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BALD EAGLES KLEPTOPARASITIZING SEA OTTERS AT AMCHITKA ISLAND, ALASKA[1]

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Most incidents of avian kleptoparasitism involve other birds as the host. Incidents of kleptoparasitism by birds on mammals are relatively uncommon (Brockmann and Barnard 1979). Bald Eagles (*Haliaeetus leucocephalus*) are well known food-stealers and have previously been reported pirating food from a large number of other bird species (Fischer 1985, Jorde and Lingle 1988). Here we present the first unequivocal account of Bald Eagles kleptoparasitizing a mammal, the sea otter (*Enhydra lutris*). Observations were made opportunistically during a study of sea otter ecology at Amchitka Island, Alaska between July 1992 and March 1994.

Bald Eagles are plentiful on Amchitka Island. Surveys between 1969 and 1972 located up to 71 active nests around the approximately 260 km of coastline (White et al. 1977) and recent observations indicate that numbers are still high. Sea otters are also very abundant, with an island population of some 5,000 to 7,000 otters which is thought to be at equilibrium with available food resources (Estes 1990). Bald Eagles prey on sea otter pups (Murie 1940, Krog 1953, Sherrod, et al. 1975), but only Kenyon (1961) presented an observation of an eagle possibly attempting to steal food from an otter. Kenyon described an eagle swooping towards an otter and suggested that it may have been interested in the fish the otter was eating.

Observations were made over approximately 30 km of coastline using Questar field telescopes and binoculars, generally from a range of less than 500 meters. During the study, we logged approximately 10,000 prey captures by otters and observed nine instances of actual or attempted food stealing by eagles plus two further incidents of apparent stealing, or of scavenging from otter prey-remains (Table 1). Given the intensity of our field work, it seems clear that piracy from otters by eagles is somewhat rare.

All observed instances of piracy occurred in winter or spring and involved otters which were at the water's surface handling or eating Pacific smooth lumpsuckers (*Aptocyclus ventricosus*). In two incidents (3 Apr 1993 and 2 Feb 1994), complete lumpsuckers were stolen from otters. In the first of these, an eagle swooped from its perch on a cliff and grabbed a lumpsucker from the chest of an otter which had just surfaced with it. The otter appeared unaware of the eagle's approach and had no opportunity to evade it. The fish was still flapping in the eagle's talons and was dropped into the sea (presumably by accident) some 50 meters from where the otter had caught it. The otter approached the splash, circled the area then dived, apparently in an attempt to recover the fish which, remarkably, appeared to have made good its escape. In the second incident, an eagle again took a lumpsucker immediately after an otter had surfaced with it. The eagle grabbed the fish while the otter was manipulating it on its chest. Although the otter attempted to retain the fish, pulling the eagle partly into the water in so doing, the eagle was able to wrest the fish away and return with it to its perch on the cliff.

Four further incidents were observed during which eagles took parts of lumpsuckers, usually the skin, from feeding otters. On two occasions (8 Feb 1994 and 17 Feb 1994), eagles grabbed lumpsucker skin with meat still attached from the otter's chest before the otter had finished eating. On 12 Mar 1994, an eagle retrieved a lumpsucker skin immediately after it had been discarded by an otter. Otters do not consume the skin of lumpsuckers and generally discard it after scraping it free of meat (pers. observ.). On 16 Feb 1994, an eagle obtained lumpsucker skin and meat after approaching the otter which had caught it. Unfortunately the observer's view was partially obscured and he was unable to ascertain whether the fish was stolen or was scavenged after being dropped.

Five failed attempts at food stealing were observed. Failure on these occasions was apparently due to the otter spotting the approaching eagle and taking action to protect their fish. The otters either rolled over on top of the fish to shield it from the eagle or made a short, shallow dive before resurfacing and continuing

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TABLE 1. Summary of Bald Eagle piracy of sea otters at Amchitka Island, Alaska.

Date	Eagles involved	Prey species	Otter involved	Result of piracy attempt
4/3/93	single adult	lumpsucker	adult female	success, whole fish
2/6/94	single adult[1]	lumpsucker	adult female	fail (twice)
2/7/94	single adult[1]	lumpsucker	adult female	success, whole fish
2/8/94	single adult	lumpsucker	adult female	fail
2/8/94	single adult	lumpsucker	unknown	fail
2/8/94	single juvenile	lumpsucker	adult male	success, small scrap
2/16/94	single adult[1]	lumpsucker	adult male	fail
2/16/94	single adult[1]	lumpsucker	adult male	success, skin plus flesh
2/17/94	pair adults[1]	lumpsucker	unknown	success, skin plus flesh
3/18/94	single adult	lumpsucker	unknown	success, skin

[1] Indicates eagles known or thought to be the same individual or member of same pair.

to eat. On only one occasion did an eagle make more than one attempt at stealing the same item from an otter; both attempts failed.

All but one attempt at food stealing were made by eagles in full adult plumage, the exception being a bird in its third year. A single eagle was associated with most piracy events (c.w. Jorde and Lingle 1988). Two birds were involved on 17 Feb 1994, when one member of a pair stole lumpsucker remains from an otter; it then had the meal stolen by a bird which appeared to be its mate. Approaches to otters were generally made from a perch on the cliffs, or from isolated rocks close to feeding otters where the eagles apparently waited and watched for otters to surface with fish. Successful attempts at stealing were made by low, fast approaches a few feet off the water which are presumably more difficult for the otters to observe and forestall than higher level approaches. The evasive action of otters in the failed attempts suggests that otters are aware of the potential for food loss to eagles and maintain vigilance while eating. It further suggests that the element of surprise is important for success by parasitizing eagles.

Brockmann and Barnard (1979) suggest several conditions which may facilitate kleptoparasitism. Two of these, namely (1) high concentration of hosts and (2) presence of suitably large, high quality prey seem to have led to the observed behavior of eagles in this study. As noted, the host species is very abundant at Amchitka Island. Lumpsuckers only occurred in otter diet from January until June, when they move inshore to breed (Yoshida and Yamaguchi 1985). During these months the numbers of otters eating fish increased dramatically (851 observed captures of fish compared with 44 between July and December) and it was only at these times that piracy by eagles was observed. Around 80% of the fish caught by otters were lumpsuckers. At other times of year, otters mainly consumed very small items, principally sea urchins (*Strongylocentrotus polyacanthus*) which are, presumably, of little interest to eagles.

It is also possible that other eagle prey, such as birds and migratory fish, were in short supply during winter and spring which may have forced eagles to seek alternative food sources. Accounts of the fishes of Amchitka (Simenstad et al. 1977) and of sea otter diet (Kenyon 1969, Estes et al. 1981, Riedman and Estes 1990, J. A. Estes, pers. comm.) suggest that spawning lumpsuckers may not occur in large numbers around Amchitka Island every year. It seems likely, therefore, that regular eagle kleptoparasitism of otters will occur only in exceptional circumstances: where otters are living at high densities, where fish make up a large proportion of otter diet and where other food sources are scarce.

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MELANIN AND THE ABRASION RESISTANCE OF FEATHERS[1]

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It has long been accepted that melanic feather keratin is more effective at resisting abrasive wear than non-melanic keratin (Averil 1923; Finnis 1959; Burtt 1979, 1986; Barrowclough and Sibley 1980; Bergman 1982; Lee and Grant 1986). The mechanical basis for this difference has yet to be determined. Voitkevich (1966) proposed that melanic keratin was less susceptible to wear as it is considerably thicker than non-melanic keratin. Differences in keratin thickness provide a reasonable explanation for the observed differences in wear resistance, however, the inclusion of granular fillers in polymers is known to increase their abrasion resistance (Lancaster 1973). As melanin is incorporated in feather keratin as granules (Filshie and Rogers 1962), it may function in this manner. Recently, Bonser and Witter (1993) found that in bills of the European Starling, *Sturnus vulgaris,* melanic keratin was significantly harder than non-melanic keratin. The wear resistance of a material is inversely proportional to its indentation hardness (Lipson 1967, Lancaster 1973, Barwell 1979). Thus, very hard materials wear less quickly than less hard ones. It is relatively easy to perform tests of indentation hardness, so this provides a very good method of determining the competence of a material to resist wear.

The maintenance of feathers is of vital importance to birds. Abrasion is an important mode of damage, and may initiate cracks in keratin that result in the fracture of feathers. This paper will quantify the differences in indentation hardness that are responsible for the differential abrasion resistance of melanic and non-melanic feather keratin.

MATERIALS AND METHODS

A primary remige was removed from each of twelve Willow Ptarmigan, *Lagopus lagopus* race *scoticus.* The birds had been stored frozen at −20°C since death. A 10 mm section of shaft was cut from each feather. The melanic dorsal, and non-melanic ventral surfaces of the shaft were separated, and the medullary foam scraped away from the keratin. Specimens were taken from opposing faces of the rachis at the same point along the rachis as it is known that substantial variation in material properties occurs along the rachis (Bonser and Purslow, in press). These specimens were glued to squares of perspex with cyanoacrylate adhesive. Vickers microhardness was determined using a Leitz "Wetzlar" miniload machine. The testing protocol followed that described by Bonser and Witter (1993). The indentor was allowed to remain on the specimen for 15 sec and the indentation measured after a further 45 sec. It is necessary to maintain rigorously these timings to prevent inaccuracies due to the viscoelastic creep of keratin. A load of 5 g was used in all tests. Ten indentations were made per specimen. Vickers hardness, VHN (kg mm^{-2}), is calculated using the formula

$$VHN = 1854P/d^2$$

where P is load in g, d is the diagonal length of the indentation in μm.

Paired *t*-test comparisons were performed on the pairs of data (melanic and non-melanic keratin) from each feather shaft.

RESULTS AND DISCUSSION

Melanic keratin from grouse primary feathers is significantly harder than non-melanic keratin ($T_{11} = 6.13$, $P < 0.001$). Mean Vickers hardness (SE) of the melanic sections was 14.63 kg mm^{-2} (0.96) and for the non-melanic sections, 10.51 kg mm^{-2} (0.44). Materials theory predicts that melanic keratin will sustain less wear than non-melanic keratin under equal abrasive con-

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