PUNCTURE-EJECTION OF OWN EGG BY LEAST BELL'S VIREO AND POTENTIAL IMPLICATIONS FOR ANTI-PARASITISM DEFENSE

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We video-recorded an adult Least Bell's Vireo (*Vireo bellii pusillus*) puncture-ejecting one of its own eggs. The behavior was detected during analysis of footage from 25 vireo nests that we videotaped continuously along the San Luis Rey River near Bonsall, California, in 2000 (Peterson 2002, Sharp 2002). The ejection occurred at 0622 on 21 July 2000 in a nest containing two 5-day-old vireo nestlings (both fledged on 27 July) and the unhatched vireo egg. Prior to ejection, one adult stood in the nest cup and the other was perched on the main branch that supported the nest. The former adult flew away, and the latter moved to the edge of the nest, looked into it, pecked the unhatched egg three times with its closed bill, stopped, and looked into the nest again. This cycle of striking the egg three to five times then looking into the nest was repeated over 44 seconds, during which the adult pecked the egg 27 times. Following the last strike, the adult grasped the egg with its bill on either side of the hole it had created and flew away from the nest with the egg. A vireo returned to the nest 9 seconds later, looked into the nest, but did not lower its head into the nest cup. We could not sex the adult vireos, and they did not vocalize during the time observed. This report is the first of puncture-ejection of an egg by a Least Bell's Vireo.

The two primary reasons a bird may remove an egg from its nest are that the egg is recognized as parasitic (e.g., Rothstein 1974, Sealy and Neudorf 1995) or damaged (Kemal and Rothstein 1988, Mallory et al. 2000). As the egg was the vireos' own, it could not have been recognized as parasitic. We do not know if the egg was damaged, but the fact that the adult struck it 27 times before removing it from the nest suggests that prior damage is unlikely. It is possible that since the egg had not hatched by day 5 of the nestling period, the vireo recognized it as inviable and ejected it. However, unhatched eggs are generally left in active vireo nests and are found in nests after fledging. In 2000, of nests with at least one hatchling ($N = 78$), unhatched eggs were encountered in 23 of 30 nests (77%) in which the number of hatchlings was lower than the number of vireo eggs laid (in seven nests, eggs disappeared for unknown reasons). Unhatched eggs were detected in nests with chicks ranging in age from 5 to 9 days during visits to band nestlings. Because we collected unhatched eggs when we banded to prevent possible damage that could attract ants, known nest predators of Least Bell's Vireo chicks (Peterson et al. 2004), we do not know how long they would have remained, but, from our experience, we believe it is likely that the majority of inviable eggs are left in nests throughout the period that they are active. We have not encountered depredated nests at which we could document that damaged inviable eggs attracted predators, but a behavior such as egg ejection that minimized such a risk would clearly be beneficial in enhancing nesting success.

Another possible explanation for the ejection is that the egg was mistaken for a fecal sac. To evaluate this possibility, we reviewed all videotapes from the day of hatching to two days after the reported ejection to compare behaviors associated with fecal-sac removal and those observed during egg-ejection. In 80 observed instances of fecal-sac removal, the maximum number of pecks into the nest in any one instance was four. On three occasions the adult pecked twice, and in all other instances, the adult lowered its head into the nest only once before removing the sac. Moreover, in all but three of the 57 fecal-sac removals from the day of egg-ejection onward, the rump of the nestling vireo was visible as it excreted the fecal sac and the adult picked up the sac in its bill; fecal sacs are also smaller than vireo eggs. Although the motor patterns of fecal-sac removal can be similar to those of egg-ejection (Rothstein 1975a, Moskat et al. 2003), the behaviors we observed during egg-ejection were extreme and distinctive relative to the typical treatment of fecal sacs.

The ability to puncture-eject eggs represents a behavior that might provide the basis for the evolution of an additional form of defense against parasitism by Brown-headed Cowbirds (*Molothrus ater*). Puncture-ejection has been shown to be an effective defense against parasitism in another small host, the eastern Warbling Vireo (*Vireo gilvus gilvus*, Sealy 1996, Sealy et al. 2000), although the smaller western Warbling Vireo (*V. g. swainsoni*) is not an ejector (Sealy 1996, Sealy et al. 2000). Bill size may constrain the latter subspecies from ejecting a cowbird egg (Rohwer and Spaw 1988, Sealy et al. 2000), and the Least Bell's Vireo (mean mass 8.5 g, Brown 1993) is smaller than *V. g. swainsoni* (mean masses 11.9 g, Gardali and Ballard 2000). Therefore, although our report indicates that Least Bell's Vireos have the ability to remove their own eggs, it does not necessarily follow that they can remove a cowbird egg from a nest. Experimental tests will be necessary to determine whether vireos recognize cowbird eggs as foreign and, if so, whether they can puncture and eject them (*sensu* Bolen et al. 2000, Rothstein 1974, 1975a, b, 1976, Sealy 1996, Sealy and Neudorf 1995). Given the current endangered status of this host, such a study will not be feasible until Least Bell's Vireo populations have increased to the point where the subspecies is no longer endangered.

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