

The Use of Green Plant Material in Bird Nests to Avoid Ectoparasites

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Certain birds characteristically place green plant material in their nests. This greenery is not part of the nest structure proper but is placed haphazardly around the edges or inside the nest. The birds replenish the sprays of green material, often daily, during incubation and the nestling period (Brown and Amadon 1968, Beebe 1976, pers. obs.).

I hypothesize that the plants are placed in the nests to repel or actually kill avian ectoparasites. Plant material may repel or kill ectoparasites because of the secondary compounds it contains. Secondary compounds often function as insect repellents in plants (Levin 1971). The compounds work as olfactory repellents, toxins, or juvenile hormone analogues to deter insects. If the parasite-repellent hypothesis is correct, the plant species chosen should be aromatically repellent, because avian ectoparasites do not ingest these leaves.

The aromatic compounds of plants are hydrocarbons, mainly monoterpenes and isoprene (Rasmussen 1972). In general, trees and long-lived shrubs emit the greatest volume of volatile compounds, whereas annuals emit the lowest volume of these compounds (Rasmussen 1972). Plant volatiles are used as a defense against herbivores but are also used by insects to locate their host plant (Freeland 1980). It has been established that volatile plant compounds can disrupt olfaction in insects by masking the particular chemical cue that the insect uses to find a host (Tahvanainen and Root 1972). If this is true of host-plant location, it may also be true of host-animal location. If my hypothesis is correct, then nest greenery would function in these manners.

There is evidence that infestations of ectoparasites

causes nestling mortality in and nest desertion by birds (Webster 1944, Neff 1945, Fitch et al. 1946, Moss and Camin 1970, Feare 1976, Wheelwright and Boersma 1979). In general, the increased mortality due to ectoparasites is caused by the loss of blood, which weakens the host, by viral disease, or by disease caused by noxious endoparasites for which arthropod parasites are vectors (Herman 1955). The groups of ectoparasites most responsible for mortality are dipterans, fleas, ticks, and mites (Herman 1955).

Three predictions follow from the hypothesis that the use of nest greenery evolved to inhibit infestations of ectoparasites. (1) Birds that reuse their nests over successive years should be more prone to the use of foliage than birds that build a new nest each year. Nest reuse is implicated because hippoboscids fly larvae overwinter in nests and emerge about the time the eggs hatch (Bequaert 1953). The larvae are large relative to their hosts. Thus, it does not take many of them to weaken their host significantly. A number of endoparasitic diseases also are transmitted by hippoboscids and simuliid flies (Herman 1955). (2) The incidence of foliage use among birds that prey on higher vertebrates (birds and mammals) should be greater than that among birds that prey on lower vertebrates, because higher vertebrates often harbor large flea populations, as well as some dipterans, ticks, and mites. Parasite transmission occurs when mammals are taken by birds; owls have been found infested with rodent fleas (Rothschild and Clay 1952). (3) The types of greenery used in the nest should be high in volatile secondary compounds.

I used the order Falconiformes in order to test the first two predictions because of the variability in greenery use, nesting habits, and food preferences that members of this order exhibit. To get the most accurate and consistent data base about relative frequency of greenery use for this comparative study, I

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used the original data slips associated with the egg sets of North American raptors housed at the Western Foundation of Vertebrate Zoology and at the University of Washington Museum. Information on European Falconiformes was taken from Harrison (1975), because European egg collectors were remiss in describing nest contents. Data about food habits for North American Falconiformes were taken from Snyder and Wiley (1976). A comparable data base does not exist for European Falconiformes. I could not test Prediction 3, because the egg collectors often failed to specify on the data slips what type of greenery was used. When greenery was identified, however, it invariably was either from trees or shrubs, never from herbaceous species, although highly aromatic herbs exist. Falconiformes that do not build nests (e.g. *Falco*, some *Cathartes*), were not included, because such birds do not make choices about nest material. Nest reuse denotes a regular tendency for a species to reuse their nest and should not be construed as a clear-cut either/or situation.

An immediate problem was determining which egg collectors were likely to mention the presence of greenery in nests. Some collectors left only meager notes about nest materials and contents. I used the data from those collectors who mentioned greenery at least once to calculate the frequency of greenery use by each species. Species that were noted to use greenery on 50% of the data slips qualified as greenery users. Cooper's Hawks (*Accipiter cooperii*) and Bald Eagles (*Haliaeetus leucocephalus*) were the only exceptions to this rule. J. McNutt (pers. comm.) observed that 29 of the 32 Cooper's Hawk nests he watched in the San Juan Islands contained green conifer sprigs that were often replenished. F. W. Preston (pers. comm.) has also found that Cooper's Hawks use greenery. Newton (1979) and A. Hanson (pers. comm.) detail extensive use of decorative nest greenery by Bald Eagles. Neither of these species was recorded to use greenery by 50% of the egg collectors. This suggests that egg collectors were likely to overlook greenery use in their notes. Thus, my decision to categorize birds as greenery users is a conservative one.

I chose species as the unit under investigation, because the multispecific genera usually contain species representing all of the behaviors being correlated. This demonstrates that phylogenetic history does not constrain greenery use and that species can be considered as independent units for the purposes of this study. Significance was determined using the Fisher 2×2 Contingency Test and the Chi-square statistic.

Greenery use is significantly correlated with nest reuse in North American and European Falconiformes, a correlation that supports the first prediction. Of the 28 species that use greenery, 22 reuse their nests, whereas only 8 of 20 species that use no greenery also reuse their nests ($\chi^2 = 8.281$, $P < 0.005$). The trend becomes even more striking when one considers the large number of Passeriformes that build

new nests yearly and use no greenery. Among passerines that reuse their nests, European Starlings (*Sturnus vulgaris*; pers. obs.), Purple Martins (*Progne subis*; A. S. Gaunt pers. comm.), and American Crows (*Corvus brachyrhynchos*; P. Arcese pers. comm.) have been reported to place fresh greenery or the highly aromatic inner bark of western red cedar (*Thuja plicata*) in their nests.

Contrary to Prediction 2, prey type is not correlated with greenery use. Of the 15 species that use greenery, only 8 have diets consisting of greater than 25% higher vertebrates, whereas 5 of 8 species that use no greenery also have diets that consist of greater than 25% higher vertebrates (Fisher Exact $P = 0.51$). This may be because parasite transmission is not common between predator and prey, because the parasites that are transmitted are not virulent to the new host, or because greenery volatiles are not effective against the relevant ectoparasites.

Greenery use varies geographically within a species. For instance, greenery was mentioned by collectors of Red-tailed Hawk (*Buteo jamaicensis*) eggs in 10% of the nests in the Pacific Northwest ($n = 10$), in 65% of the nests in the Southwest ($n = 23$), in 67% of the nests in the Northeast ($n = 20$), in 23% of the nests in Missouri ($n = 30$), and in 62% of the nests in California ($n = 55$). F. W. Preston (pers. comm.) has observed that all of the *Buteo* nests that he has looked at in the Northeast contain nest greenery. This discrepancy is probably due to the patchy data collection of the oologists. The regional differences also may be related to the availability of suitable plant species, time of leafing, or regional abundances of ectoparasites. The low incidence of greenery use in the Northwest is evidence that the availability of suitable plant species and time of leafing make little difference in whether or not greenery is used, because conifers are the predominant trees in the Northwest. They are aromatic and used in other parts of the country where they are available.

The ectoparasite-repellent-greenery hypothesis provides the most compelling and generalizable explanation for the widespread use of greenery in birds' nests. A number of other hypotheses have been postulated. (1) Greenery serves as a means of nest sanitation by covering debris in the nest. (2) It advertises nest occupancy. (3) It helps maintain humidity in the nest. (4) It serves to shade the nestlings (Bush and Gehlbach 1979). Newton (1979) discusses the first three possibilities.

The sanitation hypothesis fails to explain why the material used is invariably green, is brought to the nest before the nest is soiled, and is often placed haphazardly around the nest rim. The use of greenery to indicate nest occupancy does not explain why it is still brought after there are eggs or nestlings present. The nest-occupancy hypothesis may apply to Golden Eagles (*Aquila chrysaetos*), which place greenery in all the nests within their territory throughout the year in Washington (they maintain