SHORT COMMUNICATIONS

PLASTIC PARTICLE POLLUTION OF THE SURFACE OF THE ATLANTIC OCEAN: EVIDENCE FROM A SEABIRD

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By sampling with neuston nets, Carpenter and Smith (1972) demonstrated the presence, in 1971, of small particles of plastic on the surface of the Sargasso Sea. The particles had an average concentration of 3500 pieces/km^2 and occurred over a distance of 1300 km. The occurrence, reported here, of similar particles in the stomachs of Leach's Petrels (*Oceanodroma leucorhoa*) indicates that this form of pollution and its consequences are probably more widespread, both temporally and geographically, than is suggested by the data of Carpenter and Smith.

One of seven adult petrels collected in 1962 on Gull Island, off Witless Bay, Newfoundland, had two pieces of plastic in its gizzard. Three of seven adults collected in 1964 on Kent Island, off Grand Manan, New Brunswick, had, respectively, one, one, and four pieces in their gizzards. A fourth bird had a piece of plastic near the junction of its esophagus and proventriculus. A Kent Island nestling, found dead in its burrow, had a plastic particle in its gizzard as did one of seven nestlings that survived for up to 2 weeks in captivity. The intestines of all the specimens were examined but no plastic was found. Like other procellariiforms, Leach's Petrel often regurgitates some of its stomach contents when handled. Often the regurgitation consists only of stomach oil, but of those regurgitations containing particulate matter none of four from Kent Island or two from Gull Island contained plastic. However, there may be a tendency to retain hard objects (e.g., 9 of the 15 stomachs of adults and nestlings from Kent Island contained structures tentatively identified as polychaete pharyngeal teeth whereas none of the regurgitations did). As with the plastic described by Carpenter and Smith, most pieces found in the petrel stomachs were white and 0.2–0.5 cm in diameter (Fig. 1). However, many pieces were irregularly shaped and had jagged edges, unlike the pellet-shaped pieces with rounded ends described by Carpenter and Smith.

It is probable that the type of pollution Carpenter and Smith discovered in 1971 has actually occurred since at least 1962 or 1964. My data also indicate that other areas of the Atlantic, besides the Sargasso Sea, contain pieces of plastic. The petrels could have consumed some of the plastic during their migration, but, while Leach's Petrel migrates far south of its North Atlantic breeding areas, it apparently avoids the area of the Sargasso Sea (Palmer 1962). Furthermore, the fact that some of the Kent Island nestlings also contained plastic suggests that their parents were consuming the particles in feeding areas utilized during the breeding season. It is likely that the particles consumed by the petrels were ones which were broadcast over the open ocean and not ones from local concentrations near ships or garbage dumps, since Leach's Petrel rarely feeds in littoral waters or follows ships in order to feed on dumped waste material, as is done by related species such as Wilson's Petrel (*Oceanites oceanicus*) (Peterson 1947:8; pers. observ.). The affinity of Leach's Petrels for pelagic areas is shown by the fact that one rarely sees them at sea during the day in the Kent Island region. For example, during a full day in the summer of 1964 on the Old Proprietor Shoal area, about 8 km SE of Kent Island, hundreds of Wilson's Petrels were present but not one Leach's Petrel was sighted although Wilbur (1969) has estimated that 15,000 pairs breed on Kent Island. But 30 to 40 km S of Kent Island on the Grand Manan Banks, a small number of Leach's were observed among the still more numerous Wilson's Petrels. Leach's Petrels are able to travel 300 km a day while still showing a net gain in weight (Billings 1968). This ability, coupled with the fact that they are often away from their colony for several days, shows that feeding may occur several hundred kilometers from land. Another procellariiform, the Manx Shearwater (*Puffinus puffinus*), is known to range up to 970 km from its colony while on feeding trips (Lockley 1961:135).

The observations presented here enlarge the known scope of the biological effects of these particles as discussed by Carpenter and Smith. From the diversity of its stomach contents (Palmer 1962:233; Rothstein, unpubl. data), Leach's Petrel evidently consumes (by independent capturing actions) any ingestible object occurring within a few centimeters of the ocean's surface. Before the occurrence of plastic particles, it is probable that nearly all such objects were edible. Thus, natural selection could not have favored petrels which avoided nonedible material. The sudden, widespread appearance of nonedible floating objects such as plastic particles represents an evolutionarily novel event to which the birds do not respond in an adaptive manner. A similar interpretation may explain the consumption of elastic threads by Common Puffins (*Fratercula arctica*) reported by Parslow and Jefferies (1972). Of obvious importance is the degree of hazard plastic particles pose to Leach's Petrels and to other seabirds. Possibly, the consumption of many particles could result in a blockage or an internal injury, although petrel stomachs often contain hard natural objects such as bits of bone and claw-like objects thought to come from polychaetes. Carpenter and Smith (1972) originally suggested that the plastic may release polychlorinated biphenyls (PCB's) to seawater but have since modified this view since the type of plastic involved has PCB's only in low concentrations as contaminants (Carpenter et al. 1972). But perhaps even at these low concentrations, consumed particles of plastic could release sufficient amounts of PCB's to affect seabirds.

The present-day occurrence of plastic particles is

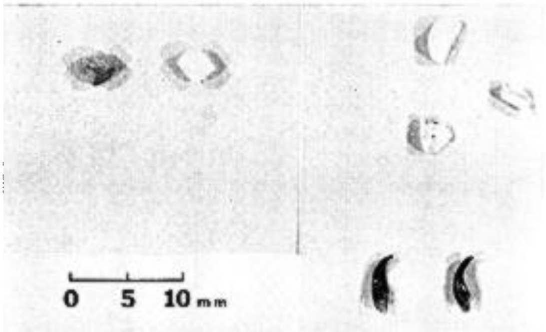

FIGURE 1. Objects found in the stomachs of two Leach's Petrels. The two pieces of plastic in the upper left corner were found in the gizzard of a petrel collected on Gull Island, Newfoundland. The three pieces of plastic as well as the two claw-like structures in the right half of the figure were all found in the gizzard of a petrel collected on Kent Island, New Brunswick. The claw-like structures have been tentatively identified as the pharyngeal teeth of a large polychaete.

best investigated with the neuston net technique utilized by Carpenter and Smith. However, the initial appearance of plastic particles in the oceans almost certainly predates the use of neuston nets, since such nets have been in use at installations such as the Woods Hole Oceanographic Institute only since about 1963 (Bartlett and Haldrich 1968). Thus, there are no collections of specimens obtained by neuston nets prior to the early 1960s, and some other approach is needed to determine when the particles first appeared. An examination of seabird stomachs (and possibly those of some marine mammals and fishes, too) collected over the last 30–40 years may be the only way to determine even the approximate date of the initial occurrence of these particles.

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AN ALBINISTIC BLUE GROUSE FROM COLORADO

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The incidence of reported albinism in grouse (Family Tetraonidae) is low, having been reported in 9 of 18 presently recognized species (Sage 1962; Ross 1963; Gross 1965). Among the Tetraonidae, albinism has been reported most often from Ruffed Grouse (*Bonasa umbellus*); a fact possibly related to its popularity as a sporting bird over large areas of the northern United States and Canada. We could find no records of albinism in Blue Grouse (*Dendragapus obscurus*), thus making the specimen described here noteworthy.

While hunting for Blue Grouse and White-tailed Ptarmigan (*Lagopus leucurus*) above tree line (elevation 12,000 ft) on 27 September 1969 at Mesa Seco in Hinsdale County, one of us (RGB) flushed a group of five grouse in which a whitish bird was observed. This bird was subsequently collected and identified as an albinistic Blue Grouse. The skin was saved and eventually came into the possession of the senior author. After preparation as a study skin, the specimen was deposited in the Denver Museum of Natural History (DMNH 36061).

Upon examination the specimen was found to be an immature male 10–11 weeks old. It appeared to be normal in all characteristics except color, with measurements of carpal length, outer rectrix, culmen, caruncle, middle toe, and tarsus being in the range of birds of the same sex and age class previously collected in Colorado (unpubl. data). The plumage of the specimen was very pale gray and clearly showed the normal barring present in Blue Grouse (fig. 1). This "pale" or "ghost barred" specimen is therefore an imperfect albino following the classification of albinism of Pearson et al. (1911–13) and Mueller and Hutt (1941). Color of the soft parts was evidently normal because the bill, toenails, and eyes were black while the feet were dark horn-colored.

Studies of imperfect albinism in poultry (Dunn 1923; Mueller and Hutt 1941) indicate this trait is caused by a sex-linked recessive gene. Price and Danforth (1941), working with California Quail (*Lophortyx californicus*), reported that albinistic or "dilute" young were weaker and less vigorous than normal-colored young. The Blue Grouse reported here appeared comparable in all respects except color to other Blue Grouse of the same sex and age. It