

## BRONZED COWBIRD HOSTS: NEW RECORDS, TRENDS IN HOST USE, AND COST OF PARASITISM

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**Resumen.** Los huéspedes del pájaro parasitario, Vaquero Ojirrojo (*Molothrus aeneus*), son resumidos para la parte sur de su rango de distribución, Honduras a Colombia. Se reportan cinco nuevos huéspedes, para Costa Rica: Soterrey Cucarachero (*Troglodytes aedon*), Antifacito Coroniolivo (*Geothlypis semiflava*), Antifacito Coronigris (*G. poliocephala*), Tangara Forriblanca (*Tachyphonus rufus*), y Saltator Gorgianteado (*Saltator maximus*). Diecinueve huéspedes se han registrado para el parásito en Costa Rica y 87 especies a lo largo de su rango de distribución (Lowther 1995). Sin duda, nuevos huéspedes se registran a medida que mas investigaciones en parasitismo sean conducidas y a medida que el parásito continua extendiendo su rango de distribución siguiendo la deforestación. Registros de nidos parasitados o aves alimentando pichones son reportados para 10 especies huéspedes que han sido previamente registrados para Cost Rica. La tendencia en el uso de huéspedes es examinada y las implicaciones de huéspedes observados alimentando solamente pichones del Vaquero Ojirrojo, pero ninguno de su propia especie examinadas.

**Abstract.** Bronzed Cowbird (*Molothrus aeneus*) host records are summarized for the southern portion of the brood parasite's range, Honduras to Colombia. Five new host species are reported, from Costa Rica: House Wren (*Troglodytes aedon*), Olive-crowned Yellowthroat (*Geothlypis semiflava*), Gray-crowned Yellowthroat (*G. poliocephalus*), White-lined Tanager (*Tachyphonus rufus*), and Buff-throated Saltator (*Saltator maximus*). Nineteen host species have been recorded for Costa Rica, 87 species throughout the cowbird's range (Lowther 1995). Undoubtedly, additional host species will be recorded as more studies are conducted on cowbird parasitism, and as the Bronzed Cowbird continues to expand its range following deforestation. Records of parasitized nests or birds feeding cowbird fledglings are presented for 10 host species previously recorded for Costa Rica. Trends in host use are examined and the implications of hosts observed feeding Bronzed Cowbird fledglings but none of their own young are discussed. Accepted 21 August 1997.

**Key words:** Avian brood parasitism, Bronzed Cowbird, *Molothrus aeneus*, fledglings, host species, reproductive cost, Costa Rica.

### INTRODUCTION

During the breeding season, Bronzed Cowbirds (*Molothrus aeneus*) range from extreme southwestern and southcentral United States through Mexico to W Panamá and NE Colombia (Friedmann 1929, Lowther 1995). Bronzed Cowbirds have been recorded parasitizing 82 species, 32 of which have been documented rearing cowbird young (Lowther 1995). Most of the information on Bronzed Cowbird hosts has been obtained from the northern part of the cowbird's range, in Mexico and SW United States (e.g., Friedmann & Kiff 1985, Carter 1986). There are no host records for the isolated subspecies, *M. a. armenti*, in Colombia (Friedmann & Kiff 1985). The only

reference to Bronzed Cowbird hosts in the Republic of Panamá is a vague statement in Wetmore *et al.* (1984), attributed to N. G. Smith, that individuals of this parasite frequented and apparently parasitized oropendola nests. In Honduras, Stone (1932, see also Monroe 1968) collected a Bronzed Cowbird fledgling that was being fed by a Plain Wren (*Thryothorus modestus*). Fourteen host species have been documented for Costa Rica (Friedmann *et al.* 1977, Friedmann & Kiff 1985, Stiles & Skutch 1989).

Here we report five host species of the Bronzed Cowbird, all for Costa Rica, that Friedmann *et al.* (1977) and Friedmann & Kiff (1985) did not list in their host catalogs: House Wren

(*Troglodytes aedon*), Olive-crowned Yellowthroat (*Geothlypis semiflava*), Gray-crowned Yellowthroat (*G. poliocephalus*), White-lined Tanager (*Tachyphonus rufus*), and Buff-throated Saltator (*Saltator maximus*). In addition, we record parasitized nests or hosts feeding cowbird fledglings in 10 host species recorded previously in Costa Rica, and examine trends in host use by the Bronzed Cowbird. Supplemented by published observations, we discuss the implications of passerines feeding only cowbird fledglings and none of their own young.

## TREATMENT OF RECORDS

Records of parasitism were sought by the senior author through correspondence with individuals who have conducted field work in the southern part of the Bronzed Cowbird's range. Parasitized egg sets were deposited in the Museo Nacional de Costa Rica (MNCR), San José, and Western Foundation of Vertebrate Zoology (WFVZ), Camarillo, California. The order of species and nomenclature follow the American Ornithologists' Union (1983, 1997), except that we treated the Yellow-green Vireo (*Vireo flavoviridis*) as a species, rather than as a superspecies of the Red-eyed Vireo (*V. olivaceus*).

## SPECIES ACCOUNTS

*House Wren* *Troglodytes aedon*. F. Gary Stiles (*in litt.*) observed a pair of House Wrens feeding a Bronzed Cowbird fledgling near San José, prov. San José. This is the first record of the House Wren as a host of the Bronzed Cowbird, but House Wrens are frequently parasitized by the Shiny Cowbird (*M. bonariensis*) in South America (e.g., Miller 1963, Fraga 1978, Kattan 1993).

*Orange-billed Nightingale-Thrush* *Catharus aurantiirostris*. On 5 June 1985, Alexander F. Skutch (*in litt.*) observed a pair of Orange-billed Nightingale-Thrushes feeding two Bronzed Cowbird fledglings at Quizzarrá, near San Isidro de El General, prov. Cartago. The female nightingale-thrush fed one fledgling, and the male fed the other (see also Skutch 1996). Skutch added that over several decades he has seen very few Bronzed Cowbirds in the Valle de El General. In the San José area, F. G. Stiles (*in litt.*) observed a pair of Orange-billed Nightingale-Thrushes feeding a Bronzed Cowbird fledgling. One early

record of parasitism on this species is Cherrie's (1891) observation of an adult feeding a cowbird fledgling near San José.

The Orange-billed Nightingale-Thrush has been recorded previously as a host of the Bronzed Cowbird, once in Mexico (Friedmann & Kiff 1985) and twice in Guatemala (Thurber & Villeda 1980). There are records of parasitism on this species by the Shiny Cowbird in Venezuela (Friedmann *et al.* 1977).

*Yellow-green Vireo* *Vireo flavoviridis*. F. G. Stiles (*in litt.*) observed a pair of Yellow-green Vireos feeding a Bronzed Cowbird fledgling near San José. There is one previous host record for this species in Costa Rica (Friedmann 1963), as well as single records from Mexico (Friedmann 1963) and Guatemala (Skutch 1960).

*Olive-crowned Yellowthroat* *Geothlypis semiflava*. On 12 April 1991, R. G. Campos observed a female Olive-crowned Yellowthroat feeding a Bronzed Cowbird fledgling near La Selva Biological Station, Sarapiquí, prov. Heredia. This is the first record of the Olive-crowned Yellowthroat as a host of the Bronzed Cowbird.

*Gray-crowned Yellowthroat* *Geothlypis poliocephala*. On 8 April 1990, R. G. Campos observed a female Gray-crowned Yellowthroat feeding a Bronzed Cowbird fledgling at Chilamate de Sarapiquí, prov. Heredia. The yellowthroat was observed three times feeding insects to the cowbird perched on barbed wire. This is the first record of the Gray-crowned Yellowthroat as a host of the Bronzed Cowbird. On 15 June 1987, Rosendo M. Fraga (*in litt.*) saw an unidentified female yellowthroat (*Geothlypis* sp.) feeding a Bronzed Cowbird fledgling near Cahuita, prov. Limón.

*Rufous-capped Warbler* *Basileuterus rufifrons*. F. G. Stiles (*in litt.*) observed a pair of Rufous-capped Warblers feeding a Bronzed Cowbird fledgling near San José. There is one previous record of parasitism on this species, from Mexico (Friedmann 1963).

*White-lined Tanager* *Tachyphonus rufus*. On 15 June 1996, M. Marin collected an adult female White-lined Tanager (WFVZ # 53,159) and its nest and clutch (WFVZ # 164,726), which contained two host eggs and one Bronzed Cowbird egg. The nest was located at elev. 900 m, 18 km ESE Turrialba, near Platanillo, prov. Cartago.

The nest, situated at the edge of a sugar cane plantation adjacent to a coffee plantation, was placed at the base of a bunch of sugar cane. It was cup-shaped and constructed of long leaves and lined with fine grasses. The tanager eggs have a dirty white base color, with reddish brown overlaid, scrawled with dark reddish brown marks (Fig. 1). Forests in the area where the nest was found have been cleared recently, which may have attracted Bronzed Cowbirds to the area. Several cowbirds were observed displaying and copulating at the edge of the coffee plantation.

This is the first nesting record of the White-lined Tanager for Costa Rica, although nests have been described in the Republic of Panamá (Stone 1918) and elsewhere (e.g., Cherrie 1916, Haverschmidt & Mees 1994). Belcher & Smoother (1937) mentioned this species as a host of the Shiny Cowbird in Trinidad and Tobago, and parasitism on this species has been recorded in Venezuela and Colombia (Friedmann *et al.* 1977).

*Flame-colored Tanager* *Piranga bidentata*. On 4 May 1987, G. Barrantes collected a clutch of the Flame-colored Tanager (WFVZ # 156,239) that contained two eggs of the host and two Bronzed Cowbird eggs. Located on Cinco Esquimas de Camizal, elev. 1700 m, prov. Alajuela, the nest was 4 m high in a Nispero (*Eryobotrya japonica*) in a dooryard surrounded by cafetales. The nest was a cup of rootlets, lined with horsehair. This is the first record of the Flame-colored Tanager as a host of the Bronzed Cowbird for Costa Rica. Hall (1965) observed a pair of this species feeding a Bronzed Cowbird fledgling in Mexico.

*Buff-fronted Saltator* *Saltator maximus*. On 18 May 1986, R. G. Campos collected a clutch of the Buff-fronted Saltator (set not located, probably lost because of recent collection move) that contained one broken host egg and one Bronzed Cowbird egg. Bronzed Cowbirds are known to destroy cowbird and host eggs (e.g., Rowley 1984, Carter 1986), but we are not sure whether the broken egg had been pecked or whether it broke during handling. Campos observed the nest being built on 10 May 1986 at a coffee plantation, elev. 900 m, 2 km W Grecia, prov. Alajuela. This is the first record of the Buff-fronted Saltator as a host of the Bronzed Cowbird.



FIG. 1. Nest of *Tachyphonus rufus* containing 2 eggs of the tanager and 1 egg of the Bronzed Cowbird.

*White-naped Brush-Finch* *Atlapetes albinucha*. On 3 June 1984, J.E. Sánchez collected a clutch of the White-naped Brush-Finch (MNCR # H-75-21-83-1) that contained one host egg and one Bronzed Cowbird egg at El Radio, 3 km SE Cartago, prov. Cartago. In 1996, Sánchez recorded a banded pair of White-naped Brush-Finches that reared one cowbird in their first nest of the season (June) and two cowbirds in the second nest (September). Sánchez observed other instances of this species feeding Bronzed Cowbird fledglings near Cartago. Other records of parasitism on this species for Costa Rica date back to 1889: Cherrie (1892) collected five nests (four parasitized) near San José. Alfaro (1904) also recorded this species as a host in Costa Rica.

Throughout the 1970's, F.G. Stiles (*in litt.*, see also Friedmann & Kiff 1985, Stiles & Skutch 1989) observed this species feeding Bronzed Cow-

bird fledglings two to three times each breeding season near the Universidad de Costa Rica, E San José. By the early 1980's, a combination of habitat (cafetal) loss and cowbird parasitism had reduced this species to low levels (see also Stiles 1990). Stiles then began to see cowbirds being fed by Prevost's Ground-Sparrow (see below).

*Black-striped Sparrow* *Arremonops conirostris*. On 5 May 1986, M. Marin collected a clutch of the Black-striped Sparrow that contained one host egg and one Bronzed Cowbird egg (Fig. 2). The shells of the pipped eggs were collected (WFVZ # 154,692). At elev. 500 m on Cerro Montezuma, c. 45 km NE Cañas, prov. Alajuela, the nest was placed 50 cm from the ground amid tall grass in a scrubby pasture. Nearby, on 28 May 1992, R. G. Campos collected a clutch of the Black-striped Sparrow (MNCR # H-75-24-837-2) that contained one host egg and one cowbird egg at Bijagua de Upala, prov. Alajuela. A third record is a pair of adults feeding and roosting with two Bronzed Cowbird fledglings observed by Isaías Alvarado over 7 days in June 1996, about 5 km from La Selva Biological Station, prov. Heredia (B. E. Young, *in litt.*). Sr. Alvarado had seen Black-striped Sparrows feeding cowbird fledglings once before in the same area. Previously reported as a host for Costa Rica (Cherrie 1892, Friedmann 1933), Stiles & Skutch (1989) considered this species to be a favorite host of the Bronzed Cowbird.

*Prevost's Ground-Sparrow* *Melozone bicaratum*. On 27 May 1985, F. G. Stiles collected a clutch of Prevost's Ground-Sparrow (WFVZ # 146,772) that contained two host eggs and three Bronzed Cowbird eggs at elevation 1250 m, NE Cuidad Universitaria, E San José. Placed 40 cm up in the center of a grass tussock (*Pennisetum perpureum*) in broken young second growth, the nest was a sturdy cup of grass stems and leaves, lined with finer stems and leaves, and had a messy "tail" off to one side. This species has been reported as a host of the Bronzed Cowbird in Guatemala (Friedmann *et al.* 1977).

F. G. Stiles (*in litt.*, see also Friedmann & Kiff 1985) first recorded parasitism on this species in June 1978 in the vicinity of the Universidad de Costa Rica. Continued habitat loss and increased cowbird parasitism in the 1980's (see Stiles 1990) saw this species replacing *Atlapetes albinucha* as

the main host in the area. Stiles then began to see cowbirds being fed more frequently by Rufous-collared Sparrows (see below).

*White-eared Ground-Sparrow* *Melozone leucotis*. In April 1982, F. G. Stiles (*in litt.*) observed a pair of White-eared Ground-Sparrows feeding a Bronzed Cowbird fledgling near San José. Also mentioned by Friedmann & Kiff (1985), this is the only record of parasitism on this species.

*Rufous-collared Sparrow* *Zonotrichia capensis*. J. E. Sánchez observed an adult of this species feeding a cowbird fledgling in the garden of the Museo Nacional de Costa Rica, San José, prov. San José, and has many times made similar observations of this behavior around Cartago. The other documented Central American record of parasitism on the Rufous-collared Sparrow is an observation of an adult repeatedly feeding a Bronzed Cowbird fledgling on a lawn in Guatemala City, Guatemala (Villeda 1979). This species is a frequent host of the Shiny Cowbird in South America (e.g., King 1973, Fraga 1978).

F. G. Stiles (*in litt.*) first recorded parasitism on this species in May 1984 near the Universidad de Costa Rica. By the late 1980's, this species was the main host there, with four records obtained in 1988 and 1989.

*Spot-breasted Oriole* *Icterus pectoralis*. On 26 May 1994, J. E. Sánchez collected a clutch of the Spot-breasted Oriole (MNCR # H-73-8-742-1) that contained four host eggs and one cowbird egg at Hacienda Solimar, Colorado Abangares, prov. Guanacaste. Three oriole eggs are broken, but apparently not pecked; the fourth egg is intact. This is the first record of this species as a victim of the Bronzed Cowbird for Costa Rica, although Spot-breasted Orioles have been recorded as hosts in Mexico and El Salvador (Dickey & van Rossem 1938, Friedmann *et al.* 1977).

Sánchez observed a pair of Spot-breasted Orioles on 8 June 1995 kill a Bronzed Cowbird nestling on a branch next to the nest, as the bird left the nest. The orioles continued to tend two oriole nestlings. To our knowledge, this is the first observation of a host attacking and killing a fledgling cowbird. However, as the nest's contents were not known prior to this observation, it could not be known whether the orioles had reared the cowbird. Foster parents generally con-



FIG. 2. Nest of *Arremonops conirostris* containing 1 egg of the sparrow and 1 egg (larger egg on right) of the Bronzed Cowbird.

tinue to feed fledgling cowbirds for several weeks after fledging (Eastzer *et al.* 1980, Woodward 1983). Ficken (1967) observed an American Crow (*Corvus brachyrhynchos*) kill a fledgling Brown-headed Cowbird (*M. ater*) that begged as it moved toward the crow. The much larger crow, which was not the host, seized the cowbird, quickly killed it, and flew away with it.

## DISCUSSION

*Trends in host use by Bronzed Cowbirds.* The five new host species documented in this paper bring the list of hosts for Costa Rica to 19 species (see Appendix) and 87 species overall for the Bronzed Cowbird (Kiff 1973, Friedmann & Kiff 1985, Lowther 1993). Friedmann & Kiff (1985: 227), however, pointed out that because the generalist strategy of host use by Bronzed Cowbirds, and some other cowbirds, are so well known, "there is no particular significance to be expected from mere additions to their host lists *per se*." Regardless, knowledge of the breadth of host use by

Bronzed Cowbirds is still incomplete, particularly in the southern portion of cowbird's the range. Hosts are better known in the northern part of the parasite's range, in Mexico and extreme S United States (e.g., Friedmann & Kiff 1985, Rowley 1984, Carter 1986, Clotfelter & Brush 1995, B. D. Peer & Sealy, unpubl. data).

In addition to the lack of information on many "old" hosts of the Bronzed Cowbird, many "new" hosts undoubtedly will be parasitized in the near future, in Costa Rica and elsewhere, because of the continuous modification of natural habitats that is allowing cowbirds to move into new areas and, hence, to come in contact with new host species (see Oberholser 1974, Kiff 1975, Dugand & Eisenmann 1983, Carter 1986, Stiles 1990). Indeed, Friedmann & Kiff (1985: 233) noted that "Because this cowbird is still expanding its geographic range, it will eventually be found to affect still other species and subspecies of birds." Expansion to the breeding ranges of many new hosts by Brown-headed and Shiny cowbirds, apparently also due primarily to habitat modification, and the destructive effects these cowbirds have had on some hosts, have been well documented (Mayfield 1965, Cruz *et al.* 1985, Rothstein 1994).

Not only is the breadth of host species used by Bronzed Cowbirds incompletely known throughout most of the breeding range, the frequency of parasitism on individual host species, particularly within entire host communities, also is not known (but see Carter 1986). Large samples of nests of each potential host species should be monitored and the proportion of parasitized to unparasitized nests recorded.

Hosts of Brown-headed and Shiny cowbirds generally either accept or reject cowbird eggs (e.g., Rothstein 1975, Cruz *et al.* 1985, Fraga 1985), but little is known of host tolerance of Bronzed Cowbird parasitism. This information is important in determining the dynamics of cowbirds and their host populations. In S Texas, where both Bronzed and Brown-headed cowbirds occur, Carter (1986) experimentally elicited ejection behavior in four nests of each of three host species. In S Texas, Great-tailed Grackles (*Quiscalus mexicanus*) ejected all experimentally introduced eggs of Brown-headed and Bronzed cowbirds (Peer & Sealy, unpubl. data).

South of the area of sympatry with the Brown-headed Cowbird, host response to parasitism by Bronzed Cowbirds has not been determined experimentally. Most parasitized clutches reported in Costa Rica were checked only once, and the nests and/or their contents were collected. Acceptance or rejection of cowbird egg(s) could not have been detected at these nests. The response to parasitism by actual and potential hosts of Bronzed Cowbirds needs to be determined experimentally.

Several workers have noted a tendency for Bronzed Cowbirds to parasitize icterines, particularly species of the genus *Icterus* (e.g., Bendire 1895; Friedmann 1929, 1963; Dickey & van Rossem 1938; Thurber & Villeda 1980; Pleasants 1981; Flood 1990; Skutch 1996) and the caciques (Dickerman 1960, Rowley 1984). In the most recent compilation of Bronzed Cowbird host records, Lowther (1995) recorded 17 species for which there are more than five records of parasitism. Of these species, six (35 %) are icterines of the genus *Icterus*. In the Republic of Panamá, Smith (*in litt.*) observed Bronzed Cowbirds visit only nests of icterines (Scarlet-rumped Cacique *Cacicus uropygialis* and at least two species of orioles *Icterus*), but in Costa Rica, Stiles & Skutch (1989, see also Friedmann & Kiff 1985) stated that the most frequently parasitized species are the White-naped Brush-Finch, Prevost's Ground-Sparrow (*M. biarcuatum*) and *Arremonops* spp. The only icterines recorded as hosts in Costa Rica are Yellow-billed Caciques (*Amblycercus holosericeus*) and Spot-breasted Orioles. Interestingly, Kiff (1973) reported that all five Yellow-billed Cacique nests examined were parasitized, some apparently by more than one female. In S Texas, however, Northern Cardinals (*Cardinalis cardinalis*) were most frequently parasitized (Peer & Sealy, unpubl. data). Clearly, the importance of icterines as hosts of Bronzed Cowbirds, relative to other potential species, will be determined only when the breadth of host use and the frequency and tolerance of parasitism on more host species are known.

*Cost of rearing Bronzed Cowbirds.* Skutch (1996) noted that passerines observed feeding Bronzed Cowbird fledglings were never reported also feeding their own young (see Robinson [1992] for parallel situation in Brown-headed Cowbird

hosts). Noting that there are records of nests containing both well-developed host young together with cowbird young (e.g., Thurber & Villeda 1980, Carter 1986), Skutch speculated that the lack of reports of hosts feeding fledged cowbirds as well as their own young was due to 1) a lack of persistence by observers who recorded only the cowbird being fed, 2) the possibility that cowbird fledglings are more conspicuous, or 3) cowbird fledglings quickly outcompete host young after they have fledged. At nests where both cowbird and host young fledge, cowbird fledglings possibly soon monopolize the care of one parent, possibly through their persistent begging (Eastzer *et al.* 1980, Woodward 1983) and, as Skutch speculated, it may be this more conspicuous feeding association that observers tend to see.

In Table 1, of seven observations of more than one Bronzed Cowbird fledgling being fed, two adults were involved in four cases. The other observations were of single cowbird fledglings being fed by single adults. Eastzer *et al.* (1980) determined experimentally that nestling Brown-headed Cowbirds fared no better than other passerine species reared by Barn Swallows (*Hirundo rustica*), but as fledglings, the cowbirds were more successful.

In the only study of Bronzed Cowbirds in which host-to-cowbird ratios at fledging have been determined, Carter (1986) found the reproductive efforts of most pairs were devoted entirely to rearing cowbird(s). Of 13 nests of four species in S Texas, host young and up to three cowbirds fledged from only three nests, all from nests of the Long-billed Thrasher (*Toxostoma longirostre*). Also in Texas (Clotfelter, unpubl. data), no host young fledged from four nests (2 Green Jay, 1 Northern Mockingbird *Mimus polyglottos*, 1 Long-billed Thrasher) that fledged up to 2 young Bronzed Cowbirds. Although observations of hosts feeding fledglings are few and anecdotal, they suggest that hosts incur a severe cost when parasitized by Bronzed Cowbirds. Indeed, Skutch (1996) pointed out that this question deserves further attention.

*Does feeding a cowbird fledgling constitute a host record?* Several records of cowbird-host interactions presented here involved adult birds feeding cowbird fledglings. We considered indi-

viduals or pairs observed feeding Bronzed Cowbird fledglings as the hosts because individuals of other species were not observed feeding the cowbirds. These observations, however, are not conclusive evidence that the individuals provisioning the cowbird fledgling(s) were its foster parents. Sealy & Lorenzana (1997) compiled about 65 records of brood parasite nestlings and fledglings, including cowbirds, being fed by adults of more than one species (see also Klein & Rosenberg 1986). In cowbird host catalogs (e.g., Friedmann 1929, 1963; Friedmann & Kiff 1985), individuals of the same species observed feeding cowbird fledglings were considered to be the foster parents. The authors, however, cautioned that some of the birds feeding young may not

have reared the cowbird. Observations of color-marked adults tending parasitic nestlings, and later fledglings, or studies using molecular techniques, are needed to verify the identity of foster parents.

#### ACKNOWLEDGMENTS

We thank those who responded to our requests for information on Bronzed Cowbirds and their hosts. Isaías Alvarado, Ethan D. Clotfelter, Rosendo M. Fraga, and Alexander F. Skutch provided details of observations of birds feeding cowbird fledglings. We are especially grateful to F. Gary Stiles for providing many records of parasitism and information on changes in host

TABLE 1. Observations of passerine birds feeding Bronzed Cowbird fledglings. In no cases were host fledglings observed being fed.

Host species	No. cowbird fledglings	No. adults	Source
<i>Tyrannus verticalis</i>	2	2	Clotfelter & Brush (1995)
<i>Tyrannus couchii</i>	2	1	Clotfelter & Brush (1995)
<i>Cyanocorax yncas</i>	1	2	Webster (1973)
		2	Collins <i>et al.</i> (1980)
	2	1	Clotfelter (pers. comm.)
<i>Thyrothorus modestus</i>	1	1	Stone (1932)
<i>Troglodytes aedon</i>	1	2	This study
<i>Catharus aurantiirostris</i>	1	1	Cherrie (1891)
		2	This study
	2	2	This study
<i>Vireo flavoviridis</i>	1	2	This study
<i>Toxostoma longirostre</i>	2	1	Webster (1950)
			Collins <i>et al.</i> (1980)
<i>Parula pitiayumi</i>	1	1	Friedmann & Kiff (1985)
<i>Geothlypis semiflava</i>	1	1 <sup>a</sup>	This study
<i>Geothlypis poliocephala</i>	1	1 <sup>a</sup>	This study
<i>Basileuterus rufifrons</i>	1	2	This study
<i>Piranga bidentata</i>	1	1 <sup>b</sup>	Hall (1965)
<i>Piranga rubra</i>	1	1	Friedmann (1933)
<i>Arremonops rufivirgatus</i>	1 <sup>c</sup>	2	Carter (1986)
<i>Arremonops conirostris</i>	2	2	This study
<i>Melospiza bicarunculata</i>	1	2	Friedmann <i>et al.</i> (1977)
		2	This study
<i>Melospiza leucotis</i>		2	Friedmann & Kiff (1985)
<i>Pipilo erythrophthalmus</i>		1	Skutch (1996)
<i>Zonotrichia capensis</i>		1	Villeda (1979)
<i>Icterus graduacauda</i>		2	Goldman & Watson (1953)
<i>Dendroica chrysoparis</i>		1 <sup>a</sup>	Webster (1976)

<sup>a</sup>Female. <sup>b</sup>Male. <sup>c</sup>One Brown-headed Cowbird fledgling also was being fed by the same adults.

use obtained during his long-term residency in Costa Rica. Lloyd F. Kiff provided information and helpful comments on the manuscript. E. D. Clotfelter and Brian D. Peer provided comments that improved the manuscript. J. E. Sánchez thanks Demetrio Peralta for his cooperation while searching for nests. R. G. Campos thanks Jean Campbell Porter for companionship in the field, Horizonte Nature Tours for logistic support, and Rafael, Monica, Nadia, Silvia and Diana Ramirez for their hospitality during visits to Bijagua de Upala. M. Marin thanks M. J. Babin for companionship in the field. Field work in Costa Rica was funded by research grants from the Natural Sciences and Engineering Research Council of Canada (S. G. Sealy) and in part from the Frank M. Chapman Fund of the American Museum of Natural History, National Geographic Society (grant 5680-96), and Western Foundation of Vertebrate Zoology (M. Marin).

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## APPENDIX. Hosts of the Bronzed Cowbird for Costa Rica.

Host species	Evidence for host use <sup>a</sup>	Source
<i>Troglodytes aedon</i>	2	This study
<i>Catharus gracilirostris</i>	1	Kiff (1973)
<i>Catharus aurantiirostris</i>	2	Cherrie (1891), this study
<i>Vireo flavoviridis</i>	2	Friedmann (1933), this study
<i>Geothlypis semiflava</i>	2	This study
<i>Geothlypis poliocephala</i>	2	This study
<i>Basileuterus rufifrons</i>	2	This study
<i>Tachyphonus rufus</i>	1	This study
<i>Piranga bidentata</i>	1, 2	Hall (1965), this study
<i>Ramphocelus passerinii</i>	1	Kiff (1973)
<i>Saltator maximus</i>	1	This study
<i>Atlapetes albinucha</i>	1, 2, 3	Cherrie (1892), Alfaro (1904), Stiles & Skutch (1989), This study
<i>Arremonops rufivirgatus</i>	2	Friedmann & Kiff (1985)
<i>Arremonops conirostris</i>	1, 2	Friedmann (1933), Friedmann & Kiff (1985), This study
<i>Melospiza bicarcatum</i>	1, 2	Friedmann & Kiff (1985), This study
<i>Melospiza leucotis</i>	1, 2	Friedmann & Kiff (1985), This study
<i>Zonotrichia capensis</i>	2	This study
<i>Icterus pectoralis</i>	1	This study
<i>Amblycercus holosericeus</i>	1	Kiff (1973)

<sup>a</sup>1, collected egg set that contains host and/or cowbird egg(s); 2, one or a pair of birds observed feeding cowbird fledgling; 3, mentioned as host without documentation.