received 11 March 1998, accepted 1 April 1998.*

Key Words.—*Cepphus,* diet, foraging, hermit crab, nestling, Pigeon Guillemot.

Colonial Waterbirds: 21(2): 242-244, 1998

Crustaceans and other invertebrates are eaten frequently by adult Pigeon Guillemots (*Cepphus columba*) (Ewins 1993), but usually comprise less than 1% (by number) of meals in chick diets (Drent 1965; Ainley *et al.* 1990; Emms and Verbeek 1991; Vermeer *et al.* 1993; Oakley and Kuletz 1996). We report on a study of two guillemot colonies in Kachemak Bay, Alaska, where hermit crabs were delivered to nestlings throughout the chick-rearing period. Predation on hermit crabs may have been in response to a local scarcity of lipid-rich schooling fish. These observations document a degree of flexibility in prey selection not previously reported for Pigeon Guillemots.

STUDY AREA AND METHODS

Kachemak Bay is located on the east shore of lower Cook Inlet, Alaska. We studied the provisioning of chicks by adult Pigeon Guillemots at two colonies (Outer Seldovia Bay and Inner Seldovia Bay) located about 2 km from each other near the town of Seldovia in southwestern Kachemak Bay. This area includes cliffs and rocky headlands that provide suitable nesting habitat for Pigeon Guillemots. We conducted all-day watches (0500 - 2300 h, two at Outer Seldovia, three at Inner Seldovia) from blinds and anchored boats, between 17 July and 5 August 1997. Using telescopes and binoculars, we recorded meal delivery times and identified prey items to the lowest possible taxonomic level. We also collected chick meals (N = 18) at these two colonies to confirm our visual identifications. Discarded meals were collected when we visited nests in the course of other field activities, and mist nets were used to block burrow entrances so that incoming adults occasionally dropped prey items they were carrying.

RESULTS

Hermit crabs were present in diets at 60% of nests (N = 5) and comprised 8% (by number) of all meals (N = 250) observed at Outer Seldovia Bay. At Inner Seldovia Bay hermit crabs were delivered to 40% of nests (N = 5) and comprised 1% of total meals (N = 286). Hermit crabs were never delivered as whole, intact items. Most meals consisted of the abdomen alone, or with part of the carapace and some legs attached. Shells were never delivered.

Other important prey taxa at the two colonies were sculpins (Cottidae), gunnels (Pholidae), pricklebacks *(Lumpenus* spp.), flatfish (Pleuronectidae), and Pacific sand lance *(Ammodytes hexapterus).* The proportion of hermit crabs in the diet of individual broods varied from 0% to 22% at the Outer Seldovia colony (Fig. 1). The taxonomic composition of nestling diet varied significantly between nests at that colony (χ^2_{20} = 122.4, $P < 0.0001$).

Two partial hermit crabs were collected at the Outer Seldovia Bay colony. We intercepted one as it was being delivered to the nest. This meal consisted of the abdomen and two of the posterior legs of an Alaskan Hermit Crab *(Pagurus ochotensis)* and weighed 5.77 g. The other sample consisted of the left claw of a hermit crab *(Pagurus* sp.). It had been discarded in a nest and

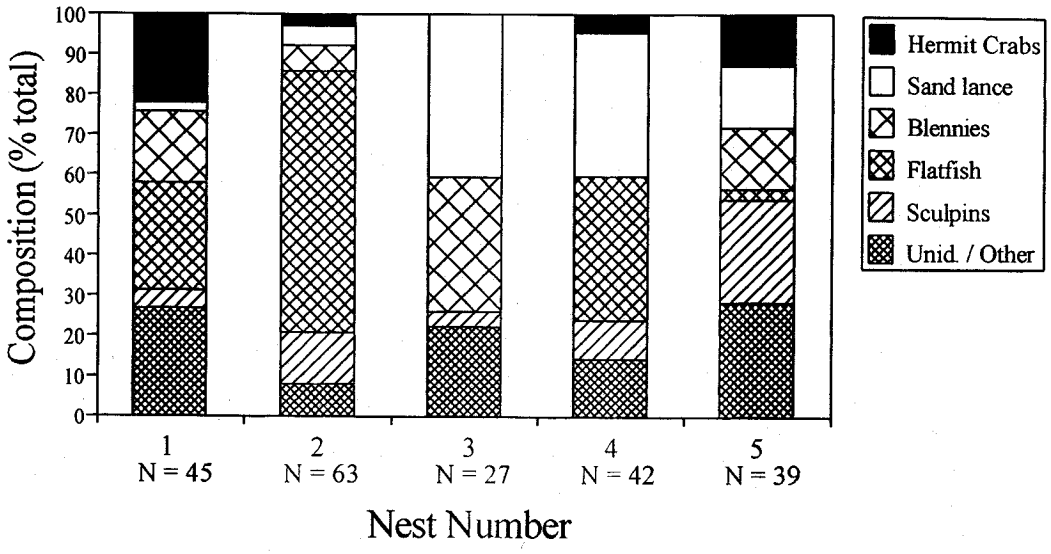

Figure 1. Diet composition (% total number) of Pigeon Guillemot chicks at five nests at Outer Seldovia Bay during summer 1997. These five nests are located within about 30 m of each other.

was apparently the remains of a delivered meal. The mean weight of fresh fish from chick meals collected in 1996 and 1997 throughout Kachemak Bay was 11.88 g (N = 56, SE = 1.09).

DISCUSSION

In contrast to other alcids, *Cepphus* guillemots forage primarily near the sea floor and eat a wide variety of benthic prey (Cairns 1981; Duffy *et al.* 1987; Ewins 1993; Clowater and Burger 1994). Adult guillemots consume benthic invertebrates, but these prey are rarely delivered to chicks (Cairns 1987; Ewins 1993). Hermit crabs have an energy density of about 12.7-12.8 kJ g^{-1} dry mass (DM) (Norrbin and Båmstedt 1984; Wacasey and Atkinson 1987), less than the 16.2-18.9 kJ g^{-1} DM reported for some benthic fish prey of guillemots (Anthony and Roby 1997) and still less than the 20.1-21.1 kJ g^{-1} DM reported for mature Pacific sand lance (Van Pelt *et al.* 1997). The weight of the hermit crab meal we collected was about half the mean weight of collected fish meals. If breeding guillemots maximize energy delivery to chicks by choosing prey of optimal size and energy content, and by maximizing delivery rates, then hermit crabs would be an attractive prey item only if they were inexpensive in terms of search effort and handling time, and could be delivered to broods at a higher rate than fish. However, hermit crabs are delivered to chicks only after they have been removed from their shells, a task that would seem prohibitively expensive in terms of handling time.

Ordinarily, this may be true, and in addition to their low energy density probably explains why hermit crabs are not a common prey item; however, the guillemots we observed in Kachemak Bay may have been preying on hermit crabs that were encrusted by the Hermit Sponge *(Suberites ficus).* Many hermit crabs caught in bottom trawls in Kachemak Bay were encrusted with these sponges (Piatt *et al.* unpubl. data), which dissolve the shells they grow on (Kessler 1985) and therefore might make encrusted hermit crabs vulnerable to guillemot predation.

Hermit crabs have not been observed in chick diets at other guillemot colonies in Kachemak Bay (Prichard 1997; Litzow *et al.* unpubl. data). Hermit crabs are common near other colonies (Piatt *et al.* unpubl. data), but data are not available to compare rates of *Suberites* encrustation around colonies. Benthic forage fish are abundant in Seldovia Bay (Piatt *et al.* unpubl. data), so the

selection of hermit crabs does not appear to result from a lack of other prey. Guillemots at other large colonies in Kachemak Bay feed their chicks a high proportion of sand lance (Prichard 1997), but these fish form a small part of the diet in Seldovia Bay. Pigeon Guillemot diet diversity tends to increase in years when favored schooling fish are absent (Ainley *et al.* 1990), so the presence of hermit crabs in guillemot diets at Seldovia Bay may reflect the opportunistic exploitation of a poorly–defended benthic invertebrate in the absence of abundant lipid–rich schooling fish.

ACKNOWLEDGMENTS

Funding and logistical support were provided by the Alaska Biological Science Center (U.S. Geological Survey), the *Exxon Valdez Oil* Spill Trustee Council, the Alaska Maritime National Wildlife Refuge (U.S. Fish and Wildlife Service), the University of Alaska Fairbanks, and Oregon State University. Max Hoberg and Kathy Turco identified collected crabs. Our thanks to Bryan Duggan, April Nielsen, Mike Shultz, Brian Smith, and Sadie Wright for their help with field work, and to Dan Roby for continuing support of guillemot research in Kachemak Bay. The findings and conclusions presented are ours and do not necessarily reflect the views or position of the *Exxon Valdez* Oil Spill Trustee Council.

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