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A case of cooperative breeding in the Hooded Warbler.—Cooperative breeding involves one or more individuals, in addition to the genetic parents, giving parental care to offspring (Stacey and Koenig 1990, Emlen 1991). In birds, this parental care may take several forms, such as feeding nestlings, nest construction, incubation, defense against predators, and territory defense (Stacey and Koenig 1990). The social organization of cooperative breeders occurs in a variety of forms including (1) nonreproductive adults helping their parents raise young, (2) "plural breeders" where more than one monogamous pair within a social group breeds simultaneously, (3) "highly gregarious" monogamous cooperative breeding groups, and (4) polyandrous or polygynandrous cooperative breeding groups (Stacey and Koenig 1990, Krebs and Davies 1991). Cooperative breeding in birds is relatively rare, existing in only 2.4% (220 of 9000) of avian species (Stacey and Koenig 1990, but see Emlen and Vehrencamp 1983). Herein, we report the first documented case of cooperative breeding in a warbler, the Hooded Warbler (*Wilsonia citrina*).

Methods.—Hooded Warblers are small, migratory songbirds that breed in selectively-logged mixed hardwood deciduous forests. We conducted this research in Crawford County, Pennsylvania (41°N, 79°W) as part of a two-year mating system study from May-August 1994 and 1995. The mating system is socially monogamous, with one male and one female occupying a single breeding territory (Stutchbury et al. 1994, Evans Ogden and Stutchbury 1994). We discovered the nest where cooperative breeding occurred on June 16, 1995. When the nestlings were five days old, a banded female, a banded male (B) and an unbanded male (U) were caught with mist nets near the nest. Unbanded adults were banded with U.S. Fish and Wildlife aluminum bands and unique color band combinations to identify individuals. Upon returning nestlings to the nest after banding them, the female and U male began chipping rapidly near the nest while the B male chipped rapidly approximately 10–15 m away. This peripheral male then flew to the nest and fed one of the nestlings.

To determine if both males were feeding nestlings, the nest was video-taped from 08:00–09:00 EDT each day for four days. Playback experiments were also conducted to determine the role of the males in territory defense. A recording of male "repeat" and "mixed" mode song patterns (Wiley et al. 1995) was used. After feeding rate observations were complete

on the fourth day, three playback experiments of a 10-min. duration were conducted in mid-morning in the center of the territory. A model of a male Hooded Warbler was placed beside the playback speaker. Playbacks were conducted at approximately 30-min. intervals. Repeating the playback experiment confirmed that the same male was responding each time.

Results.—Mean feeding rates (±SE) (N = 4 h) for the female was 7.4 ± 3.0 trips/h. Mean feeding rates for the B and U males were 9.6 ± 1.6 trips/h and 1.1 ± 0.2 trips/h respectively. The feeding rate for the B male was significantly higher (unpaired *t*-test, $t = 5.29$, df = 6, $P = 0.002$) than that of the U male. Feeding rates did not differ significantly between either the female and the B male (*t*-test, $t = -0.65$, df = 6, $P = 0.54$) or the U male (*t*-test, $t = 2.12$, df = 6, $P = 0.08$).

The degree of aggressive behavior during playbacks varied between the two males. Both males chipped rapidly and countersang within one minute of the start of the playback. However, only the B male circled repeatedly around the model (at a radius of 10–15 m), changed its perch frequently and flew within 5 m of the model twice. The U male stayed about 20–25 m away. Neither male physically attacked the model. Each time I approached the nest, all three adults flew to the nest in defense.

Discussion.—Previously in this study area, feeding behavior to nestlings has been observed for 5–6 h/nest for about 60 nests, with no prior instances of cooperative breeding (Evans Ogden and Stutchbury 1994, Neudorf, unpubl. data). Therefore, cooperative breeding is rare (1/60 or 1.5%) in Hooded Warblers. The "auxillary" male (U) could have shared paternity with the "dominant" male (B) because about 40% of female Hooded Warblers produce extra-pair young from fertilizations with neighboring males (Stutchbury et al. 1994). High levels of extra-pair matings could increase the likelihood of cooperative breeding, just as it may favor adoption of fledglings in this species (Stutchbury and Evans Ogden, unpubl. data). In 1994, the auxillary male was pair-bonded with this same female on a nearby territory, but was genetically unrelated to his offspring that year (Tarof, Stutchbury and Piper, unpubl. data). This cuckoldry, along with subsequent mate-switching the following year by the female, may be explained by the relative low quality of this auxillary male. Why the dominant male permits an ASY (after-second year) auxillary male to help raise offspring is a question that has perplexed researchers since cooperative breeding was first reported (Skutch 1935), particularly with a territorial species such as Hooded Warblers. Although males were never seen at the nest together, no overt aggression was observed. We expect that cooperative breeding may be widespread in warblers, although it likely occurs at very low frequencies within a species.

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