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THE SCIENTIFIC NATURALIST Why do some birds carry their chicks?

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One of the more endearing but poorly understood forms of parental care is the transport of offspring. As a search with Google Images readily reveals, a diversity of taxa with parental care carry their offspring: mammals (e.g., primates, bats, anteaters), birds (e.g., some swans, grebes, loons), reptiles (e.g., crocodiles, caiman), fish (e.g., mouth-brooding species, seahorse), and various arthropods (e.g., spiders, giant waterbugs, scorpions). Why some animals carry their offspring while others do not is poorly understood. Here I use birds as an example to explore this problem. I focus on the aquatic birds that carry their chicks while swimming—the chicks climb on the back of the parent and are ferried around the water on their parental platform (Fig. 1). However, the costs and benefits I discuss are likely to apply to many of the above-mentioned animals that carry their offspring.

In birds, carrying chicks on the back is perhaps most widespread in the grebes (Order Podicipediformes) and most if not all species appear to carry their chicks (Fjeldså 2004). During a study of American Coots (*Fulica americana*) near Williams Lake, British Columbia, Canada I incidentally observed and photographed Eared Grebes (*Podiceps nigricollis*) carrying their chicks

over several weeks in June 2007 (Fig. 1). In our coot study, we use camouflaged floating blinds to observe coot broods; however, grebes are particularly oblivious to our blinds so I was often able to follow and observe grebes families at very close distances. These observations, and contrasts with my observations of coot families where chicks are never carried (Fig. 2), motivated questions about why birds might carry their offspring.

A description of the breeding behavior of Eared Grebes helps to put the carrying behavior into the context of an entire parental strategy. Eared Grebes are not territorial, but nest in colonies. At my study site, colonies ranged in size from a few pairs to upward of 100 pairs, and nests were often very close together (1–2 m; Lyon and Everding 1996). Once the chicks at a nest hatched, the family left the nesting area and moved around the wetlands, and they did not return to their nest or colony. Instead, the parents served as the home base and, for about the first week of life, the chicks were carried almost continuously by one of the parents. Typically, one parent carried the chicks while the other foraged for food to bring to the chicks, and the chicks were fed while they sat on the back of the parent, a floating restaurant of sorts. In birds like grebes that forage under water, chick carrying requires biparental care because a single parent cannot simultaneously carry the chicks and dive under the water in search of food. The parents controlled whether the chicks remained on their back and easily shook the chicks off their back into the water when they no longer wanted to carry the chicks. This shaking displacement motion was often used to transfer



FIG. 1. Eared Grebe chicks being carried by a parent at the Westwick Lakes system of three small lakes near Williams Lake, British Columbia, Canada.

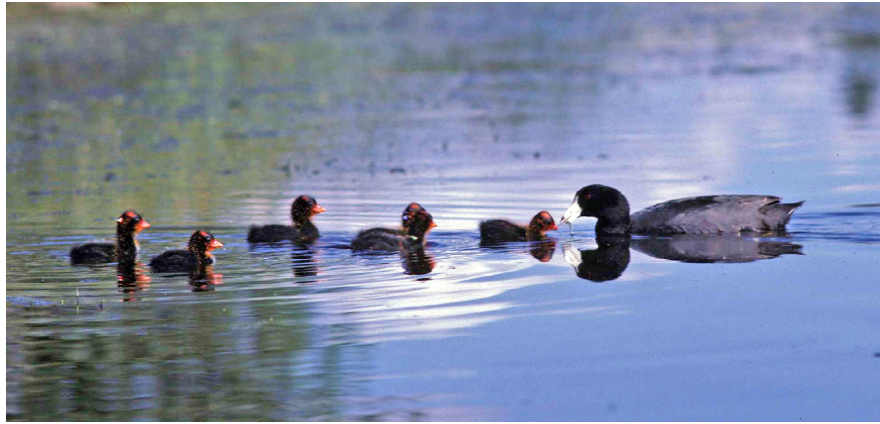


FIG. 2. American Coot chicks are mobile and follow the parents to be fed but, unlike grebes, the chicks are never carried on the parents' back.

the chicks from one parent to the other; chicks were shaken off the back of one parent into the water and the second parent then approached and allowed the chicks to climb aboard. As the chicks got older (and larger), the parents also increasingly used the shaking motion to prevent chicks from clambering up on to their backs.

Why would grebes and other birds carry their young? A couple of benefits to chick carrying have been mentioned very briefly in passing, including thermoregulation (Fjelds  2004) and safety from predators (Johnsgard and Kear 1968). However, we lack a detailed consideration of the various benefits and, equally important, the potential trade-offs between alternative options. I use a comparison of the reproductive biology of Eared Grebes and American Coots, a species that does not carry its chicks (Fig. 2), to consider how different factors might interact to favor chick carrying. Grebes and coots both feed their offspring and both have mobile chicks at hatching (Shizuka and Lyon 2013), but coots remain on their small territories for the entire breeding season whereas Eared Grebes nests in colonies and leave these colonies after hatch and move about entire wetlands with their families. Although American Coots have much larger broods than Eared Grebes, brood size cannot explain the difference between all coots and grebes (all grebe species carry chicks but no coot species do). Some coot species have small broods; for example, broods of Red-gartered (*Fulica armillata*) and Red-fronted Coots (*Fulica rufifrons*) of South America are much smaller than those of the American Coot and are similar to those of grebes that carry their chicks at high frequencies (e.g., Western Grebe; *Aechmophorus occidentalis*; Lyon and Eadie 2004; B. E. Lyon and J. M. Eadie, *unpublished data*).

Many grebe species brood their chicks while carrying them so one obvious benefit to chick carrying is a thermoregulatory benefit for the chicks. Eared Grebe chicks' plumage is not waterproof at hatching and they can only begin to maintain their own body temperature at about 10 days of age (Cullen et al. 1999). Brooding is therefore

essential and the parent keeps chicks warm by covering them with their wings and back feathers. Many aquatic birds, however, brood their chicks without carrying them, so thermoregulation cannot be the sole factor that explains chick carrying in grebes. For example American Coot chicks are brooded in nests, sometimes in the original nest and sometimes in special brood nests built after the chicks hatch. During brood observations, we often see coot families returning to their brood nest for a brooding session after a bout of feeding on the water, particularly during cold weather. Coot families forage entirely on their territories until the end of the breeding season and these territories are very small compared to predicted territory size based on body size (Schoener 1968; B. E. Lyon and D. Shizuka, *unpublished data*). Consequently, coot families never forage too far from their brood nests and little time is consumed returning to the nests to brood chicks.

In theory, grebes could also use brood nests to warm the chicks but, depending on the breeding strategy, this could impose substantial travel costs. Pied-billed Grebes (*Podilymbus podiceps*), like coots, are territorial and they do sometimes brood chicks on platforms on the territory (Muller and Storer 1999). Eared Grebes, in contrast, are not territorial and range widely over the entire breeding wetland while foraging, often at considerable distance from the nest site. Returning to the nest site (or any other fixed location) to brood chicks would consume considerable travel time. Having mobile families, and the ability to brood chicks wherever the family happens to be foraging, eliminates these travel costs (see Moreno [1984] for a more general version of this foraging idea). Less travel time means more foraging time, which translates into more food for the offspring. In some grebe species, families can travel great distances: LaPorte et al. (2013) note that Western Grebes, another colonial species, may wander several kilometers from the nesting colony in search of food.

I suggest that it is the combination of brooding and high degree of family mobility that might explain chick carrying in some grebes. Carrying chicks, and brooding them while

carrying, allows for a much more efficient foraging strategy with minimal travel costs. Thus, the primary benefit to carrying chicks might be increased family mobility, but this mobility requires that chicks be brooded during carrying. Ydenberg (1989) used similar trade-off logic, a trade-off between travel time and nest site safety, to explain why chicks in some auks (Family Alcidae) remain in the nest while others leave the nest shortly after hatching and follow a parent to foraging areas at sea. The mobility-brooding hypothesis cannot be tested in grebes based on the evolution of chick carrying itself because all grebes carry their chicks; in terms of trait evolution, chick carrying per se is likely to have arisen in an ancestor of all extant grebes. However, grebe species do appear to vary in the frequency with which they carry their chicks (T. Arnold, *personal communication*), and the duration of the chick-carrying period also varies considerably among species (Ogilvie 2003). Therefore, the hypothesis could be tested by determining if highly mobile, colonial-nesting species carry their chicks more frequently, or for a longer period during the chick stage, than more sedentary, territorial species.

Another potential benefit to carrying chicks could be a reduced risk of predation for the chicks. Johnsgard and Kear (1968) suggested that variation in one aspect of predation, specifically nocturnal predation, might explain why far northern species of swans (Family Anatidae) do not carry chicks while some temperate zone swans do: northern species experience little nighttime darkness and should suffer less risk of nocturnal predation. However, this explanation cannot explain why the swans (and other species) carry their chicks during the daytime. For some taxa, predation from fish could be important because predatory fish are known to consume aquatic birds, particularly small young birds. For example, one study of Northern Pike (*Esox lucius*) found that over 1% of the stomachs of the sampled fish contained ducklings, and smaller numbers contained young coots and grebes (Solman 1945). A study of Common Goldeneye (*Bucephala clangula*) in Finland found the survival of small young ducklings correlated with risk of predation from pike (Paasivaara and Pöysä 2004). Carrying offspring would be one possible evolutionary response to reduce fish predation. Interestingly, goldeneye and other ducks do not carry their offspring, perhaps because the offspring must feed themselves; the large brood sizes of many waterfowl might also make carrying chicks difficult (Johnsgard and Kear 1968). Some grebes and loons, which also carry their young, breed in lakes where northern pike or other predatory fish occur so mortality from fish might explain in part why these birds carry their offspring. Eared Grebes normally inhabit shallow fishless lakes so predation seems an unlikely explanation for why this species carry their offspring. As above, since most grebes carry their chicks a test of the role of predation for the grebes

would have to examine the frequency or duration of carrying in relation to predation, not chick carrying per se.

One final observation provides anecdotal evidence that carrying chicks can increase their survival in lakes with predatory fish. In several years during the past decade, one or two pairs of coots and one pair of Pied-billed Grebes nested at Westlake Pond, a small urban wetland near my house in Santa Cruz, California, USA. Each year, the grebes successfully raised chicks, but from five different years where I knew coots had initiated nests, only one coot chick was ever produced. I suspect that predation from introduced large-mouthed bass (*Micropterus salmoides*), a voracious predator added to this wetland for recreational fishing, explains this pattern. Only once have I seen a recently hatched coot chick at this wetland; a small chick emerged from the dense vegetation around its nest, plopped onto the water and was promptly snatched by a bass. Grebe chicks are a similar size to coot chicks and must be vulnerable to predation; that grebes successfully raise chicks every year at this particular wetland is likely due to their habit of carrying their chicks. This speculation could be rigorously tested with a broader geographic comparison because coots and grebes nest widely in central California, sometimes on wetlands with bass and sometimes on fishless ponds. At an even broader geographic level, the swans provide an additional opportunity to test the importance of fish predation on chick carrying. The prediction is that species that carry their chicks often live in lakes with predatory fish whereas those that do not carry their chicks inhabit lakes free of such predators.

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