

including one inside a nest cavity. Six other islands showed no indication of abnormally low nesting success, and were probably not visited by ermine.

The major effects of ermine on guillemot breeding appeared to be discouragement of egg-laying and a reduction of hatching success due to nest abandonment. Many cavities on Black, Yellow, and Green islands which were occupied in previous years were not used in 1983. Eggs laid on islands where ermine presence was confirmed or suggested were often displaced from the nest cup and lacked the shiny appearance which is normal for regularly incubated eggs (pers. observ.). Guillemots may have been reluctant to enter their nests if they had seen an ermine in the colony, which would explain the reduction in both egg-laying and hatching.

Ermine visited islands as far as 1.6 km from the mainland (Pitsulak City), and may have reached Kingitauyu Island as well (2.2 km). This latter island is the highest of the 12 examined (22 m above sea level), which suggests that conspicuousness from the mainland may increase likelihood of visitation.

Ermine must have reached these islands either by crossing the ice or by swimming. If they came over the ice, they must have arrived at least two weeks before laying, since heavy ice disappeared from the area in early June. If ermine were on islands during the pre-laying period, they might have subsisted on eggs abandoned the previous year. Such food, however, would not have been available on Pitsulak City, because all unhatched eggs were cleared from the island the previous fall. Ermine may instead have reached the islands by swimming. A local Inuit told me of seeing an ermine swimming in salt water, and Seton (1929) reported anecdotal accounts of the species' ability to swim.

Ermine numbers are known to vary with those of lemmings (Finerty 1980), and the 1983 boom in ermine populations that led to the invasion of coastal islands in the study area may have been related to the lemming cycle. Although ermine and guillemots (*Cepphus* spp.) are broadly sympatric (Storer 1952, Banfield 1974), reports of predation by small weasels on guillemots are rare (e.g., Kartaschew 1960, Bianki 1967). The number of colonies

penetrated in the present study, however, suggests that ermine are quite capable of reaching coastal islands in years when their populations are high, and that such invasions may be more frequent than the paucity of records suggests.

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Biology Department, Carleton University, Ottawa K1S 5B6, Canada. Present address: Newfoundland Institute for Cold Ocean Science, % Biology Department, Memorial University of Newfoundland, St. John's, Newfoundland A1B 3X9, Canada. Received 7 December 1983. Final acceptance 12 September 1984.

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OBSERVATIONS OF SCRUB JAYS CLEANING ECTOPARASITES FROM BLACK-TAILED DEER

FRANK R. ISENHART

AND

DAVID F. DESANTE

Instances of proto-cooperation between birds and other large animals are relatively uncommon, although certain examples are quite well-known. These include the Greater Honeyguide (*Indicator indicator*) leading the honey badger (*Mellivora capensis*) to a beehive (Skead 1951), the Egyptian Plover (*Pluvianus aegyptius*) picking leeches and small bits of food from the open mouths of crocodiles (Howell 1979), and the Small Ground Finch (*Geospiza fuliginosa*) grooming ticks from the skin of the marine iguana (*Ambllyrynchus cristatus*; Amadon 1967). Uniquely among birds, the two African species of oxpeckers (*Buphagus* spp.) habitually associate with herds of large grazing animals

and derive a major portion of their diet as ectoparasites taken from the skins of these animals (Mackworth-Praed and Grant 1955).

In North America, examples of such proto-cooperation are rare. Although Cattle Egrets (*Bubulcus ibis*), cowbirds (*Molothrus* spp.), and occasionally other blackbirds often perch on the backs of cattle or other large grazers, they are thought to use the cattle only as "beaters" to stir up insect food from the grass (Heatwole 1965, Dinsmore 1973). It is not clear that cowbirds or Cattle Egrets ever pick insects off the animals themselves. This behavior is, therefore, better considered an example of commensalism rather than proto-cooperation. In contrast, Black-billed Magpies (*Pica pica*) pick and eat ticks from the backs of elk (*Cervus canadensis*) and mule deer (*Odocoileus hemionus*), an example of true proto-cooperation (Linsdale 1946).

Here we report a series of observations of an apparently proto-cooperative association between Scrub Jays (*Apelocoma coerulescens*) and Columbian black-tailed deer (*Odocoileus hemionus columbianus*) in which jays regularly picked ticks and perhaps other ectoparasites from the skin of deer. Dixon (1944) first reported such behavior between a Scrub Jay and a California mule deer (*O. h. californicus*) in Sequoia National Park, California. Schulz and Budwiser (1970) reported another Scrub Jay presumably taking ectoparasites from the back of a black-tailed deer 4 km northeast of Alpine Lake in Marin County,

California. For both cases, single observations were reported of individual Scrub Jays alighting on a deer's back, picking at the deer's skin, and flying off. We have tallied eight additional cases, five of them involving single jays and three involving pairs of jays. These observations include the interaction of at least five different Scrub Jays (two of which were individually color-banded) and 17 deer, although we do not know exactly how many different deer were involved because they were not marked.

The first observation was made in spring 1982 by Jack Swenson on the undisturbed, mature part of the 36-ha coastal scrub study plot of the Palomarin Field Station of the Point Reyes Bird Observatory (PRBO), at the southern end of the Point Reyes National Seashore (PRNS), Marin County, California. The remaining observations were made between January and May 1983 by Isenhardt, David Siemens, and David Fortna. Five of these incidents occurred near the location of the 1982 sighting and three occurred about 2 km northwest on a recently burned coastal scrub study plot. Both areas were situated on variously gentle to steep south-southwest-facing slopes that are immediately adjacent to the Pacific Ocean. The vegetation there consisted primarily of extensive areas of successional stage coastal scrub (recovering from grazing and limited cultivation prior to 1965), interspersed with smaller patches of mature undisturbed coastal scrub. Coyote bush (*Baccharis pilularis*, var. *consanguinea*) was the predominant shrub in both areas, but substantial numbers of other coastal scrub species also occurred, especially in the undisturbed areas. One plant associate, blueblossom (*Ceanothus thrysiflorus*), is known to be an especially favored waiting place for the Pacific Coast tick (*Dermacentor occidentalis*), a common parasite of both humans and deer at Palomarin (Robert S. Lane, pers. comm.). The open coastal hills are bordered to the east and north by douglas-fir (*Pseudotsuga menziesii*) forest and, in the arroyos and canyons, by broadleaf evergreen woodland. The close juxtaposition of these various habitats, and the protection afforded by the PRNS, combine to support large resident populations of both Scrub Jays and black-tailed deer.

In a typical interaction between a jay and a deer, the jay would land on the neck, back, or head of the deer and proceed to "clean" the entire dorsal surface of the animal, including the upper flanks and hind limbs, tail, back, neck, head, and antlers. Every few seconds, the jay would peck at the deer's skin. Two types of pecks were used. One type was delivered forcefully and the other softly, usually preceded by a brief waiting period. These different pecks may have reflected two types of food selection; hard pecks may have been for ticks, and soft ones for keds (hippoboscids) and deer flies (Tabanidae). Throughout this period, the deer would remain motionless. In one case, the deer was moving when the jay alighted on its back, but stopped and stood on three legs during the 5-min cleaning period. On three occasions, the deer extended their ears while the jays concentrated on that area of the head. Presumably, this allowed the birds to exploit an otherwise inaccessible area of the deer's ear and head. In all cases, the jays called before and after, but never during, the interaction.

In a typical interaction between a pair of jays and a deer, the birds perched atop a small tree (4–8 m high) or flew from treetop to treetop. In either case, the jays usually called loudly. When a deer appeared or was found, one jay alighted on the deer's back and behaved as described above, while the other remained perched in the top of a nearby tree (5–8 m). When the one jay completed its cleaning, it returned to its partner (the known mate in the case of the color-banded pair of jays), and the pair either moved on to another deer or waited for one to appear.

Activity suggesting "cleaning station" behavior was also noted with pairs of jays. In one case, two jays were seen perched atop a douglas-fir. Thick coastal scrub surrounded the tree except where a rocky outcropping (8 × 4 m) extended out from the base. While the jays were calling, a

deer entered the raised open area; one bird immediately flew onto its back, while the other remained on its perch. The deer remained motionless even though it faced an observer, 150 m away. Cleaning followed in the sequence described above, after which the jay returned to its partner and the deer departed. After 3 min, two additional deer appeared on the outcropping and were cleaned in the same manner as the first. We do not know whether or not the jay that performed this cleaning was the same individual that cleaned the first solitary deer. When this jay was finished with both deer, it returned to its partner and both deer re-entered the thick vegetation beside the tree. This interaction lasted 20 min and occurred in full view of a human observer. The observer's presence did not seem to affect the deer's or the jays' behavior, as we confirmed subsequently by using more inconspicuous observation points and even a blind; the same behavior was seen as before.

Corvids are widely accepted as highly intelligent birds (Linsdale 1937) with well-developed learning capabilities (Brower et al. 1970). At Palomarin, young color-banded Scrub Jays remain with their parents for up to five months after fledging and could well learn to clean deer during this time. Young Scrub Jays disperse during their first fall or winter and may go surprisingly far. One Scrub Jay that was color-banded at Palomarin during its first winter was recaptured four years later as a resident of Carson Ridge, 11 km east-northeast of Palomarin. This location is approximately 3 km northeast of Alpine Lake, and must be close to the location where, in 1965, a Scrub Jay was seen atop a deer by Schulz and Budwiser (1970). Thus, it is possible that young jays could learn cleaning behavior from their parents and spread it among other jays when they disperse from their natal territories. Several other pairs of color-banded Scrub Jays at Palomarin, however, occupy territories adjacent to the territory of a "learned" pair of jays, and have never been seen to alight upon a deer, although deer are equally abundant and accessible in their territories. Certain of these jays are now eleven years old and have been intensively studied for more than five years without any evidence of proto-cooperation with deer. To some degree, the deer's role in this interrelationship may also localize the behavior. Linsdale (1946) noted that some deer would not cooperate when magpies attempted to clean them and would push the magpies off their backs with their noses. Perhaps some deer are more receptive to this form of proto-cooperation than others.

During one 2-h observation, over 80% of a single jay's time was spent looking for or interacting with deer. When two deer and two jays were together, only one jay cleaned while the other watched from a nearby tree. Presumably, the cleaning behavior must be highly beneficial for such an investment of time and energy to be worthwhile. Furthermore, this behavior has been observed at Palomarin only from late winter through spring, when ticks are at least ten times more numerous (on humans) than during the rest of the year. We do not know to what extent this proto-cooperation between Scrub Jays and black-tailed deer exists throughout the year or exists in other coastal or inland populations.

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A MUTUALISTIC FEEDING ASSOCIATION BETWEEN BOAT-TAILED GRACKLES AND PIED-BILLED GREBES

JEROME A. JACKSON

At noon on 25 December 1978, I observed a feeding association between Pied-billed Grebes (*Podilymbus podiceps*) and female Boat-tailed Grackles (*Quiscalus major*) on Horn Island, approximately 10 km south of Ocean Springs, Jackson County, Mississippi. My attention was drawn to the birds because of their numbers, proximity to one another, and their frenzied behavior. Observations were made with a 20× spotting scope from 30 m away at a ca. 1-ha freshwater pond fringed with yaupon (*Ilex vomitoria*) and low (<0.3 m) grasses and herbaceous vegetation. When first seen, two grebes were feeding within 1 m of one another and within 0.3 m of a grassy shoreline. Water depth did not exceed 0.2 m and the grebes were capturing prey from the surface. A tight group of eight female Boat-tailed Grackles was clustered at the water's edge near (often within 0.1 m) the grebes. The mixed group moved steadily along the shore at about 1 m/10 s.

As the grackles worked their way through the grass, climbing, hopping, and flying, I saw numerous grasshopper nymphs jumping in front of them. Some were captured by the grackles, others escaped to the water where many were caught by the grebes, and still others escaped back to land either to be eaten by waiting grackles or to be chased back to the water. Because of the rapid movement, the number of birds, and the partially obscuring vegetation, it was difficult to determine capture rates. For brief periods when I was able to keep one bird in view, grackles caught grasshoppers at an average rate of one every 9 s (range 5-17 s, $n = 11$) and grebes caught grasshoppers at a rate of one every 11 s (range = 5-23 s, $n = 14$). These peak rates were for individuals closest to the water's edge, capture rates seemed slower for birds more distant. This feeding frenzy continued for nearly 20 min, at which time the group arrived at a dense cattail (*Typha latifolia*) stand. The grackles then flew off as a group and the grebes disappeared into the cattails.

Although the grebes were the primary beneficiary of the feeding association, the observed behavior was mutualistic rather than merely commensal. Most captures by both species resulted from flushing of the insects back and forth between the land and the water. Leck (*Am. Midl. Nat.* 86:

241-242, 1971) described a similar instance of feeding by Pied-billed Grebes and Snowy Egrets (*Egretta thula*) in which the grebes were chasing small fish into shallow water where they were captured by both species, the grebes benefitting by the herons "chasing" fish from their refuge in vegetation. Mueller et al. (*Auk* 89:190, 1972) reported similar interactions between Pied-billed Grebes, a Tricolored Heron (*E. tricolor*), and a Snowy Egret. Paulson (*Auk* 86:759, 1969) reviewed examples of feeding associations between other grebe species and other aquatic birds. The observation reported here is novel in that it involved interaction with a terrestrial bird species, and unusual prey for the grebes.

Similar involvement of multiple individuals of two bird species was described by Clark (*Fla. Field Nat.* 6:45-46, 1978) for a feeding association of American White Pelicans (*Pelecanus erythrorhynchos*) and Wood Storks (*Mycteria americana*), and by Rodgers (*Fla. Field Nat.* 6:44-45, 1978) for Brown Pelicans (*Pelecanus occidentalis*) and Wood Storks. Both of these cases also recognized one species (the Wood Stork) as the primary beneficiary of the association. Those associations might also have been mutualistic, however, because fish that escaped the Wood Storks were probably often herded back into the path of the pelican assemblages.

Such interactions involving multiple individuals of each predator species herding multiple prey individuals are likely to be mutualistic. Various authors have referred to such associations as "cooperative" (e.g., Leck 1971) or "commensal" (e.g., Paulson 1969, Clark 1978, Rodgers 1978). None of the interspecific associations there described suggested that the relationship resulted from active association by both species. Rather it appears that one, the grebe or the Wood Stork in the cases described above, was attracted to the feeding activities of the other. Thus "cooperative" seems an inappropriate descriptor. In all of the cases described here, however, both species probably benefited from the activity, albeit the grebes and storks perhaps more so. Thus, the associations are more than "commensal." It seems significant that in none of the cases was interspecific evasive or aggressive actions observed. This supports the notion that the associations were mutualistic. It is easy to imagine, however, that under circumstances of more distant or closer association and/or decreased or increased numbers of grebes, the relationship might become one of commensalism or kleptoparasitism, respectively. Interspecific feeding associations thus seem to form a graded series from commensalism to mutualism to kleptoparasitism, depending on the closeness of the birds and the numbers of the "benefitted" species.

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