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Note

Auklet (Charadriiformes: Alcidae, *Aethia* spp.) chick meals from the Aleutian Islands, Alaska, have a very low incidence of plastic marine debris

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ABSTRACT

The ingestion of plastic marine debris is a chronic problem for some of the world's seabird species, contributing to reduced chick survival, population declines, and deposition of contaminants via absorption in birds' gastrointestinal tract. We analysed the frequency of ingested plastic in chick meals delivered by adults in four species of auklet – Crested (*Aethia cristatella*), Least (*A. pusilla*), Parakeet (*A. psittacula*), and Whiskered (*A. pygmaea*) – from three breeding colonies in the Aleutian Islands, Alaska, USA over a 14-year period from 1993 to 2006. Among 2541 chick meals, we found plastic in only one – from a Whiskered Auklet on Buldir Island in 1993. While adult Parakeet Auklets have a high frequency of plastic ingestion (over 90%), no chick meals contained plastic. Unlike other seabirds, the planktivorous auklets do not appear to offload plastic to their chicks, and we conclude that auklet chicks are probably at a low risk of contamination from plastic debris.

1. Introduction

Since ingestion of plastic marine debris was first documented in seabirds in the 1960s (Kenyon and Kridler, 1969; Day et al., 1985), it has become a growing problem in the world's oceans (Moore, 2008). This anthropogenic pollution may be mistaken for food by foraging seabirds including penguins (Spheniscidae), albatrosses (Diomedeidae), petrels and shearwaters (Procellariidae), storm-petrels (Hydrobatidae), diving petrels (Pelecanoididae), tropicbirds (Phaethontidae), frigatebirds (Fregatidae), pelicans (Pelecanidae), cormorants and shags (Phalacrocoracidae), gannets and boobies (Sulidae), phalaropes (Scolopacidae), skuas and jaegers (Stercorariidae), gulls and terns (Laridae), and auks (Alcidae). Adults then return to breeding colonies where plastic items and particles can be offloaded as adults provision their chicks (e.g., Fry et al., 1987; Laist, 1997; Robards et al., 1997). Plastic ingestion can result in decreased chick survival, and in serious cases, could contribute to population declines (Sievert and Sileo, 1993; Priddel et al., 2006). Furthermore, plastics in the marine environment accumulate and concentrate contaminants, such as organic pollutants (Mato et al., 2001), and can transport these, in addition to the metal and metalloid contaminants inherently present in post-manufacture plastic particles (Saron and Felisberti, 2006; Cadore et al., 2008; Teuten et al., 2009). Among seabirds, plastic ingestion reduces chick survival (Hutton et al., 2008), is correlated with increased contaminant burden (Ryan, 1987, 1988), and decreased body condition or fat deposition (Connors and Smith, 1982; Ryan, 1988).

In the North Pacific Ocean, incidences of plastic ingestion in a wide variety of seabirds increased between the 1970s and the late 1980s (Robards et al., 1995), and plastic densities of 316,800 pieces km^{-2} have been recorded (Day et al., 1990), with higher densities associated with oceanographic features, such as the Alaskan Gyre (Day and Shaw, 1987). Large number of seabirds of a variety of species breed in the North Pacific, especially in the Aleutian Islands of Alaska (Byrd et al., 2005), making this an excellent site to document incidences and changes in plastic ingestion. Related to a study of food habits (Bond et al., submitted for publication), we examined of the occurrence of plastic in meals delivered to chicks among four planktivorous seabirds at three sites, and over a 14-year period. We studied the four species of *Aethia* auklets – Crested (*A. cristatella*), Least (*A. pusilla*), Parakeet (*A. psittacula*) and Whiskered Auklets (*A. pygmaea*) – on Buldir, Kiska, and Kasatochi Islands in the western and central Aleutians from 1993 to 2006.

Auklets are small, socially monogamous seabirds, and are among the most abundant seabirds in the northern hemisphere (Gaston and Jones, 1998). Adults capture prey at sea and deliver it to their chicks at breeding colonies; the chicks' diet consists primarily of calanoid copepods (*Neocalanus* spp. and *Calanus* spp.), euphausiids (mainly *Thysanoessa* spp.), and smaller quantities of gammarid or hyperiid amphipods, and decapod larvae (Bédard, 1969; Day and Byrd, 1989; Harrison, 1990). Among adult *Aethia* auklets, plastic ingestion is most prevalent in Parakeet Auklets,

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with very low incidences of plastic ingestion among the other three species (Robards et al., 1995). Our objective was to quantify the occurrence of plastic in chick meals brought by adult birds to their nest-bound young among all *Aethia* auklet species from three breeding sites that span the Aleutian Islands over a 14-year period.

2. Methods

We collected chick meals brought by parents returning to the colony at three colonies in the Aleutian Islands, Alaska – Buldir Island (1993–2006, Crested, Least, Parakeet and Whiskered Auklets), Kiska Island (2001–2006, Crested and Least Auklets), and Kasatochi Island (1996–2006, Crested and Least Auklets). These three colonies span 585 km of the Aleutian chain (Fig. 1), and because auklets generally forage within 50 km of their breeding colony (Obst et al., 1995), there is little overlap among foraging birds from any of our study sites.

Auklets carry chick meals in a throat pouch, which is regurgitated when birds are captured in a noose carpet or mist net (Jones, 1992; Byrd and Williams, 1993; Jones, 1993a,b; Jones et al., 2001). Each year, we sampled meals throughout the chick-rearing period, which spans from late June to early August. Chick meals were collected, and the proportion of the meal that could be recovered from the regurgitated contents was estimated to the nearest 5%. Samples were stored in 75% ethanol until prey identification. Plastic marine debris was then enumerated as part of the prey identification process, and plastic particles weighed to the nearest 0.01 g using an electronic balance. Here, we report the frequency of occurrence of plastic in chick meals (i.e., the proportion of meals that contained plastic) for each island-species-year combination.

3. Results

We collected 2541 chick meals between 1993 and 2006 (Table 1). Among these, only one chick meal contained plastic marine debris – a single item in a Whiskered Auklet chick meal collected on 15 June 1993 on Buldir Island. This corresponded to a 4% frequency of occurrence among all Whiskered Auklet chick meals collected on Buldir that year ($n = 24$), and a 0.21% frequency of occurrence over all Whiskered Auklet chick meals from 1993 to 2006 ($n = 486$). The piece of plastic weighed 0.02 g, a size and mass similar common prey items (Bond et al., unpublished data), and to plastic particles ingested by Parakeet Auklets (Robards, 1993). The chick meal that did contain plastic was similar to other Whiskered Auklet chick meals from that year, and comprised (by mass) 91% *Neocalanus plumchrus/flemingeri*, 3% *Thysanoessa* spp., and 6% plastic. No plastic marine debris was identified in chick meals from Least, Crested, or Parakeet Auklets.

Table 1
Sample sizes of chick meals sampled from four species of *Aethia* auklets on three breeding colonies from 1993 to 2006. CRAU: Crested Auklet, LEAU: Least Auklet, PAAU: Parakeet Auklet, WHAU: Whiskered Auklet.

Year	Buldir				Kasatochi		Kiska	
	CRAU	LEAU	PAAU	WHAU	CRAU	LEAU	CRAU	LEAU
1993	1	–	6	23	–	–	–	–
1994	37	4	3	16	–	–	–	–
1995	46	8	16	48	–	–	–	–
1996	78	15	5	71	36	19	–	–
1997	82	31	3	36	39	51	–	–
1998	103	25	12	26	35	36	–	–
1999	88	32	1	38	36	33	–	–
2000	29	12	8	33	34	33	–	–
2001	45	32	–	28	31	33	7	59
2002	54	31	–	32	39	37	–	17
2003	23	21	2	31	30	24	3	31
2004	33	30	27	37	34	33	–	23
2005	39	24	29	31	35	29	–	–
2006	36	29	28	36	34	28	24	30
Total	693	294	140	486	383	356	34	160

4. Discussion

Plastic ingestion by auklets has been investigated in two different ways. Robards et al. (1995) shot adult birds at sea during 1988–1990 and examined stomachs, while the present study focussed on chick meals regurgitated from the throat pouches of birds captured with noose carpets and mist nets during 1990–2006, so both the methods and time span of the two studies differed significantly. Robards et al. (1995) found that 2.5% of adult Crested Auklets and 93.8% of adult Parakeet Auklets collected had plastic debris in their stomachs, an apparent increase in the frequency of plastic debris in Parakeet Auklet stomachs from 1969 to 1977 (Day, 1980). Robards et al.'s (1995) sample sizes were less than 30 for Least and Whiskered auklets, perhaps too small for powerful comparisons with the other species. Our study is most notable for the virtual absence of plastic debris in auklet chick meals during 1990–2006, including those of the Parakeet Auklet, for which more than 90% of adult stomachs contained debris, usually multiple items, during 1988–1990 (Robards et al., 1995).

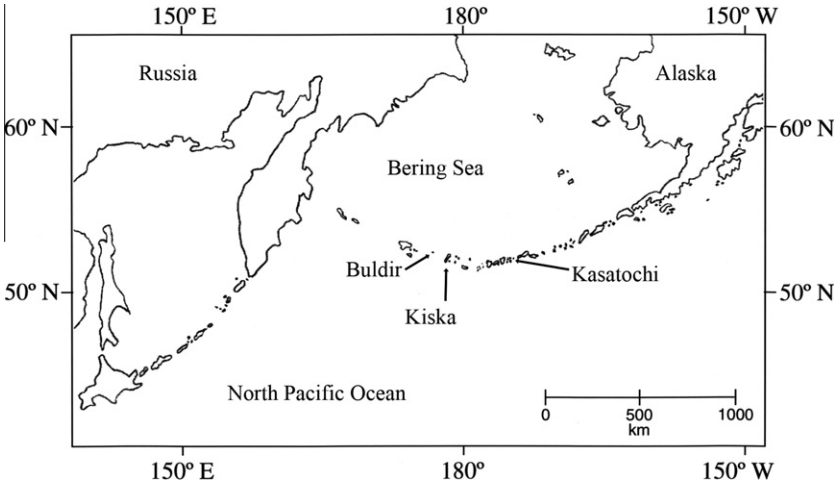

Fig. 1. Map of the Aleutian Islands, Alaska, showing our three study colonies.

In some seabird species, especially Procellariiformes (albatrosses, shearwaters, and petrels), plastic debris accumulated by adults can be regurgitated to chicks, that subsequently suffer reduced survival (Kenyon and Kridler, 1969; Sievert and Sileo, 1993; Hutton et al., 2008). Our results indicate this may not be the case among *Aethia* auklets, and suggest that auklet chicks may be at generally low risk of plastic ingestion and contamination by associated pollutants. This does not imply that adult auklets are not at risk of the negative effects of plastic ingestion, based on the earlier stomach contents analysis (Robards et al., 1995). However, adult auklets provision chicks by transferring loads of undigested fresh prey, within hours of capture, from a gular pouch (Portenko, 1934), not from the stomach, where plastic appears to accumulate. If there were plastic in these pouch loads of prey, only it would be offloaded to chicks, as adult auklets do not regurgitate prey from their stomachs to chicks. It is possible that plastic is ingested and retained in the stomachs of adult auklets during periods of food scarcity (e.g., winter) when they are not provisioning chicks, explaining the virtual absence of plastic in auklet chick meals found here.

We did not collect adult auklets for stomach analysis that could be directly compared to results reported by Robards et al. (1995) and Day (1980). We believe it is unlikely that Parakeet Auklets have stopped eating plastic pellets, especially given the increasing temporal trend in plastic ingestion between 1969–1977 and 1988–1990, and other evidence of increasing amounts of plastic pollution in the North Pacific Ocean (Moore, 2008). To determine the degree to which adult auklets are still consuming plastic, techniques such as stomach lavage (e.g., Bocher et al., 2000), or the use of emetics like syrup of ipecac (e.g., Montague and Cullen, 1985; Diamond et al., 2007) are safe and would increase sample sizes for stomach contents, and not require that the birds be necropsied.

The literature on seabird plastic ingestion so far suggests that plastic is a problem for scavenging seabirds, those whose prey (e.g., fish eggs) is often attached to floating plastic items, and for species that feed at the surface or use pursuit dives (Day et al., 1985). However, the absence of plastics in adult birds' stomachs does not mean that they do not ingest plastic that passes through the gastrointestinal tract. Microplastics also accumulate pollutants that can be deposited as the plastic passes through the bird (Mato et al., 2001; Thompson et al., 2004). Furthermore, two species of zooplankton similar to auklets main prey items (*Calanus pacificus* and *Euphausia pacifica*) ingested microplastics in equal proportion to natural food (Moore, 2008).

We therefore conclude that auklet chicks do not appear to be at direct risk from plastic ingestion, but that a more complete assessment of adults would be required to draw conclusions as to the threat posed to them by the ingestion of plastic marine debris. The results underline the requirement for studies of a broad range of species and age classes potentially affected by this issue, and indicate the need for caution before making generalizations about its effects.

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