INTERSPECIFIC FEEDING ASSEMBLAGES OF MARINE BIRDS OFF BRITISH COLUMBIA

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MIXED species flocks of birds, particularly of passerines, have received much attention in recent years and have given researchers opportunities to assess the degree of niche overlap among species as well as the factors that influence flocking behavior (e.g. Short 1961, Crook 1965, Willis 1966, Morse 1970, Terborgh and Diamond 1970, Cody 1971, and others). The striking local concentrations of seabirds that are frequently encountered have drawn the attention of several students (e.g. Ashmole and Ashmole 1967, Martin and Myres 1969, King 1970, and others). Most of these workers' observations were made from moving boats that could not be stopped to permit recording quantitative descriptions of the species and individuals involved, the prey taken, and the formation of such assemblages.

Many seabirds (particularly the planktivores) congregate where food is especially concentrated, frequently along convergent "fronts" or "current rips," actually contact points between unlike water masses, at some of which convergence and sinking occurs (see Martin and Myres 1969). At many convergent fronts zooplankton species capable of resisting the downward flow become concentrated in the surface layers (Cromwell 1953), and nektonic animals are attracted to the area. As Ashmole (1971: 248) pointed out, the importance of this phenomenon in the biology of the oceans is not yet clear, but the local effects can be dramatic (see Blackburn 1965, Griffiths 1965). Ashmole and Ashmole (1967) speculated on the significance of convergent fronts to tropical seabirds through their attractiveness to tunas and other fish that drive micronekton to the surface and so make food available to birds. Such fronts or current rips commonly provide access to a single but often temporary commodity. Therefore, although marine birds show a wide variety of adaptations for feeding (see Bédard 1969, Ashmole 1971), consumption of a common resource by several species implies niche overlap and suggests that a state of competition among the species exists at least potentially.

While studying the Ancient and Marbled Murrelets in 1970 and 1971 (Sealy 1972) on and in the vicinity of Langara Island, Queen Charlotte Islands, British Columbia, I also observed mixed assemblages of feeding seabirds there. This paper examines the species composition and number of individuals of each species in 53 such mixed feeding assemblages watched in 1971 (Table 1), the feeding methods of each species (based

TABLE 1

RELATIVE FREQUENCY AND ABUNDANCE OF MARINE BIRDS IN MIXED FEEDING ASSEMBLAGES NEAR LANGARA ISLAND FROM 5 MAY TO 8 AUGUST 1971

Species[1]	Frequency (%)[2]	Abundance[3]
Arctic Loon (*Gavia arctica*)[4]	5.7	4 (2–7)
Sooty Shearwater (*Puffinus griseus*)[4]	11.3	86 (1–500)
Brandt's Cormorant (*Phalacrocorax penicillatus*)[5]	1.9	1
Pelagic Cormorant (*P. pelagicus*)[6]	17.0	4 (1–10)
Oldsquaw (*Clangula hyemalis*)[4]	1.9	2
Bald Eagle (*Haliaeetus leucocephalus*)[6]	1.9	1
Northern Phalarope (*Lobipes lobatus*)[4]	1.9	3
Parasitic Jaeger (*Stercorarius parasiticus*)[4]	3.8	1
Glaucous-winged Gull (*Larus glaucescens*)[6]	67.9	21 (3–45)
Herring Gull (*L. argentatus*)[4]	7.5	8 (2–14)
Black-legged Kittiwake (*Rissa tridactyla*)[5]	96.2	200 (25–500)
Common Murre (*Uria aalge*)[5]	7.5	2 (1–4)
Pigeon Guillemot (*Cepphus columba*)[6]	9.4	3 (1–12)
Marbled Murrelet (*Brachyramphus marmoratum*)[6]	11.3	3 (1–6)
Ancient Murrelet (*Synthliboramphus antiquum*)[6]	22.6	54 (1–200)
Cassin's Auklet (*Ptychoramphus aleutica*)[6]	3.8	1
Rhinoceros Auklet (*Cerorhinca monocerata*)[6]	88.7	44 (6–100)
Horned Puffin (*Fratercula corniculata*)[5]	3.8	1
Tufted Puffin (*Lunda cirrhata*)[6]	15.1	5 (1–17)

[1] Order and nomenclature follows A.O.U. check-list (1957).
[2] Percentage of the 53 mixed feeding flocks in which the species was represented.
[3] Mean number of individuals of each species in the 53 flocks analyzed. Figures in parentheses indicate the range in numbers.
[4] Migrants.
[5] Nonbreeding summer residents and/or visitants.
[6] Breeding species.

on Ashmole 1971: 224–234) in these assemblages (Table 2), and the prey available compared to that taken by the birds (Table 3).

All data presented here were obtained during the period 5 May to 8 August 1971 in the vicinity of Langara Island (54° 14′ N, 133° 00′ W), mostly along the island's east side 1–3 km from shore. Mixed assemblages were seldom encountered farther offshore. The depth of the sea where the observations were made was from 15–40 fathoms. For the physical oceanographic features of the waters near Langara Island see Crean (1967).

Every 10 days during the observation period in 1971 (10 samples), two or three individuals representing species with different feeding methods (Table 2) were collected from the same feeding assemblage. The proventriculi, crops, and/or muscular stomachs were removed from the specimens and placed in 10% formalin for subsequent examination (see Table 3). Plankton hauls were made with limited success with a 50-cm conical closing net of 0.45 mm mesh in the waters where the assemblages were feeding to determine what prey was available to the birds.

Individuals of a particular species usually arrived at the feeding site as a flock and departed similarly, except when a species was represented

TABLE 2
FEEDING METHODS OF MARINE BIRDS IN MIXED ASSEMBLAGES NEAR LANGARA ISLAND IN 1971[1]

Species	Piracy	Dipping	Surface seizing	Hydro-planing	Pursuit plunging	Pursuit diving
Arctic Loon						x
Sooty Shearwater				x	x	
Brandt's Cormorant						x
Pelagic Cormorant						x
Oldsquaw						x
Bald Eagle		x				
Northern Phalarope			x			
Parasitic Jaeger	x					
Glaucous-winged Gull		x	x			
Herring Gull			x			
Black-legged Kittiwake		x	x			
Common Murre						x
Pigeon Guillemot						x
Marbled Murrelet						x
Ancient Murrelet						x
Cassin's Auklet						x
Rhinoceros Auklet						x
Horned Puffin						x
Tufted Puffin						x

[1] Methods of feeding based on Ashmole (1971: 224–234).

by only one individual. In all seven mixed feeding assemblages that I watched form (from distances of about 300 m using 7 × 35 binoculars), all involved the finding of prey by one or more individuals of the same species. These birds were soon joined by flocks or single individuals of other species that flew directly to the site and began to feed. In five assemblages the nuclear species was the Black-legged Kittiwake, with the Bald Eagle and Ancient Murrelet the nuclear species in the other two assemblages.

Foraging in mixed flocks is widespread among birds, particularly outside the breeding season. Recent comparative studies (e.g. Crook 1965, Lack 1968, Morse 1970) suggest that flocking may enhance the efficiency with which the birds can exploit their food supplies and facilitate the detection of approaching predators. Crook (1965) distinguished between the loosely integrated flocks of many insectivores and the tightly integrated flocks widespread among birds that exploit a food supply occurring in patches of local abundance. Morse (1970), on the other hand, believed that the advantages gained by some mixed flocks is an ability for their species to exploit available resources in a maximally effective manner, given that other species with overlapping spectra of habitat utilization are present and utilizing common resources.

Mutual aid in finding food is considered by some authors (Gannon 1934, Rand 1954) to be a primary factor in the formation of feeding

TABLE 3

PREY AVAILABLE AND TAKEN BY MARINE BIRDS IN MIXED ASSEMBLAGES NEAR LANGARA ISLAND IN 1971

Birds	Sample size	Date	Prey taken	Prey available
Black-legged Kittiwake	1	9 May	*T. spinifera*[1]	*T. spinifera*
Ancient Murrelet	2	〃	〃 〃	〃 〃
Black-legged Kittiwake	1	17 May	*T. spinifera*	*T. spinifera*
Marbled Murrelet	1	〃	〃 〃	〃 〃
Glaucous-winged Gull	1	22 May	*T. spinifera*	*T. spinifera*
Ancient Murrelet	6	〃	〃 〃	〃 〃
Black-legged Kittiwake	1	10 June	*A. hexapterus*[2]	*A. hexapterus*[3]
Rhinoceros Auklet	1	〃	〃 〃	〃 〃
Black-legged Kittiwake	1	18 June	*A. hexapterus*	*A. hexapterus*
Rhinoceros Auklet	1	〃	〃 〃	〃 〃
Tufted Puffin	1	〃	〃 〃	〃 〃
Sooty Shearwater	1	26 June	*A. hexapterus*	*A. hexapterus*
Black-legged Kittiwake	1	〃	〃 〃	〃 〃
Black-legged Kittiwake[4]				
Rhinoceros Auklet[4]				

[1] All specimens of *Thysanoessa spinifera* were between 12 and 18 mm in length.
[2] All specimens of *Ammodytes hexapterus* were between 45 and 60 mm in length.
[3] The rapid swimming *A. hexapterus* were seldom obtained in the plankton hauls, but as no individuals of other species were taken, it is assumed that only *Ammodytes* was available.
[4] One each of the Black-legged Kittiwake and Rhinoceros Auklet were collected from mixed flocks on 8, 17 and 22 July and 5 August; on all dates both species were feeding on *A. hexapterus*, the available prey.

flocks. The discovery of a large food supply by one bird may attract others, thus enabling the sharing of food (Short 1961). Short also believed that this sharing probably involves a decrease in aggressiveness on the part of the discoverer of a food source as it feeds, the bird allowing closer approach by other individuals as its hunger diminishes. Marler (1956), on the other hand, found that hunger did not affect individual distance, at least in the Chaffinch (*Fringilla coelebs*).

In the present study, it is evident that certain species, notably the Black-legged Kittiwake, help other species (Rhinoceros Auklet, Glaucous-winged Gull, etc.) find places where food is available. It is highly unlikely that any benefit accrues to the kittiwakes that discover the food source. As only a single species and size of prey appears to be available to the individuals in these assemblages (Table 3), competition for this resource potentially exists. If, at the time a flock is feeding, the amount of potential prey available at the surface in that area is far greater than the birds can utilize, there will be no competition. If the food is not greater, there will be both intraspecific and interspecific competition, and the latter will be reduced by the different feeding methods (Table 2) because some prey not available to certain species will be available

to others. Thus the differentiation in feeding methods increases the effective food supply. Information on the amount of prey actually available relative to the number of birds utilizing it is critical to reducing the degree of competition or lack of it.

A question raised by the present study is how important is the method of feeding described above to the species involved? Although work on Langara Island in 1971 began 17 March, no mixed species assemblages were observed there until 5 May. These assemblages continued until at least 8 August when my observations ceased, but they were less prevalent at the later date. It must be emphasized that monospecific feeding by all of the species observed in the mixed assemblages (Table 1) occurred before the mixed assemblages were encountered and also during the period when mixed feeding assemblages were prevalent. Thus it appears that these local concentrations of food provide only temporary and/or supplemental food resources for most of the species involved.

Only four species (Pelagic Cormorant, Glaucous-winged Gull, Black-legged Kittiwake, Rhinoceros Auklet), which were the most regular and abundant species in the assemblages (Table 1), were seen in these assemblages during the entire period mixed assemblages were observed. The kittiwakes (consisting of about 10 immatures to one adult) were nonbreeders; a population of about 2,500 individuals was present near Langara Island. They fed almost entirely within the area considered here—in compact flocks, usually containing other species. In most of the assemblages that I watched form, the kittiwakes discovered the food source and were joined later by the other species. It would be advantageous for a species that apparently relies even temporarily on a food in a limited space to be able to discover this food source efficiently on its own without relying on other species to do so first; such appears to be the case with kittiwakes near Langara Island during summer. It would also benefit other species that feed predominantly in monospecific flocks (Pelagic Cormorant, Glaucous-winged Gull, Rhinoceros Auklet) to be able to avail themselves of the opportunity to supplement their food resources with food located by other species.

Adult Rhinoceros Auklets observed in 1971 taking fish for their young were not encountered in mixed assemblages; in fact, usually only single individuals were seen. Tufted Puffins, which breed in two colonies on and near Langara Island (Drent and Guiguet 1961), were seen feeding in mixed assemblages only within 2 km of their nest sites. The Ancient Murrelet breeds early on Langara Island and the adults and newly hatched young leave for sea by mid-June (Sealy 1972). Adults were encountered feeding in these mixed assemblages only on seven occasions (Ancient Murrelets in the remaining five flocks were juveniles that

occurred in the area only later in the summer) and this method of feeding played an insignificant role in its general feeding ecology during summer (Sealy 1972).

ACKNOWLEDGMENTS

The work on Langara Island in 1971 was supported by grants from the National Science Foundation (GB-25986 to N. G. Hairston) for research in Systematic and Evolutionary Biology at the University of Michigan, the Frank M. Chapman Memorial Fund of the American Museum of Natural History, and the Society of the Sigma Xi. Nelson G. Hairston and Robert W. Storer read an earlier draft of the manuscript and offered suggestions. My wife, Noreen, greatly aided in the field work.

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