DIRECT REMOVAL OF FECAL SACS BY ROCK WRENS

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Removal of fecal sacs from nests during nestlings' development is an adaptive behavior shared by most species of passerines (Skutch 1976, Welty 1982, Weatherhead 1984). The selective forces that have shaped nest-sanitation behavior remain unclear, but clean nests are thought to be less likely to attract predators (Petit and Petit 1987, Petit et al. 1989; but see Ibáñez-Álamo et al. 2014a). Nest-sanitation behavior also appears to improve a host's rejection of a brood parasite's eggs (Moskat et al. 2003, Guigueno and Sealy 2012). In many studies nest sanitation is linked explicitly to measures of parental investment, including feeding rates (Ricklefs 1977, Gustafsson and Sutherland 1988, Markman et al. 2002). All of these studies indicate that the removal of fecal sacs can improve reproductive success for the parents, but fewer studies have focused on the role of nestlings' behavior in nest sanitation, particularly in coordination with parental actions. Such behaviors have been known for some time. For example, Blair and Tucker (1941) described "active cooperation" behaviors, in which nestlings of multiple species with varied nest types were observed making deliberate movements to facilitate removal of their feces. Selection for behaviors that facilitate efficient removal of fecal material should be beneficial because they prevent nest contamination and decrease the time and energy expenditure given to nest sanitation (Thomson 1935, Spencer 2005, Ibáñez-Álamo et al. 2013). Nestlings of a few passerine species have been observed to raise their tails in response to adults' visits to the nest in order to facilitate cloacal stimulation, after which the adults pick up the fecal sacs and either remove them from the nest or eat them (Selous 1933, Smith 1942, Davis 1978). Other researchers describe parent birds waiting near nestlings to remove fecal sacs from the nest floor (Gabrielson 1912, Laskey 1948, Ley and Williams 1998). In the House Wren (*Troglodytes aedon*) in Surinam, Haverschmidt (1952) described parents removing fecal sacs directly from the cloacae of nestlings, a behavior also described by Dobbs et al. (2001) in the Scaled Antpitta (*Grallaria guatimalensis*). This direct removal of fecal sacs likely eliminates a parent bird's need to search for and pick up feces during the time of maximum provisioning effort, and it could limit the amount of potentially harmful bacteria within nests (Ibáñez-Álamo et al. 2014b). Direct removal of fecal sacs can be difficult to observe, particularly in cavity nests or nest boxes, and may therefore go underreported and undescribed. To date there have been few accounts of nestlings cooperating with parents to remove waste in species nesting in rock cavities, and even fewer photos or videos documenting such coordinated sanitation behaviors.

The Rock Wren (*Salpinctes obsoletus*) nests in rock cavities, with both males and females participating in chick rearing and nest sanitation (Lowther et al. 2000, Warning and Benedict 2015; Figure 1). From 2012 to 2014 we used direct observation and motion-activated cameras (Reconyx, Holmen, WI) to observe five pairs of Rock Wrens provisioning their young on public lands in montane shrublands near Fort Collins, Colorado (40° 31.56° N, 105° 09.29° W). The nests contained 3–5 chicks (average 4) with broods ranging in age from 7 to 14 days. We placed cameras (adjusted to 1 m focal length) ~1 m from three ground-based nests and directly observed two nests located in cliff cavities. We did not quantify rates of fecal-sac removal or standardize observation effort across nests so report only qualitative natural history data. Because

Figure 1. A Rock Wren carrying a fecal sac away from the nest at Lory State Park, Colorado, on 2 July 2013.

Photo by Dave Leatherman

of shadowing within the nest cavities during our observations, we describe behaviors near the nest-cavity entrances as nestlings became more mobile, within 1–2 days of fledging.

At each of the five nests, we documented Rock Wrens removing fecal sacs both from the floor of the nest cavity and directly from the cloacae of nestlings (Table 1).

During direct removal, which typically followed a feeding, a chick turned away from its parent, raised its tail, and produced a fecal sac in apparent response to the approaching or waiting adult. The adult Rock Wren quickly removed the fecal sac directly from the cloaca, carried the waste in flight, and dropped it away from the nest (Figure 2; see also video recorded by Meyer on 14 June 2012 at youtu.be/Uag8xfJ3qbM).

Our photos and video provide clear documentation of a phenomenon that has previously been described in only a few bird species. Rock Wren nestlings coordinate their behaviors with their parents', aiding in efficient removal of waste from nests. Many other species are likely to behave similarly. In other species researchers have described unusual adaptive nest-sanitation behaviors and changes in nest-sanitation behavior over time (Blair and Tucker 1941, Glück 1988). Further studies are needed to determine the specific benefits of this behavior to the Rock Wren and to determine

Table 1 Locations, Active Dates, Observation Dates, and Methods of Observing Fecal-Sac Removal from Five Rock Wren Nests in Larimer County, Colorado

Location	Known active dates	Observation date(s) of fecal sac removal	Method	Type(s) of removal observed
Devils Backbone Open Space	5 June–16 June 2012	14 June	Direct observation	Cloacal
Lory State Park				
S. Valley Trail	30 June–7 July 2013	3 July, 7 July	Direct observation	Cloacal, nest floor
Quarry Cove	15 June–20 June 2014	19 June, 20 June	Motion camera	Cloacal
Shoreline Trail	16 June–24 June 2014	23 June, 24 June	Motion camera	Cloacal, nest floor
Pine Ridge Natural Area	22 June–28 June 2014	27 June	Motion camera	Cloacal, nest floor

Figure 2. Time sequence from a motion-activated camera showing a Rock Wren removing a fecal sac directly from the cloaca of a nestling on 23 June 2014.

Photos by Nat Warning

how the prevalence and proportion of direct removal of fecal sacs may change over the course of nestlings' development.

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