# THE PELAGIC FEEDING HABITS OF IVORY AND ROSS' GULLS

GEORGE J. DIVOKY

Little information is available on the pelagic feeding habits of the Ivory Gull (*Pagophila eburnea*) and Ross' Gull (*Rhodostethia rosea*). This paper reports the food found in the stomachs of 13 Ivory and 24 Ross' gulls collected from an icebreaker in the Chukchi Sea, and 7 Ross' Gulls collected from shore near Point Barrow, Alaska. Observations on the feeding behavior of these two species in the Chukchi, Beaufort and Bering Seas are also presented, and the importance of sea ice as a feeding area is discussed.

Specimens were collected between 24 September and 9 October 1970 in the eastern Chukchi Sea southwest of Point Barrow and north of Cape Lisburne (for specific localities see Watson and Divoky 1972). With one exception, all birds were collected at the edge of the pack ice, either in leads or in the brash ice just south of the consolidated pack. Sea surface temperatures ranged from –1.8° to 1.7°C. A single Ross' Gull was collected in an ice-free area with a sea surface temperature of 3.1°C. Seven Ross' Gulls were collected from shore in 1975, two at Cooper Island, 32 km E of Point Barrow on 4 September, and five at Point Barrow between 9 and 18 September. Pack ice was visible 2 to 3 km from shore and grounded ice floes were present on part of the shoreline. Sea surface temperatures ranged from –1.5° to 0°C at these localities. Ross' Gulls were observed in the Chukchi Sea in summer and fall and the Beaufort Sea in fall. Ivory Gulls were observed in the Beaufort Sea in summer, Chukchi Sea in fall and Bering Sea in winter. Terms used to describe feeding methods are from Ashmole and Ashmole (1967:70–71).

## IVORY GULL

Juvenile arctic cod (*Boreogadus saida*) was the primary food in Ivory Gull stomachs (table 1), as indicated by the presence of otoliths. The otoliths ranged from 1 to 6.5 mm, corresponding to fish of approximately 40 to 140 mm total length. Two benthic tunicates found in one stomach must have been taken after they floated to the surface. A single amphipod, *Apherusa glacialis*, was present in one stomach; *Potentilla* sp. seeds were present in two stomachs.

Ivory Gulls fed by hovering and contact dipping. Most fed within 2 to 3 m of the ice. They were observed sitting on the water only three times, but were not feeding. When the ship was breaking ice in the Beaufort and Chukchi Seas, the propellers frequently washed arctic cod onto ice floes. These were eaten by Ivory and other gulls. In the Bering Sea, Ivory Gulls occasionally fed on small, unidentifiable items washed onto the ice by natural waves (fig. 1). In the Chukchi Sea flocks of these gulls were twice seen flying over surfacing whales and may have been feeding on items they brought to the surface. Garbage thrown on the ice often was scavenged, natural refuse only rarely. In the Chukchi Sea in fall a single Ivory Gull was observed picking at walrus (*Odobenus rosmarus*) feces on an ice floe.

It frequently is stated that the Ivory Gull depends on the carcasses and feces of pack ice mammals for much of its food (Salomonsen 1950:290–292, Lovenskiold 1964:271, Dement'ev et al. 1969:467). Seals killed by polar bears (*Ursus maritimus*) are thought to be a major food source (Summerhayes and Elton 1928). Thus, Birkenmajer (1968) attributed the decline of the Ivory Gull population on Spitsbergen to a declining polar bear population. Kurotshkin (1970) explained the high mobility of the Ivory Gull's jaw on the basis of a staple winter diet of frozen polar bear, seal and walrus feces.

Little evidence from the western Arctic supports these ideas of the Ivory Gull's dietary dependency. I saw no Ivory Gulls in association with 20 polar bears observed in the Beaufort Sea or the 15 observed in the Chukchi Sea (Watson and Divoky 1972, Divoky, unpubl. data). Polar bears are common in both these seas in winter but Ivory Gulls remain with the ice edge as it advances southward into the Bering Sea (Bailey 1948: 264). They are found there in the loose ice at the southern edge of the pack in the general vicinity of St. Matthew Island (Irving et al. 1970, Divoky, unpubl. data). This is outside the range of polar bears, which now rarely occur south of St. Lawrence Island (Jack W. Lentfer, pers. comm.).

Evidence suggesting that pinnipeds are a major supplier of food in the western Arctic also is lacking. The walrus would provide the most constant and readily available food



The Condor 78:85–90, 1976

TABLE 1. Stomach contents of Ivory and Ross' Gulls collected in the Chukchi Sea in fall.

| Food items | Ivory Gull no. | Ivory Gull %[a] | Ross' Gull no. | Ross' Gull % |
|---|---|---|---|---|
| (No. of stomachs) | (13) | | (24) | |
| Arctic cod: | | | | |
| *Boreogadus saida* | 12 | 92 | 19 | 79 |
| Amphipods (total): | 1 | 8 | 13 | 54 |
| *Apherusa glacialis* | 1 | 8 | 10 | 42 |
| *Anonyx nugax* | | | 1 | 4 |
| *Gammarus locusta* | | | 1 | 4 |
| *Atylus bruggeni* | | | 1 | 4 |
| Unidentified | | | 2 | 8 |
| Echiuroid: | | | | |
| *Echiurus echiurus* | | | 4 | 17 |
| Pyurid ascidian | 1 | 8 | | |
| Coleoptera | | | 1 | 4 |
| Plant material (total): | 3 | 23 | | |
| Phaeophyceae (brown algae) | 1 | 8 | | |
| *Potentilla* sp. seeds | 2 | 15 | | |
| Ship's refuse | 1 | | | |

[a] No. of stomachs containing the item/total no. stomachs examined.

source because it hauls out on the ice more frequently than other pinnipeds and leaves ice floes covered with feces. While Ivory Gulls in the Chukchi Sea in fall commonly were seen in areas where walrus feces were plentiful on the ice, only one instance of scavenging on the feces was recorded. Although Ryder (1957) observed Ivory Gulls in the Bering Sea in February feeding among walruses on ice floes, I found them in the Bering Sea in February and March to be well south of the large concentrations of walrus (Divoky, unpubl. data). Ryder also observed Ivory Gulls, as well as Black-legged Kittiwakes (*Rissa tridactyla*) and Glaucous Gulls (*Larus hyperboreus*), feeding on seal carcasses. Seals probably provide little food except in April and May when all the pack ice pinnipeds are whelping and placentas may be a major food source as they are in parts of the eastern Arctic (Tuck 1960:104–105).

Zooplankton may be an important food item in the spring when Ivory Gulls move north into the Chukchi Sea (Bailey 1948:247). During that season, Brower found Ivory Gulls to be more common at Barrow during westerly winds when they fed on an "invertebrate scum" floating on the water's surface (Bailey 1948:248).

Stomachs of Ivory Gulls from the eastern Arctic contain primarily fish and invertebrates. Manniche (1910) found mainly fish bones and crustaceans although he also found

FIGURE 1. A flock of adult and immature Ivory Gulls feeding on items washed onto the ice in the Bering Sea in April. (Photo by George E. Hall.)

insects in the stomach of one summer bird and a piece of seal flesh in another. The stomach of a gull collected off Greenland (Cottam 1936) contained primarily invertebrates, including 115 *Thysanoessa inermis*, 5 *Apherusa glacialis* and traces of arctic cod and copepods. An Ivory Gull shot at a glacier face was full of *Thysanoessa* sp. (Hartley and Fisher 1936). Jackson (1899:419–420) found "shrimps," fish, pelecypod shells and brown algae in the stomachs of nine birds. Only small crustaceans were present in the birds examined by Kumlien (1879).

Fish and invertebrates are probably the primary food during breeding. Bateson and Plowright (1959) saw mostly fish and crustaceans being fed to young. The two birds they collected contained only arctic cod. Montague (1926) found fish and carrion in the stomachs of birds collected at breeding sites.

Although scavenging by Ivory Gulls has been recorded often in the eastern Arctic (e.g., Lovenskiold 1964:271–272), there is no evidence that such scavenging provides most of the diet throughout the year. Much of the scavenging observed was on garbage and carrion provided by man. Many species of gull will use such refuse, but there is no indication that scavenging by birds not associated with man is as frequent. Apparently, the Ivory Gull's habit of rarely sitting on the water has reinforced the view that it is unable to obtain food from the water and that scavenging on carrion and feces constitutes the bulk of its feeding activity. Montague (1926) surmised that fishes found in Ivory Gull stomachs were not obtained from the water but were picked up after being dropped by other birds. As this paper and previously published reports on stomach contents show, the Ivory Gull does obtain much of its food from the water.

The role that pack ice mammals play in providing food for the Ivory Gull cannot be ascertained until regular observations of feeding activity are made throughout the year in various regions; however, the species is not as dependent on pack ice mammals as previous authors have stated. Rather the Ivory Gull appears to feed primarily on fish and invertebrates associated with the ice and to a lesser extent on the feces and carcasses of mammals found at the pack ice edge.

## ROSS' GULL

Juvenile arctic cod were found in 79% of the Ross' Gull stomachs collected at sea (table 1). Otolith size was the same as in the Ivory Gull. Because otoliths persist in the stomach for some time, the relative importance of arctic cod as a food item is probably exaggerated. Amphipods were an important part of the diet in the Chukchi Sea, being present in 54% of the stomachs. *Apherusa glacialis* was the most abundant amphipod; one stomach contained 160, six contained between 40 and 90, and three contained less than 5. Three *Anonyx nugax*, two probable *Gammarus locusta* and one *Atylus bruggeni* also were found. Four stomachs contained ventral setae of an echiuroid worm, although echiuroids are benthic organisms too large to be food for Ross' Gull even if they float to the surface. Walrus and bearded seal (*Erignathus barbatus*) feed on echiuroids (John J. Burns, pers. comm.), and it seems likely that Ross' Gulls ingested the setae while feeding on feces. The setae are highly chitinized and could pass through a pinniped digestive tract intact. A piece of coleopteran exoskeleton present in one of the stomachs apparently persisted from the breeding season when insects are the primary food (Buturlin 1906). Previous accounts of the pelagic feeding habits of the Ross' Gull are rare. Collett and Nansen (1900) found shrimp (*Hymenodora glacialis*) and arctic cod in eight birds and *Gammarus locusta* in one.

Ross' Gulls collected from shore were feeding primarily on a diverse assemblage of invertebrates (table 2). Arctic cod, although present in 57% of the stomachs, was usually represented only by single skeletal elements. This differed from birds collected at sea which frequently contained whole fish. *Apherusa glacialis* was present in 71% of the stomachs although the number per stomach was less than in birds collected at sea; one stomach contained 35 and the rest had less than 20 each. Chaetognaths, present in only 29% of the stomachs, were numerous (75 in one, 40 in the other). Other invertebrates in the stomachs were represented by less than five individuals each. Sedge seeds present in one stomach were taken at the shoreline as indicated by their presence in the esophagus.

TABLE 2. Stomach contents of Ross' Gulls collected from land near Point Barrow, Alaska in early September.

| Food items | No. | %[a] |
|---|---|---|
| (No. of stomachs) | (7) | |
| Arctic cod (*Boreogadus saida*) | 4 | 57 |
| Amphipods (total): | 5 | 71 |
| *Apherusa glacialis* | 5 | 71 |
| *Onisimus litoralis* | 1 | 14 |
| Chaetognaths | 2 | 29 |
| Copepods | 2 | 29 |
| Mysids | 1 | 14 |
| Euphausids | 1 | 14 |
| Decapods | 1 | 14 |
| Polychaetes | 1 | 14 |
| Cyperaceae seeds | 1 | 14 |

[a] As in table 1.

At sea, Ross' Gulls hovered and surface fed primarily within 2–3 m of ice. In more open water birds usually plunged to the surface, and fed with little submersion of the body. Ross' Gulls were not attracted to the ship's garbage, and only a single bird scavenged on walrus feces on an ice floe.

Ross' Gulls were observed feeding usually within 3 m of shore, in or near flocks of surface feeding Red Phalaropes (*Phalaropus fulicarius*) and Sabine's Gulls (*Xema sabini*). Ross' Gulls fed by contact dipping, plunging to the surface and wading at the water's edge. They appeared to minimize the time their plumage was in contact with the water. Birds plunging to the surface took flight a few seconds after hitting the water. Wading birds avoided depths where they would have to swim. Such behavior probably accounts for Dement'ev et al.'s (1969:487) and Salomonsen's (1972) statements that Ross' Gulls rarely, if ever, sit on saltwater. My observations at sea, however, show that sitting on water is not uncommon.

## DISCUSSION

In the Chukchi Sea in fall, both Ivory and Ross' gulls are found more frequently at the edge of the pack ice than in the open water south of it (Divoky 1972, Watson and Divoky 1972). The apparent reasons for this were the abundance and availability of prey organisms associated with ice. Arctic cod and *Apherusa glacialis* belong to an under-ice fauna that may be an important food source for several species of arctic seabirds.

The under-ice biota is poorly known, and only fragmentary information is available on its component species. Phytoplankton blooms occur in and on the underside of sea ice (Apollonio 1961). At least in areas with multi-year ice, the phytoplankton associated with the ice supports an under-ice zooplankton community. Amphipods are a major part of this community and are found either swimming in the water directly below the ice or clinging to its undersurface. Some amphipod species are found under the ice only in winter and are dispersed by meltwater in spring (Mohr and Geiger 1968). Others, including *Apherusa glacialis*, are found under the ice throughout the year (MacGinitie 1955). Although the arctic cod is found in open water away from the ice (Alverson and Wilimovsky 1966, Quast 1974), it is common under the ice, where it evidently feeds on under-ice organisms.

The lack of techniques for quantitatively sampling the under-ice fauna precludes comparison of prey densities between ice and open water areas. Observations and sampling in the Chukchi Sea at the time the birds were collected does, however, allow some comments about the two areas. Trawling in open water south of the pack ice showed that arctic cod were uncommon in the upper 11 m of water (Quast 1974). Conversely, arctic cod commonly were seen in surface waters next to ice floes. Vertical plankton tows showed zooplankton to be scarce in the water column both next to the ice and in open water (Wing 1974). That these plankton tows failed to sample the organisms associated with the ice is indicated by their failure to catch *Apherusa glacialis* which was so common in stomachs of Ross' Gulls from the same areas.

The prey organisms associated with the ice are probably easier for birds to locate than surface organisms in open water. The ice acts as a windbreak, and surface waters on the lee side are relatively calm, providing increased visibility. Also, arctic cod swimming over underwater ice shelves are highly visible from above.

Although the ice-associated fauna is the major food source in fall for the Ivory and Ross' gulls, the latter species also is seen at the shore at Barrow (Gabrielson and Lincoln 1959:463) where chaetognaths, crab zoea and other invertebrates are abundant. Ivory Gulls do not use this food and only occasionally are seen from land at Barrow (Bailey 1948:247–248).

While both species are found primarily at the ice edge in the Chukchi Sea in fall, they differ in their association with ice during the rest of the year. Ivory Gulls depend on ice during the breeding season. Breeding colonies usually are close to the pack ice or glaciers. Glacier faces provide a concentration of organisms at the water's surface due to upwelling of nutrient rich waters (Hartley and Fisher 1936, Hartley and Dunbar 1938). The importance of the ice to Ivory Gulls during the breeding season is suggested by the observation of Dalgety (1932) that the average clutch size was smaller in a year with little ice than it was in a year with more ice. Montague (1926) believed that adult birds fly to the pack ice for food for their young. Traditional breeding colonies of Ivory Gulls may be deserted if ice disappears from the area (Birkenmajer 1968).

The Ross' Gull has no association with the pack ice during breeding but nests on river deltas where the primary food is insects. Immediately after breeding, however, Ross' Gulls move north to the pack ice (Buturlin 1906).

During the winter, both species are associated with pack ice but occupy ecologically distinct areas. Ross' Gulls apparently winter primarily in the Arctic Ocean (Bailey 1948:252) with only a small number passing through the Bering Strait (Fay and Cade 1959). Ivory Gulls winter primarily at the ice edge in the Bering Sea with few, if any, individuals remaining in the Arctic Ocean. Most of the ice in the Arctic Ocean is multi-year ice capable of supporting a well-developed under-ice fauna. Almost all ice in the Bering Sea is first-year ice. It supports an in-ice plankton bloom (McRoy and Goering 1974), but ice-associated zooplankton and arctic cod populations do not have time to develop. Thus, Ross' Gulls probably feed on the under-ice fauna during the winter. Ivory Gulls winter in an area where the fauna is not present.

Primary productivity in the Bering Sea in winter is low except for the phytoplankton bloom occurring in the ice and one occurring in the surface waters at the southern edge of the ice (McRoy and Goering 1974). Because the bloom occurring in the ice is not immediately available to grazing zooplankton, the ice edge bloom is the only food for zooplankton near the water's surface. While no sampling of fish or zooplankton associated with this bloom has been conducted, it seems likely that organisms supported by the bloom provide food for Ivory Gulls. This would explain the association of Ivory Gulls with the southern edge of the Bering Sea ice (Divoky, unpubl. data). In spring when the ice melts, the phytoplankton in the ice is released into the water making the ice edge bloom less important.

## ACKNOWLEDGMENTS

I thank the captains and crews of the U. S. Coast Guard icebreakers *Glacier* and *Staten Island* for their assistance at sea. The Naval Arctic Research Laboratory provided logistic support at Barrow. R. J. Boekelheide, D. D. Gibson and G. E. Watson provided valuable assistance in the field. I am grateful to B. L. Wing and K. O. Coyle for identifying the invertebrates and to J. C. Bartonek, J. J. Burns, F. H. Fay, C. P. McRoy, J. C. Quast and G. E. Watson for critically reviewing the manuscript. Field work in 1975 was supported by the Outer Continental Shelf Energy Program.

## LITERATURE CITED

ALVERSON, D. L., AND N. J. WILIMOVSKY. 1966. Fishery investigations of the southeastern Chukchi Sea. p. 843–860. *In* N. J. Wilimovsky and J. N. Wolfe [eds.], Environment of the Cape Thompson region, Alaska. U. S. A. E. C. Div. Tech. Inf.

APOLLONIO, S. 1961. The chlorophyll content of arctic sea ice. Arctic 14:197–200.

ASHMOLE, N. P., AND M. J. ASHMOLE. 1967. Comparative feeding ecology of sea birds of a tropical oceanic island. Peabody Mus. Nat. Hist. Yale Univ. Bull. 24:1–131.

BAILEY, A. M. 1948. Birds of arctic Alaska. Colorado Mus. Nat. Hist., Popular Ser. 8:1–317.

BATESON, P. P. G., AND R. C. PLOWRIGHT. 1959. The breeding biology of the Ivory Gull in Spitsbergen. Br. Birds 52:105–114.

BIRKENMAJER, K. 1968. Observations of Ivory Gull, *Pagophila eburnea* (Phipps), in the south of West Spitsbergen (Vestspitsbergen). Acta Ornithol. 11:123–134. (Engl. Transl., Foreign Sci. Publ. Dept., Natl. Cent. Scientific, Tech. Econ. Informa. Warsaw, Poland. 1972.)

BUTURLIN, S. A. 1906. The breeding grounds of the Rosy Gull. Ibis, Ser. 6 8:131–139.

COLLETT, R., AND F. NANSEN. 1900. An account of the birds. p. 1–53. *In* F. Nansen [ed.], Norwegian North Polar Expedition 1893–1896. Scientific Results. Vol. 1. Longmans Green, London.

COTTAM, C. 1936. Food of arctic birds and mammals collected by the Bartlett Expeditions of 1931, 1932 and 1933. J. Wash. Acad. Sci. 26: 165–177.

DALGETY, C. T. 1932. The Ivory Gull in Spitsbergen. Br. Birds 26:2–7.

DEMENT'EV, G. P., N. A. GLADKOV, AND E. P. SPANGENBERG. 1969. Birds of the Soviet Union. Vol. 3. Engl. Transl., Israel Prog. Sci. Transl., Jerusalem.

DIVOKY, G. J. 1972. The pelagic birds and mammals of the Chukchi Sea in fall. M.S. Diss., Michigan State Univ.

FAY, F. H., AND T. J. CADE. 1959. An ecological analysis of the avifauna of St. Lawrence Island, Alaska. Univ. California Publ. Zool. 63:73–150.

GABRIELSON, I. N., AND F. C. LINCOLN. 1959. The birds of Alaska. The Stackpole Co., Harrisburg, Pennsylvania, and Wildl. Manage. Inst., Washington, D.C.

HARTLEY, C. H., AND M. J. DUNBAR. 1938. On the hydrographic mechanism of the so-called brown zones associated with tidal glaciers. J. Mar. Res. 1:305–311.

HARTLEY, C. H., AND J. FISHER. 1936. The marine foods of birds in an inland fjord region in West Spitsbergen. Pt. 2. Birds. J. Anim. Ecol. 5:370–389.

JACKSON, F G. 1899. A thousand days in the Arctic. Vol. 1. Harper and Bros., New York.

IRVING, L., C. P. MCROY, AND J. J. BURNS. 1970. Birds observed during a cruise in the ice-covered Bering Sea in March 1968. Condor 72:110–112.

KUMLIEN, L. 1879. Birds. p. 69–105. *In* L. Kumlien [ed.], Contributions to the natural history of arctic America made in connection with the Howgate Polar Expedition, 1877–1878. U. S. Natl. Mus. Bull. 15:1–200.

KUROTSHKIN, E. N. 1970. Taxonomic position and morphological peculiarities of the genus *Pagophila*. Acta Ornithol. 12:269–291.

LOVENSKIOLD, H. L. 1964. Avifauna Svalbardensis: with a discussion on the geographical distribution of the birds in Spitsbergen and adjacent islands. Norsk Polarinst. Skrifter 129:1–455.

MACGINITIE, G. E. 1955. Distribution and ecology of the marine invertebrates of Point Barrow, Alaska. Smithson. Misc. Collect. 128:1–201.

MANNICHE, A. L. V. 1910. The terrestrial birds and mammals of north-east Greenland. Biological observations. Medd. om Grønland 45:1–200.

MCROY, C. P., AND J. J. GOERING. 1974. The influence of ice on the primary productivity of the Bering Sea. p. 403–421. *In* D. W. Hood and E. J. Kelly [eds.], Oceanography of the Bering Sea. Univ. Alaska Inst. Mar. Sci. Occas. Publ. 2:1–623.

MOHR, J. L., AND S. R. GEIGER. 1968. Arctic basin faunal précis—animals taken mainly from arctic drifting stations and their significance for biogeography and water-mass recognition. p. 297–313. *In* J. E. Sater [coord.], Arctic drifting stations. Arct. Inst. N. Am.

MONTAGUE, F. A. 1926. Further notes from Spitsbergen. Ibis 68:136–151.

QUAST, J. C. 1974. Density distribution of juvenile arctic cod, *Boreogadus saida* (Lepechin), in the eastern Chukchi Sea in the fall of 1970. Fish. Bull. 72:1094–1105.

RYDER, R. A. 1957. Avian-pinniped feeding associations. Condor 59:68–69.

SALOMONSEN, F. 1950. Grønlands fugle. The birds of Greenland. Ejnar Munksgaard, Kobenhavn.

SALOMONSEN, F. 1972. Zoogeographical and ecological problems in arctic birds. Proc. XV Int. Ornithol. Cong., p. 25–77.

SUMMERHAYES, V. S., AND C. S. ELTON. 1928. Further contributions to the ecology of Spitsbergen. J. Ecol. 16:193–268.

TUCK, L. M. 1960. The murres. Can. Wildl. Ser. 1:1–260.

WATSON, G. E., AND G. J. DIVOKY. 1972. Pelagic bird and mammal observations in the eastern Chukchi Sea, early fall 1970. U. S. Coast Guard Oceanogr. Rep. 50:111–172.

WING, B. L. 1974. Kinds and abundance of zooplankton collected by the USCG icebreaker *Glacier* in the eastern Chukchi Sea, September–October 1970. NOAA Tech. Rept. U. S. Natl. Mar. Fish. Serv. SSRF-679. 18 p.

*Alaska Department of Fish and Game, 1300 College Road, Fairbanks, Alaska 99701.* Accepted for publication 27 May 1975.