# GENERAL NOTES

*Wilson Bull.*, 98(1), 1986, pp. 126–131

**Growth of Shiny Cowbird and host chicks.**—The Shiny Cowbird (*Molothrus bonariensis*) is an obligate brood parasite that uses more than 180 species of birds as hosts within its range through South America and the West Indies (Friedmann et al., Smithson. Contr. Zool. 235, 1977; Manolis, Ph.D. diss., Univ. Colorado, Boulder, Colorado, 1982; Wiley, Condor 87:165–176, 1985). Although in some circumstances parasitism is advantageous to the host (Smith, Nature 219:690–694, 1968; Smith, pp. 7–15 *in* Host-parasite Interfaces, B. B. Nickol, ed., Academic Press, New York, New York, 1979), generally, cowbird parasitism has a negative effect on host reproduction by reducing productivity and nest success (reviewed in Payne, Ann. Rev. Ecol. Syst. 8:1–28, 1977). Like other forms of social parasitism (e.g., acarine nest parasites, Moss and Camin, Science 168:1000–1002, 1970; warble flies [*Philornis deceptivus*] on nestling Pearly-eyed Thrashers [*Margarops fuscatus*] and Puerto Rican Parrots [*Amazona vittata*], Arendt, Auk 102:270–280, 281–292, 1985, Wiley, pp. 137–159 *in* Conservation of New World Parrots, R. Pasquier, ed., Int. Council Bird Preserv. Tech. Bull. 1, 1980; blowflies [*Protocalliphora splendida*] on Tree Swallows [*Tachycineta bicolor*], Stahura, North Am. Bird Bander 7:140–144, 1982), avian brood parasitism may adversely affect host offspring growth and viability. Whereas Shiny Cowbird chicks do not eliminate their host nestmates by eviction or killing as do several avian parasites (reviewed in Payne 1977), the addition of the parasite chick(s) to the nest may set up competitive interactions between the species that could be detrimental to the host's offspring, particularly if the young of the host are the smaller and behaviorally less vigorous of the two species.

As part of a study of the ecology of the Shiny Cowbird and its hosts in the Caribbean, I monitored growth of cowbird and host chicks. Nestling cowbird growth rates might be suspected to vary with the size of the host species, both as a result of receiving different quantities of food concomitant with the size of the host adult, and due to competitive interactions with foster siblings of various-sized species. To test this prediction and examine growth rates in parasitized nests, I observed cowbird and host-chick growth at the nests of three species widely disparate in size: Yellow Warbler (*Dendroica petechia*), Yellow-shouldered Blackbird (*Agelaius xanthomus*), and Greater Antillean Grackle (*Quiscalus niger*).

*Study area and methods.*—I studied Shiny Cowbirds and their hosts at Roosevelt Roads Naval Station, 60 km east of San Juan, at the easternmost point of Puerto Rico. I have described the study areas in detail elsewhere (Wiley and Wiley, Wildl. Monogr. 64, 1979; Wiley 1985). Where I conducted the study, mangrove forest dominates the extensive tidal lands and accounts for about 25% (814 ha) of the station's vegetative cover. Data included here are from March through July, 1980 and 1981.

I located nests during searches through the study areas every other day. Each nest was marked with a coded tag (inconspicuously placed) and plotted on field maps. At each visit to the study areas I inspected nests to determine number of host and, if present, parasite eggs and chicks. At selected nests, chicks were weighed and measured on alternate days. Weights were taken using Pesola spring scales. Measurements were made to the nearest 0.1 mm with vernier or dial calipers and included length of exposed culmen (culmen length), length of tarsus (tarso-metatarsus), length of forearm (radius-ulna), length of seventh primary, and length of tail (Baldwin et al., Sci. Publ., Cleveland Mus. Nat. Hist. 2:1–165, 1931). Hatchlings were marked individually with food dye (blue, green, yellow, orange) on an inconspicuous part of the body (e.g., under wing). Older chicks were banded with three celluloid leg bands in unique color combinations. At some nests, I manipulated broods to equalize chick loads among parasitized and nonparasitized pairs for more equitable growth comparisons. Chicks of equal ages were fostered into the experimental nests.

I followed statistical methods as presented by Sokal and Rohlf (Biometry, 2nd ed., Freeman, San Francisco, California, 1981), and Zar (Biostatistical Analysis, Prentice-Hall, Englewood Cliffs, New Jersey, 1975). I used a randomization approach (a Monte Carlo method) to test growth data (Sokal and Rohlf 1981:787). Randomization tests consist of three steps: (1) an observed sample of variates is considered to be one of many possible, equally probable, outcomes that could occur by chance; (2) the possible outcomes that could be obtained by randomly rearranging the variates are enumerated; and (3) from the resulting distribution of outcomes, the single observed outcome is tested with respect to whether it is improbable enough to warrant rejection of the null hypothesis; e.g., observed growth rate of a chick in a parasitized nest is not different from the rate of a chick in a nonparasitized nest. I used Sokal and Rohlf's (1981) RANTST program for computation of the randomization tests. A sample of 500 permutations of variates (#2 above) was used to obtain probability values for equivalence of mean daily growth between species or between host chicks in parasitized and nonparasitized nests. These probability values were combined (Sokal and Rohlf 1981: 779) to get an overall probability value for equivalence of mean growth of parasitized and nonparasitized nestlings or mean growth of parasite and host chicks.

*Results.*—Adult Shiny Cowbirds (male $\bar{x}$ = 38.7 ± 0.05 [SE] g, N = 479; female $\bar{x}$ = 31.9 ± 0.04 g, N = 670) averaged about 48% of adult Greater Antillean Grackle weights (male $\bar{x}$ = 86.4 ± 0.61 g, N = 89; female $\bar{x}$ = 61.7 ± 0.51 g, N = 95), 276% of adult Yellow Warbler weights (both sexes $\bar{x}$ = 12.8 ± 0.40 g, N = 12), and about the same as adult Yellow-shouldered Blackbird weights (both sexes $\bar{x}$ = 38.4 ± 1.10 g, N = 8).

Cowbird chicks had a daily mean weight of 15.1 ± 0.63 g (N = 204; this is equivalent to 0.92 blackbird chick, 0.58 grackle chick, and 1.69 warbler chick). Weighed and measured host and cowbird nestlings were from the following mean brood sizes: Yellow Warbler nests—2.7 ± 0.17 (N = 4 nests) chicks in parasitized nests, 2.0 ± 0.0 (N = 9) chicks in nonparasitized nests; Yellow-shouldered Blackbird nests, parasitized—3.8 ± 0.25 chicks (N = 4), nonparasitized—1.9 ± 0.24 chicks (N = 8); Greater Antillean Grackle nests, parasitized—1.6 ± 0.17 chicks (N =3), nonparasitized—2.9 ± 0.16 chicks (N =14). Because brood sizes between parasitized and nonparasitized hosts were not equal nor were brood sizes equivalent among the three host species, comparisons among these groups required additional interpretation. Attempts to create even brood loads among pairs by artificially manipulating brood composition and size were unsuccessful in that most of the manipulated broods failed or natural brood adjustments again altered loads.

Despite the greater brood load in parasitized nests, Yellow Warbler chicks (N = 7) sharing nests with young cowbirds showed the same absolute growth (mm or g per day) rates as chicks (N = 17) in nonparasitized nests. Grackle chicks in parasitized and nonparasitized nests also exhibited similar growth curves for weight, culmen, and tarsus. However, chicks (N = 3) at parasitized grackle nests lagged behind chicks (N = 27) at nonparasitized nests in forearm ($P = 0.05$), seventh primary ($P < 0.02$), and rectrix ($P < 0.01$) development. Yellow-shouldered Blackbird chicks (N = 8) in parasitized nests showed retarded development for weight and length of tarsus and forearm (all $P < 0.001$) compared with chicks (N = 15) at nonparasitized nests.

Absolute growth curves of cowbirds were dissimilar to those of each of the host species I studied. Yellow Warbler chicks weighed less ($P < 0.001$) and had culmen ($P < 0.001$) and forearm ($P = 0.02$) measurements that were consistently less than those of cowbird chicks of comparable ages. The tarsi of Yellow Warblers grew faster than did those of cowbird chicks ($P = 0.05$). Warbler primary feathers grew faster ($P = 0.005$) until the ninth day when feather growth of the larger cowbirds surpassed the host chicks' growth. Cowbird chicks in

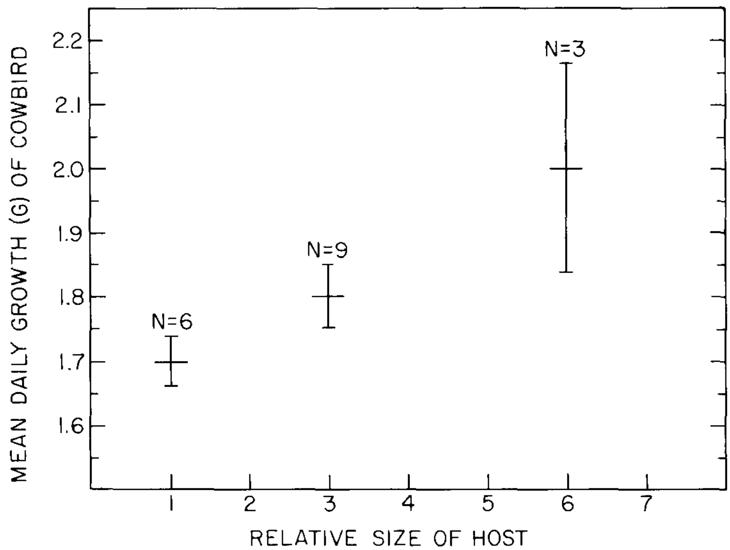


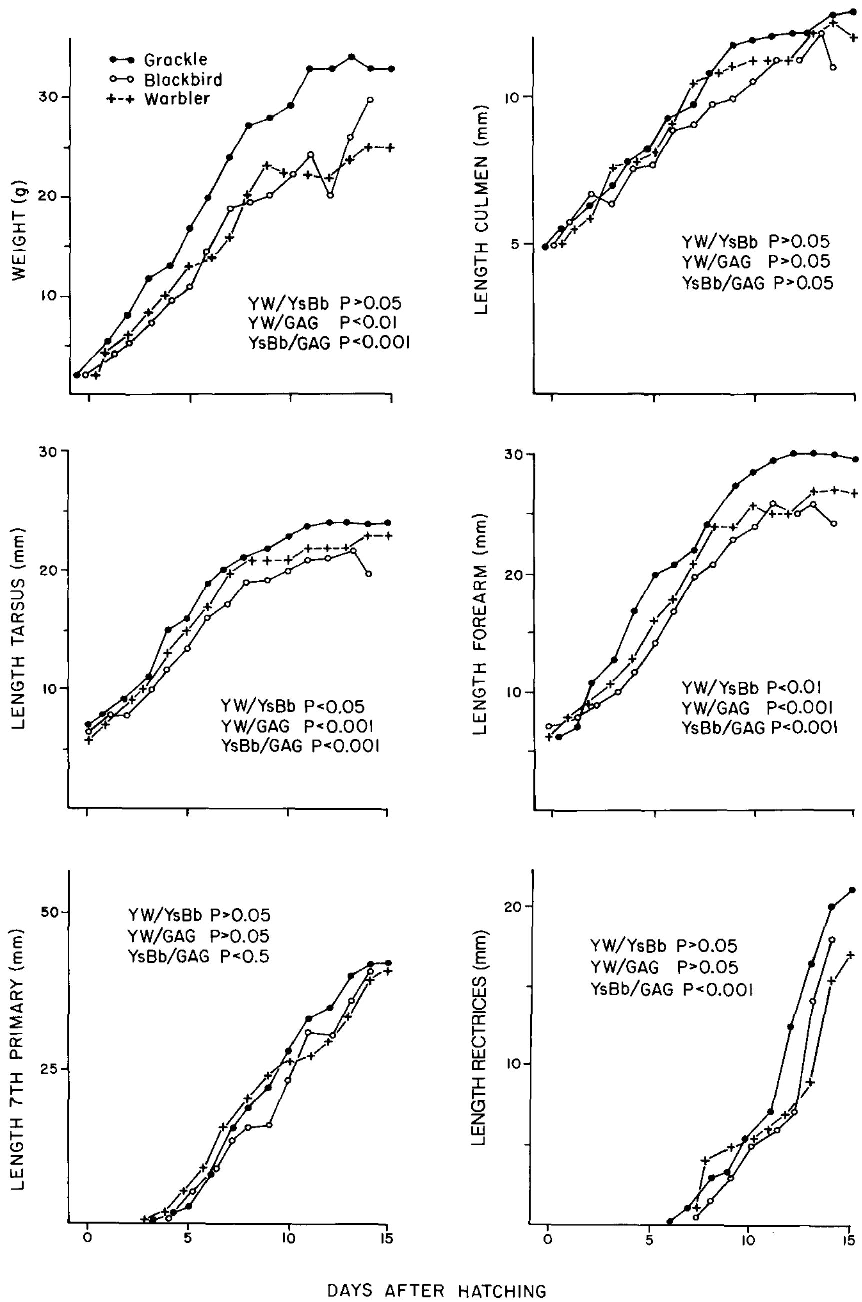

FIG. 1. Relationship of Shiny Cowbird chick growth rate (mean daily weight gain in g) to size of three host species in Puerto Rico: Yellow Warbler ($\bar{x}$ adult weight = 12.8 g), Yellow-shouldered Blackbird (38.4 g), and Greater Antillean Grackle (74.1 g). Vertical lines represent ±1 standard error.

Yellow-shouldered Blackbird nests were smaller on average than comparably aged host chicks with respect to all measurements (weight—$P < 0.02$, tarsus length—$P < 0.005$, length 7th primary—$P = 0.02$, length rectrices—$P < 0.001$), except forearm length. Grackle nestlings were heavier ($P < 0.01$) and larger (all $P < 0.001$) than equal-aged parasite chicks for all growth parameters measured.

There were also differences in relative growth rates (daily change proportionate to current size, "instantaneous daily growth"; Brody, Bioenergetics and Growth, Reinhold, New York, New York, 1945) among host and cowbird chicks. Yellow Warbler and Yellow-shouldered Blackbirds aged 0–4 days showed greater relative growth rates than Shiny Cowbird chicks ($\bar{x}$ Yellow Warbler relative growth [combined weight, and length of tarsus, culmen, forearm] = 26.5% per day; $\bar{x}$ Yellow-shouldered Blackbird = 27.3%; $\bar{x}$ Shiny Cowbird = 19.6% in both species' nests; $0.10 > P > 0.05$). The relative growth rate of Yellow Warbler chicks ($\bar{x}$ = 9.6%/day) declined to below that of Shiny Cowbird chicks ($\bar{x}$ = 10.8%/day; $P > 0.05$) from day 5 to fledging (day 10). After the host chicks had left the nest, the Shiny Cowbird chick relative growth rate continued to decline to an average of 0.7%/day. Relative growth rates of Shiny Cowbird and Yellow-shouldered Blackbird chicks were alike from days 5 to

⟶

FIG. 2. Shiny Cowbird chick growth in nests of three different-sized host species (Yellow Warbler, Yellow-shouldered Blackbird, Greater Antillean Grackle) at Roosevelt Roads Naval Station, eastern Puerto Rico.


Grackle
Blackbird
Warbler
WEIGHT (g)
YW/YsBb P>0.05
YW/GAG P<0.01
YsBb/GAG P<0.001
LENGTH CULMEN (mm)
YW/YsBb P>0.05
YW/GAG P>0.05
YsBb/GAG P>0.05
LENGTH TARSUS (mm)
YW/YsBb P<0.05
YW/GAG P<0.001
YsBb/GAG P<0.001
LENGTH FOREARM (mm)
YW/YsBb P<0.01
YW/GAG P<0.001
YsBb/GAG P<0.001
LENGTH 7TH PRIMARY (mm)
YW/YsBb P>0.05
YW/GAG P>0.05
YsBb/GAG P<0.5
LENGTH RECTRICES (mm)
YW/YsBb P>0.05
YW/GAG P>0.05
YsBb/GAG P<0.001
DAYS AFTER HATCHING

10 (12.0% vs 13.4%) and days 11 through 14 (3.5% vs 2.8%; $P > 0.05$). The relative growth rates of Greater Antillean Grackle and cowbird chicks were more comparable than those of the parasite chicks and the smaller host species throughout the nestling period: days 0 to 4—grackle = 26.7%/day vs cowbird 28.3%, days 5 to 10—10.5% vs 9.4%, days 11 to 14—2.7% vs 1.3%; all $P > 0.05$.

Growth rate (absolute) of cowbirds increased significantly with host body size (product-moment correlation coefficient [$r$] = 0.996) (Fig. 1). Cowbirds raised in grackle nests showed relatively greater daily size attainment than Yellow-shouldered Blackbird-raised chicks for all growth parameters measured, except culmen length (Fig. 2). Cowbirds in grackle nests also attained greater daily weight, tarsus, and forearm growth than parasites raised in Yellow Warbler nests, although cowbird culmen and feather development were not different (Fig. 2). Despite the Yellow Warbler's smaller size, cowbirds raised by warblers showed no overall difference in weight gain or culmen and feather growth than those raised by the larger Yellow-shouldered Blackbird. However, cowbirds raised by Yellow Warblers exhibited greater tarsus and forearm growth than blackbird-raised parasites (Fig. 2).

*Discussion.*—Comparison of growth rates of host chicks at parasitized and nonparasitized nests were confounded by unevenness of brood loads among nests. Nestlings in smaller broods ($\bar{x}$ = 2) of unparasitized Yellow-shouldered Blackbirds had higher growth rates than did chicks in parasitized nests where brood loads were elevated above normal (i.e., nonparasitized) brood sizes (4 vs 3 chicks). Perhaps chicks in nests with above-normal numbers of nestlings show retarded growth rates because adults are unable to supply enough food to the brood.

I found no difference in growth rates of Yellow Warbler chicks at parasitized and nonparasitized nests. Apparently, adult warblers were able to supply enough food to maintain good nestling growth for the brood sizes I studied. Chicks measured were from nonparasitized nests averaging two chicks per nest compared with parasitized nests where broods averaged an equivalent of three Yellow Warbler chicks (one warbler + one cowbird chick). Nonparasitized warblers occasionally fledge three chicks so the equivalent brood load of three nestlings may not stress adult warbler food provisioning capabilities and chicks may be expected to show growth rates comparable to two-chick nests.

Growth rates of Greater Antillean Grackle chicks in parasitized nests were retarded compared with those of chicks in unparasitized nests despite lower brood loads at the parasitized nests. The slower growth of chicks at parasitized nests may be related to the cowbird's shorter incubation period. A cowbird hatching earlier than the grackle chicks has an advantage in development, particularly begging behavior. Adults may respond to the more aggressive and better-developed begging responses of the cowbird chick by providing it with more food than the less-developed grackle nestling (Gochfeld, Living Bird 17:41–50, 1979; Wiley, Ph.D. diss., Univ. Miami, Coral Gables, Florida, 1982).

Growth rates of cowbird chicks were related to host mass. Probably this relationship was due to the amount of food supplied by the different-sized hosts (i.e., larger hosts provided chicks with greater amounts of food than smaller hosts). I did not attempt to determine whether various host species were supplying different quantities of foods to chicks, although casual observations made from blinds at nests suggested this was true. However, this apparent relationship could have been partly an effect of different brood loads in the nests of the three host species I studied; i.e., parasitized warbler and blackbird nests held greater equivalent chick loads than did grackle nests (three and four vs fewer than two at grackle nests).

Parasitized blackbird nests carried relatively larger brood loads than parasitized Yellow Warbler nests, which may have contributed to the lower growth rates of cowbirds raised by blackbird- compared to warbler-raised parasites. Also, sample size was small for older blackbird-raised cowbirds, which may have contributed to the oscillation in weights during the last few days in the nests.

Presumably, chicks fledging at heavier weights are more likely to survive than lighter fledglings as they have energy reserves to see them through the critical period of early flight and independence from their foster parents. If the relationship between host size and cowbird chick growth rate is real, one would expect parasites to choose nests of larger species (or individuals) in which to deposit their eggs. There are several possible disadvantages, however, to parasitizing large species, including: (1) birds larger than the cowbird could inflict serious injury to the parasite if the latter is caught at the nest, (2) large birds normally lay larger eggs and hatchability of parasite eggs is lower in nests with large host eggs than in nests of hosts similar in size to the cowbird (Wiley 1982), and (3) competitive interactions between large host chicks and cowbird chicks (particularly where host brood sizes are normal; all the parasitized grackle nests I watched had below average brood sizes) may put the parasite nestlings at a disadvantage in obtaining food from the adult. Therefore, I would expect cowbirds to parasitize species larger than grackles only rarely.

*Acknowledgments.*—I thank Ray Erickson, H. Randolph Perry, Jr., and Frank H. Wadsworth for their encouragement. I was supported by the Endangered Wildlife Research Program of the U.S. Fish and Wildlife Service and the U.S. Forest Service. I received additional logistical support from the U.S. Navy and from Sean Furniss, Caribbean Islands National Wildlife Refuge Manager. For their assistance in the field, I thank Julio Cardona, Nelson Green, Quamie Greenaway, Beth Wiley, and Michael Zamore. This research was submitted in partial fulfillment of the requirements for the Ph.D. degree in the Department of Biology, University of Miami, Florida. For their many helpful suggestions during this study I thank the members of my graduate committee: Theodore Fleming, Steven Green, Julian Lee, Earl Rich, and C. Richard Robbins. I am grateful to Donald Caccamise and Robert Payne for their useful review on a draft manuscript. I am particularly grateful for the guidance and warm friendship given me by Oscar Owre.—JAMES W. WILEY, *Puerto Rico Field Station, Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, P.O. Box 21, Palmer, Puerto Rico 00721.* *Received 30 Nov. 1983, accepted 26 Aug. 1985.*

*Wilson Bull.*, 98(1), 1986, pp. 131–137

**Autumn Sandhill Crane habitat use in southeast Oregon.**—Greater Sandhill Cranes (*Grus canadensis tabida*) of the Central Valley Population (CVP) are residents of the Pacific states and southern British Columbia, nesting primarily in southcentral and eastern Oregon and northeast California (Littlefield and Thompson, Proc. Int. Crane Workshop 2:113–120, 1979). Although the population has been studied extensively since the mid-1960s, many aspects of the life history of the population have not been presented.

Considerable information has been published on roosting habitat (e.g., Lewis, Proc. Int. Crane Workshop 1:93–104, 1976; Bennett, M.S. thesis, Univ. Wisconsin, Stevens Point, Wisconsin, 1978; Lovvorn and Kirkpatrick, J. Wildl. Manage. 45:842–857, 1981) and field use (Guthery, M.S. thesis, Texas A&M Univ., College Station, Texas, 1972; Lovvorn and Kirkpatrick, J. Wildl. Manage. 46:99–108, 1982) of Sandhill Cranes in the west central and midwestern states. Most studies, however, were on wintering and traditional spring and autumn stopover areas, and little information has been published on an autumn staging area. Melvin and Temple (Proc. Int. Crane Workshop 3:73–87, 1981) defined an autumn staging area as a locality where cranes congregate during the first segment of fall migration, usually no more than a day's flight from nesting areas, whereas a traditional stopover area was described as a congregation area along the migration route. Malheur National Wildlife Refuge (NWR), Harney Co., in southeast Oregon has been the major fall staging area for the CVP at least since the late 1930s.