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GOLDEN WHITE-EYE (*Cleptornis marchei*)

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INTRODUCTION

Long thought to be a honeyeater (Meliphagidae), the Golden White-eye (*Cleptornis marchei*), or Canario in the Chamorro language, has no close relatives. It appears to have evolved in isolation into a singularly unique form, much as the Hawaiian honeycreepers have done. Despite its uniqueness, it remains largely unstudied other than for periodic population surveys. It is known historically from Saipan and Aguiguan in the Mariana Islands of the western tropical Pacific. Prehistorically, it also occurred on Tinian, which sits between these two islands, and to the south on Rota.

The brilliant yellow-orange plumage, bill and legs and whistled, warbling song separate this species from all others within its limited range. It defends an all-purpose territory against conspecifics and appears to be socially dominant over the only other white-eye species present. It occupies a variety of wooded habitats but reaches its greatest density in mature native forest. It is a versatile forager of the forest canopy and understory, where it gleans and probes surfaces for insects and fruits.

The Golden White-eye is listed as endangered and, although remaining common within its range, at least the Saipan population might be declining as development and urbanization proceed there. It is also under threat from the potential establishment of the predatory brown tree snake (*Boiga irregularis*) on Saipan. To aid in its conservation, the species has been translocated to the more northerly, uninhabited Mariana Islands of Sarigan and Alamagan, where it is prospering.

IDENTIFICATION

Field Identification

The brilliant yellow-orange plumage, bill and legs, indistinct white eye ring and whistled, warbling song separate this species from all others within its limited range. The small, sexually monomorphic passerine typically occupies the forest understory.

Similar Species

The only other white-eye within its range is the Bridled White-eye (*Zosterops conspicillatus*), which is much smaller, greenish-yellow and has a black beak and legs. The Bridled White-eye also typically occurs in large flocks. Unlike the melodious song of the Golden White-eye, the Bridled White-eye's vocalizations are primarily thin *chit-chit-chit* notes and whines. Other co-occurring small passerines include the brilliant red Micronesian Myzomela (*Myzomela rubrata*) and the brown and burnt orange Micronesian Rufous Fantail (*Rhipidura versicolor*). In the Palau Islands, the similarly sized Giant White-eye

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(*Megazosterops palauensis*) is tan and olive and has a loud, polyphonic song that is unlike any other.

PLUMAGES, MOLTS AND STRUCTURE

Plumages

Juvenile. An early report of the appearance of juvenile birds described them as darker and duller than adults (Bruce 1978). Field observations of birds in juvenal plumage indicated that they were indeed duller than adults, with areas of brownish-yellow on the back and side of the head and brownish-yellow streaks on the breast (Craig 1990). Juveniles also have been reported to have white mottling and paler yellow feathers on the head and face prior to the first preformative molt and often have largely unpneumatized skulls. Very young juveniles exhibit dusky coloring at the base of the bill and sometimes on the tarsi. Some birds in first molt cycle and formative plumage also have partially unpneumatized skulls, but reliability of this in relation to the first preformative molt requires further study (Radley et al. 2011).

Juveniles are presently presumed to be aged as hatching year in August–November and hatching year/second year in September–August. Juveniles should occur from June–September. Hatching year/second year birds should show molt limits between the wing and back and narrow, worn and tapered outer primaries and rectrices. These are believed to be aged as such in September–August (Pyle et al. 2008).

Adult. The crown, auriculars, breast, rump and undertail coverts are yellow-orange after the definitive prebasic molt. The throat averages paler yellow-orange, the nape is more greenish and the flanks and upper tail coverts are more strongly orange. The back is yellowish-green and the upper wing, tail, wing coverts and alula are fringed in yellow-orange. The wing, tail and alula are otherwise olive tan with whitish on their medial ventral surfaces. The underwing coverts and axillars are whitish and tinged with yellow-orange. There is an indistinct, whitish eye ring with white also extending toward the gape. The plumages of the sexes appear to be alike. There are no clear differences in plumages between Saipan (Fig. 1) and Aguiguan (Fig. 2) populations. Brood patches and cloacal protuberances are reliable for assigning gender during breeding, although some males can develop partial brood patches. (Radley et al. 2011, RJC personal observation). A partial albino bird with light creamy-white primaries was reported by Bruce (1978).

Birds possess 10 primaries, nine secondaries, and 12 rectrices. After hatching year/after second year birds show uniform wing coverts and back feathers and broader, fresher outer primaries and rectrices. They presumably can be aged as such in September–August. Some intermediates between hatch-

ing year and after hatching year may be difficult to age by these criteria and should be aged unknown/after hatching year (Pyle et al. 2008).

Molts

The first preformative molt appears to be partial and the definitive prebasic molt is complete. Molt on the back and wings of specimens and captured birds ($n = 324$ individuals) suggests that the first preformative molt includes body feathers and possibly some lesser, median and inner greater coverts on some birds. The feather replacement sequence may be irregular as in the Bridled White-eye. Replaced feathers are darker and more yellowish-green than retained greenish-brown juvenal feathers that become increasingly faded and worn with age. Wear clines suggest that flight-feather replacement sequences occur in typical patterns (Pyle et al. 2008, Radley et al. 2011).

Saipan specimens taken in July and August were in partial molt, whereas those from September were in fresh plumage (Hartert 1898). Additional specimens taken in July–September were molting (Baker 1951). Individuals captured on Saipan in January ($n = 4$), March ($n = 1$), May ($n = 1$), June ($n = 1$), September ($n = 3$) and October ($n = 2$) had no molt. Individuals captured in June ($n = 1$) showed some primary molt and in October ($n = 1$) showed heavy body, tail and wing covert molt. A bird captured on Aguiguan in May had fresh plumage, indicating recent completion of molt (RJC unpublished data). Specimens from Saipan and Aguiguan examined in December ($n = 1$), January ($n = 5$), February ($n = 3$) and April ($n = 1$) were not in molt. Captured Saipan individuals showed low proportions undergoing flight-feather molt in April–May, but over half were undergoing molt after 20 June. Wear on adult feathers, which were fresher in December and wearing by April, support a late summer/fall molting period after breeding, perhaps primarily in July–October (Pyle et al. 2008, Radley et al. 2011).

Bare Parts

Juveniles have been described as having brownish bills and light yellow legs (Oustalet 1889). They also are reported to have a lighter bill than adults (Baker 1951). More recently, a Saipan individual captured in September, likely a juvenile, had a dull bill. Adults have a yellow-orange bill and legs. Nestlings have a bright yellow gape. The iris is brown (RJC personal observation).

Measurements

Linear measurements. Golden White-eye specimens from Saipan showed that males ($n = 7$) had a flattened wing length of 77–80 mm, full culmen of



FIG. 1. The Saipan Golden White-eye illustrating brilliant colors.

19–20 mm, tarsus length of 25–27 mm and tail length of 61–66 mm. Females ($n = 5$) had a flattened wing length of 72–75 mm, full culmen of 17.5–18.5 mm, tarsus length of 23–25 mm and tail length of 56–59 mm (Baker 1951).

Captures on Saipan from 1988–1993 showed that males had a wing chord of 73.1 ± 2.7 mm ($n = 11$), bill length from proximal nares of 10.5 ± 0.6 mm ($n = 11$), bill depth at proximal nares of 4.0 ± 0.4 mm ($n = 11$), tarsus length of 26.0 ± 1.6 mm ($n = 11$) and tail length of 66.0 ± 2.6 mm ($n = 10$). Females ($n = 2$) had a wing chord of 69.2 ± 2.9 mm, bill length from proximal nares of 9.0 ± 0.1 mm, bill depth at proximal nares of 4.2 ± 0.7 mm, tarsus length of 26.0 ± 2.6 mm and tail length of 61.5 ± 4.0 mm (Craig 2021a, RJC unpublished data).

Captures on Saipan from 2008–2009 showed that males had a wing chord of 75.3 ± 3.1 mm ($n = 125$), exposed culmen of 15.6 ± 0.8 mm ($n = 35$) and bill length from nares of 10.5 ± 0.6 mm ($n = 35$). Females had a wing chord of 70.5 ± 2.7 mm ($n = 90$), exposed culmen of 13.1 ± 0.7 mm ($n = 17$) and bill length from nares of 8.9 ± 0.4 mm ($n = 21$) (Radley et al. 2011).

Male Saipan specimens ($n = 8$) had a wing chord of 72–82 mm, exposed culmen of 13.9–15.5 mm, bill length from nares of 9.3–12.2 mm and tarsus length of 24.5–29.0 mm. Female specimens ($n = 8$) had a wing chord of 64–76 mm, exposed culmen of 12.7–14.0 mm, bill length from nares of 8.3–11.8 mm and tarsus length of 22–28 mm. Measurements indicate moderate to strong sexual dimorphism, with

both wing length and especially bill length useful for sexing. Bill length also proved reliable against the presence of a cloacal protuberance for sexing males (Pyle et al. 2008).

Captures on Aguiguan in May 1992 ($n = 9$) had a wing chord of 69.4 ± 2.2 mm, bill length from proximal nares of 9.6 ± 0.4 mm, bill depth at proximal nares of 3.8 ± 0.2 mm, tarsus length of 24.3 ± 2.0 mm and tail length of 61.9 ± 2.5 mm. Three of these were males sexed by cloacal protuberance and had a wing chord of 69.9 ± 1.9 mm, bill length from proximal nares of 9.7 ± 0.4 mm, bill depth at proximal nares of 4.0 ± 0.1 mm, tarsus length of 24.6 ± 0.7 mm and tail length of 63.3 ± 2.0 mm. No birds displayed brood patches (Craig et al. 1993b, RJC unpublished data).

Mass. Saipan captures from 2008–2009 had a male mass of 20.3 ± 1.7 g ($n = 113$) and a female mass of 16.2 ± 1.5 g ($n = 80$) (Radley et al. 2011). Saipan captures from 1988–1993 had a male mass of 20.8 ± 1.9 g ($n = 11$) and a female mass of 17.6 ± 1.3 g ($n = 2$). May 1992 Aguiguan captures had a mass of 15.7 ± 0.8 g ($n = 9$). Three of these were sexed as males and had a mass of 16.4 ± 0.5 g (Craig 2021a, Craig et al. 1993b, RJC unpublished data).

SYSTEMATICS

Systematics History

The type specimen of the Golden White-eye, obtained from Saipan, was first reported as *Ptilotis*



FIG. 2. The Aguiguan Golden White-eye shows no clear plumage differences with birds from Saipan..

Marchei (Oustalet 1889), although he considered it sufficiently distinct to propose the genus *Cleptornis* for it. Authors have classified it as *Cleptornis* since; e.g., Wilesworth (1891), Oustalet (1895), Hartert (1898), Seale (1901), Ornithological Society of Japan (1942).

Historically, the species has been placed in the Meliphagidae (Oustalet 1889), although its taxonomic affiliation was first questioned by Bruce (1978), who suggested an evolutionary link between honeyeaters and white-eyes. Pratt et al. (1987) hypothesized that the species was instead in the Zosteropidae—a view supported by the DNA studies of Sibley and Ahlquist (1990) and Slikas et al. (2009), who also noted a distant link between honeyeaters and white-eyes.

Geographic Variation

Discriminant function analysis, albeit with small samples, suggest that Aguiguan birds are smaller than Saipan birds (Craig et al. 1993b).

DISTRIBUTION

The Golden White-eye is known historically from Saipan and Aguiguan (Pratt et al. 1979, Engbring et al. 1986).

Historical Changes to the Distribution

Prehistoric bone deposits from the Mariana islands of Tinian, Aguiguan and Rota demonstrate that the Golden White-eye was once present on all three (Steadman 1999) in addition to Saipan. The lack of historical reports from Aguiguan prior to 1954 (e.g., Yamashina 1940, Baker 1951) suggest the possibility that it was rare or locally extinct there and then recolonized. Some reports from Saipan in the 1930s and 1940s, during a time of extensive sugarcane production, suggest that it was also uncommon there (Stott 1947, Baker 1951). Beginning in 2011, the species has been translocated to the more northerly Mariana island of Sarigan (Radley 2012). Beginning in 2018, it was also translocated to Alamagan (Newland et al. 2018).

HABITAT

The earliest reports of Saipan habitat described nests in native trees—*Guamia*, *Eugenia* and *Ochrosia* (known locally as Langiti but listed as Rakiti) (Hartert 1898). This suggests that at this time the Golden White-eye was principally associated with native forest. Stott (1947) also reported it solely from forest. Marshall (1949) added that by virtue of its large eyes it appeared to be adapted for life in the shade—the forest understory. However, Bruce (1978) found it to occur in forest particularly at 1-3 m up, although it also occupied the forest canopy. A fuller but qualitative description of habitat is of birds inhabiting dense forest, introduced *Leucaena* thickets, scrubby woods near open fields and in exotic



FIG. 3. A Saipan Golden White-eye feeding on papaya fruits.

trees in urban areas (Pratt et al. 1979). Particularly high population densities have been found in locations with residential development and agriforest, with the species thought to inhabit all woody vegetation and particularly brushy areas. Lowest densities were in locations with extensive fields (Engbring et al. 1986). Nest records from the Division of Fish and Wildlife, Commonwealth of the Northern Marianas showed that nests were located in all types of wooded and semi-open habitats, including limestone forest ($n = 5$), suburban yards ($n = 4$), farms/agriforest ($n = 2$) and *Leucaena* thickets ($n = 2$) (Stinson and Stinson 1994).

Quantitative analysis of Saipan microhabitat use demonstrated that in native limestone forest the Golden White-eye occupied the forest canopy and mid-understory in roughly equal proportions and occasionally used even the lowest portion of trees. It typically used a wide variety of smaller tree species. Birds occupied both native limestone forest and *Leucaena* thickets, although in the latter it spent most of its time in the thicket canopy. In both habitats, it occupied the outer crown far more than the inner (Craig 1990, Craig and Beal 2001). Population densities were far greater in native forest than in disturbed habitats, including *Leucaena* thickets (Craig 2021). It occurred in all wooded habitats, including strand forest and suburban areas, although it was

generally absent from *Miscanthus* savanna (Craig 1996).

On Aguiguan, birds inhabited native forest at densities similar to those of Saipan, although they also occupied areas once cultivated for sugarcane that had grown up to introduced *Lantana* thickets. They predominantly used the upper and mid-forest layers, as on Saipan (Craig et al. 1993c).

MOVEMENTS AND MIGRATION

There are no documented historical instances of inter-island movement, even though an island like Tinian is only a few km from populations on Saipan and Aguiguan. Clearly, however, the species had dispersed at least among the islands of Saipan, Tinian, Aguiguan and Rota, where there is prehistoric evidence of its presence (Steadman 1999).

DIET AND FORAGING

In the earliest Saipan description of foraging, the Golden White-eye was reported to capture invertebrates as it rapidly flitted from twig to twig (Marshall 1949). A later but brief qualitative examination of Saipan foraging described the species as using its strong feet and long legs to probe in tree bark crevices and large branches as it hopped back and forth on vertical branches and vines. It also hung upside



FIG. 4. A Saipan Golden White-eye nest and eggs.

down to examine leafy twigs, trunk knotholes and under bark flakes. One bird fed at a flower but appeared to be only probing for insects. Another secured three insect larvae after several seconds of poking and scratching with its bill at a cluster of fallen vegetation in the crotch of branches. Each larva was beaten twice against a small branch before it was swallowed. Another bird briefly flashed its slightly raised wings outward before catching an insect that it flushed (Bruce 1978).

In dry season quantitative observations made on Saipan in 1988–1989 ($n = 252$), the Golden White-eye was found to be more sluggish and to move more deliberately through the foliage than the Bridled White-eye, but it was agile and hung upside down from perches while it searched the undersides of branches and leaves. It also stretched upward from perches to inspect leaves, sometimes standing on leaf clusters. It flew or hopped between perches and often made attacks on prey <1 time/min. Another technique used was to move along branches or slender, leaning tree trunks and periodically search the undersides for prey. Percent use of foraging methods in native limestone forest and introduced *Leucaena* thickets was ca. 75% glean, 22% probe and 2% hov-

er, with technique use varying little between habitats (Craig 1990). Use of foraging methods during a limestone forest wet/dry season cycle in 1990–1991 ($n = 246$) was 74% glean, 24% probe and 2% sally/hover (Craig and Beal 2001). On Aguiguan ($n = 56$), use of foraging methods was 75% glean and 25% probe (Craig et al. 1993c).

Microhabitat for Foraging

Despite of the Golden White-eye's long legs and thrush-like build, it was initially thought not to feed on the ground (Marshall 1949). However, Bruce (1978) reported it feeding on the ground occasionally. Later quantitative observations indeed demonstrated that foraging occurred in all locations from the ground to treetops. In measures made over the dry seasons of 1988–1989 ($n = 252$) in Saipan native limestone forest and introduced *Leucaena* thickets, the top outer portion of trees was the predominant foraging substrate, with percent time foraging there 47% in limestone forest and 55% in *Leucaena* thickets. In limestone forest, foraging time was 33% in the middle-outer portion of trees and 6% in the lowest portion of trees. The lower half of *Leucaena*



FIG. 5. A Saipan Golden White-eye adult and juvenile.

thickets was used 25% of the time. The remainder of time in both habitats was spent foraging in the inner portions of trees. The species foraged primarily from live leaves 58 and 51% of the time in limestone forest and *Leucaena* thickets, respectively, although it also foraged from dead leaves, flowers, fruits, branches and tree trunks. Fruit and dead leaves were used more and live leaves and flowers were used less in *Leucaena* thickets than in limestone forest. Perch sizes 0.25–<1.0 cm were used 76% of the time in limestone forest and 57% of the time in *Leucaena* thickets. Perches >4 cm or <0.25 cm were used infrequently in either habitat. Percent use of plants in limestone forest was: 33.0% *Cynometra*, 13.3% vines, 10.5% *Erythrina*, 7.7% each *Pisonia*, *Ficus*, 5.6% *Leucaena*, 4.9% *Guamia*, 3.5% *Melanolepsis*, 2.8% *Aglaia*, 2.1% *Premna*, 1.4% each *Maytenus*, *Randia*, 0.7% each *Papaya*, *Artocarpus*, *Phyllanthus*, *Pandanus*, *Barringtonia*, *Hibiscus*, *Ochrosia* and *Intsia*. In *Leucaena* thickets, 74.0% of foraging occurred in *Leucaena*, which was overwhelmingly predominant in the thicket canopy and understory (Craig 1990).

During a wet/dry season cycle in 1990–1991 in Saipan limestone forest ($n = 378$), the Golden White-eye used the top portion of trees 42% of the time and the mid-lower portion 58% of the time. Time spent foraging from live leaves was 46%, dead leaves 26%, branch/trunks 22%, fruits 12% and flowers 4%. Use of perch sizes was 49% <0.5 cm and 51% >0.5 cm.

Use of plants was 24.3% *Cynometra*, 12.0% vines, 9.4% *Ficus*, 9.4% *Guamia*, 6.8% *Pisonia*, 6.0% *Psychotria*, 7.3% *Premna*, 5.6% *Melanolepsis*, 2.1% *Intsia* and 17% other. Limestone forest observations from 1988–1989 vs. 1990–1991 were generally similar, with the principal differences being that there was an increase in use of the mid-lower forest, a decrease in use of live leaves but an increase in use of dead leaves from the earlier to later observations (Craig and Beal 2001). Other tree species used in limestone forest foraging included the native *Aidia*, *Ochrosia*, *Neisosperma*, *Cerbera*, *Erythrina*, *Dendrocnidae*, *Pouteria*, *Maytenus*, *Eugenia*, *Morinda*, *Aglaia*, *Artocarpus* and *Pipturus* and the introduced *Albizia*, *Leucaena*, *Carica* and *Acacia*. In seasonal comparisons of 1990–1991 foraging, the mid-zone of trees was used more, fruit was used less, gleaning was used less and probing was used more in the dry ($n = 89$) vs. the wet season ($n = 123$) (RJC unpublished data).

On Aguiguan, dry season measures of Golden White-eye foraging ($n = 56$) showed 51% use of upper portions of trees and 49% use of mid-lower portions. Use of foraging surfaces was 43% live leaves, 5% dead leaves, 43% branch/trunks, 4% fruits and 5% flowers. Use of perch sizes was 48% <0.5 cm and 52% >0.5 cm. Compared with dry season data from Saipan, allocation of foraging time was generally similar, although on Aguiguan foraging occurred more in the top portion of trees and more from

The earliest description of diet is that the Golden White-eye ate mostly berries with hard pits, which were swallowed whole, although it also took seeds, insects and spiders (Marshall 1949). Later, a brief qualitative examination of diet reported that food was mostly adult and larval insects as well as other arthropods and berries (Bruce 1978). Based on quantitative foraging data, the species principally feeds upon invertebrates, including flying insects, although it also eats seeds and engages in some frugivory and nectarivory (Craig 1990, Craig and Beal 2001). It has been observed to eat the seeds of native *Momordica* and the fruits of native *Momordica*, *Premna*, *Ficus*, *Melanolepsis*, *Psychotria*, *Artocarpus* and *Muntingia* and introduced *Lantana* and *Carica*. (Fig. 3) It feeds upon the flowers of native *Erythrina* and *Aidia* and introduced *Lantana* and appears to take nectar from the flowers of native *Pisonia*, *Erythrina*, *Muntingia*, *Psychotria*, *Morinda* and *Aidia* (Craig 1996, RJC unpublished data).

Songs. The Golden White-eye was initially thought not to sing (Marshall 1949). Later, the song was described as melodious whistles heard infrequently, although the species was thought not to sing during the latter part of the breeding season (Bruce 1978). The song was further described as an extended, loud, distinctive warble given infrequently (Engbring et al. 1986) in May–June but frequently in August (RJC unpublished data). Written as words, the song was first described as *SEE ME-can you SEE ME-I can SEE YOU-can you SEE ME* (Pratt et al. 1987). Later, more extensive observations from 1988–1993 on Saipan reported that the species sang year-round, except during the protracted dry season of 1993, when no singing occurred during June–July despite almost daily field observations. This latter observation may help to explain Marshall’s (1949) failure to detect any song. Singing also appeared to be infrequent in January but frequent in May–June 1991 (Craig 1996, RJC unpublished data).

-zoo-zee-ZEE-ZEE-ZEE-zoo-ZEEE as well as shorter and longer versions and variations on this (RJC unpublished data).

The Golden White-eye often engages in over-the-wing head-scratching (Bruce 1978) although it also can head-scratch under-the-wing (clearly seen in both instances). It bill-wipes on a branch after capturing prey and drinks water drops that collect at leaf tips (RJC unpublished data).

1996, RJC unpublished data).

Social and Interspecific Behavior

During three days of observation on Saipan, the Golden White-eye was found to occur singly, in pairs or small groups of 3–6 at all heights in trees but particularly at 1–3 m, where its acrobatic movements were active but deliberate. In the upper forest canopy, it appeared to occur in looser groups, although it kept less far out on branches than the smaller Bridled White-eye. When perched, the tail was often cocked upward and sometimes moved slowly up and down. The wings were usually held slightly drooped but often flicked outward during foraging. The head was partly lowered and the tail was held downward without spreading any rectrices. A group of five on and near the ground called noisily to each other before dispersing in different directions but keeping within visual range of each other. Immature birds in family groups remained by parents. One, however, did not beg but had insects placed into its throat and afterwards sat motionless for minutes before it again began to move. Allopreening occurred among pairs and small groups, with one bird raising its head in a submissive posture to another, who preened the feathers of the neck, nape, breast and other up-parts (Bruce 1978).

In observations made in January–February 1988–1989, the species foraged in groups of 3.0 ± 0.9 individuals ($n = 28$ observations). These were family groups, as verified from 1988–1993 by food begging of juveniles, adult preening and feeding of juveniles, and plumage differences between adults and juveniles. When food begging, juveniles fluttered their drooped wings and held their bodies toward horizontal with head raised. Juveniles also sometimes perched on branches with an adult with bodies touching. Three sleeping birds facing in opposite directions on a branch were also observed to be touching. When flushed from a nest, the adult flew to the ground and engaged in a broken wing display (Craig 1990, 1996, RJC unpublished data).

Aggressive encounters with the Bridled White-eye occurred during canopy foraging. Golden White-eye individuals flew at the smaller birds and partially extended both wings outward towards them. The Golden White-eye also made calls and opened its bills at the peak of wing-spreading. After an aggressive encounter, foraging resumed (Bruce 1978). Of the four small passerines that inhabit Saipan forests, the Golden and Bridled white-eye were the only species to show regular interspecific aggression ($n = 20$ observations). The Golden White-eye supplanted the Bridled from perches, snapping its bill when landing, chased it, and flew through flocks of foraging birds, which dispersed them. However, the two species also foraged within 2 m of each other. In two instances, a Golden White-eye also appeared to chase a Rufous Fantail (*Rhipidura versicolor*) and in another

a Rufous Fantail chased a Golden White-eye from near its nest. In contrast to this aggression, the Golden White-eye was sought out by the Rufous Fantail to assist in its foraging. The Rufous Fantail followed 1–2 m behind a foraging Golden White-eye, hawking insects disturbed from leaves. In contrast, the Micronesian Myzomela (*Myzomela rubratra*) was observed to chase individuals and disperse flocks of Golden White-eyes ($n = 4$) (Craig 1990, 1996). At the nest, Golden White-eye adults chased away other birds from the nest including the Eurasian Tree Sparrow (*Passer montanus*), Bridled White-eye and other Golden White-eye individuals (Stinson and Stinson 1994).

BREEDING

Phenology

The first nesting on Saipan was reported for May and June (Oustalet 1889). Another early Saipan nest was found on 7 July (Hartert 1898). A more recent nest was under construction on 15 February 1981 (Engbring et al. 1986). Three 1989 nests were found on 2 and 8 May and 9 June. The second nest contained two eggs when found but was destroyed by children on 15 May after four days of observation. The third nest contained two newly hatched chicks when examined on 15 June. Both adults at the 9 June nest previously had been color banded and at least the male was known to have nested in the same tree in March–early April. The chicks were flapping their wings on 27 June and appeared to be close to fledging. The nest was empty on 28 June and the chicks were presumed fledged (Stinson and Stinson 1994).

In wet/dry season observations made in 1990–1993, breeding occurred in January (gathering nesting material, eggs, hatchlings, fledglings), February (eggs), March (eggs), May (gathering nesting material, recently fledged nest), June (eggs), July (copulation, carrying nesting material, eggs, nestlings), August (nest construction), and October (eggs). Song and food begging occurred year-round, except during the protracted dry season of 1993, when no singing occurred during June. This latter observation may help to explain Marshall's (1949) failure to detect any singing by this species (Craig 1996, RJC unpublished data).

Nest

The first Saipan nest (Fig. 4) described was one attached to two ca. 2 mm thick leafy branches on a bifurcated branch. It was constructed of horsehair-like plant fibers that were intertwined and had green moss on the outside (Oustalet 1889). Another nest was in an *Ochrosia* tree. It hung from a fork of a thin branch with the branch's end concealed by leaves.

The sides of the nest were not tightly woven and consisted of roots and grasses and had leaves and light green cocoon silk on the outside. It was 5.5 cm high and 7–8 cm. wide and was not lined with soft material. More nests found in late August in *Guamia* and *Eugenia* trees also were shaded on one side by overhanging leaves (Hartert 1898).

A more recent nest on Saipan was located in second growth woody vegetation and placed in a *Leucaena* tree 2.5 m up. It was composed of shredded *Cocos* fibers, fine strands of grass and other fine vegetation. It hung from a 1 cm thick branch and was placed directly beneath a *Cocos* frond (Engbring et al. 1986). Nest records from the Division of Fish and Wildlife, Commonwealth of the Northern Marianas showed that nests were 2.92 ± 1.62 m above the ground ($n = 13$) in native *Casuarina* ($n = 3$), *Guamia* ($n = 3$), *Cynometra* ($n = 2$) and *Randia* ($n = 1$) and introduced *Leucaena* ($n = 2$), *Citrus* ($n = 1$) and *Malpighia* ($n = 1$). Of nests found in 1989, the first was composed primarily of *Casuarina* stems, grasses, vine tendrils and coarse hairs 7.6 cm long. The second also was made of *Casuarina* stems and grasses (Stinson and Stinson 1994).

A 31 January 1988 nest with eggs in interior limestone forest was 1.8 m up in a 2.4 m *Guamia* and was 10 cm wide, 6 cm deep and with a 4.5 cm cup depth. A 4 February 1988 nest with eggs in a *Leucaena* thicket within 30 m of *Miscanthus* clumps was 2 m up in a 6.1 m *Leucaena* and was 7.5 cm wide, 5.5 cm deep and with a 4 cm cup depth. A 25 January 1989 nest with nestling in ca. 13 m *Barringtonia*–*Artocarpus* forest was 2.7 m up in a 3 m *Cynometra* and was 8 cm wide and 7 cm deep. A 7 February 1989 nest with eggs in 12 m *Guamia*–*Ochrosia* forest was 1.5 m up in a 2 m *Guamia* and was 10 cm wide and 7 cm deep. A 16 May 1991 recently used nest in ca. 11.5 m limestone forest was 1.8 m up in a 2.1 m *Eugenia*. A 20 June 1991 nest with eggs in 9 m limestone forest was 1.8 m up in a 2 m *Cynometra*. A 20 June 1991 nest with eggs in 9 m limestone forest was 1.8 m up in a 2 m *Cynometra*. A 5 July 1991 nest with nestlings in 12 m limestone forest was 3.7 m up in a 6.1 m *Cynometra*. A 15 August 1991 nest under construction in limestone forest was 4.6 m up in an *Aglaia* sapling. An 8 October 1991 nest in limestone forest was 2.1 m up in a 3 m *Guamia* sapling. A 25 October 1991 nest with an egg in limestone forest was 2.4 m up in a *Guamia*. A 14 March 1992 nest with nestlings in ca. 366 m elevation native forest was 1 m up in vines hanging from a *Guamia* (RJC unpublished data).

Eggs

A Saipan nest was reported to have two elongated bluish-white eggs without spots (Oustalet 1889), although the eggs described were those of *Zosterops* (Hartert 1898), which indicates that this record is unreliable. Another egg was described as pale blue

without gloss, spotted with rufous, particularly on the thicker end, and measured 20 x 15 mm. Additional eggs, of which 2–3 were present/nest, were like this one although some were deeper sky-blue. The richly marked rufous spots were smaller on some eggs and larger and more blotched on others. They measured $20.3 \pm 0.6 \times 15.1 \pm 0.7$ mm ($n = 8$) (Hartert 1898). Recent descriptions are similar, with eggs reported as pale bluish-green and having reddish-brown spotting concentrated on the wide end. Egg weights were 1.8, 2.2, 2.2 and 2.3 g. Of 11 active nests found, 10 contained two eggs and the other contained a hatchling (Stinson and Stinson 1994). Mean clutch size is 1.85/nest ($n = 39$) (BirdLife International 2024). A 31 January 1988 nest had two eggs with one measured at 18.1 x 15.1 mm. A 4 February 1988 egg was 20.0 x 14.9 mm (RJC unpublished data).

Incubation

The 2 May 1989 nest with two eggs was observed for 21 hr over 22 days. For the week prior to egg-laying, adults visited the nest intermittently and moved in and out of the nest tree while calling loudly. Daily nest checks from 2–10 May resulted in an egg appearing on 9 May and a second present on 10 May. An egg hatched after 14 days of incubation. Two days after hatching, the nestling had a mass of 6.4 g and on day 7 it was 15.2 g. The other egg vanished on day 13, possibly the result of green tree skink (*Lamprolepis smaragdina*) predation, as this introduced lizard is known to prey upon Golden White-eye eggs. At hatching, the nestling was altricial and had yellow skin (Stinson and Stinson 1994).

Adults incubated continuously during the daylight hours. Over 29 hr of observation, they left the nest unoccupied for 50 min and left for no more than 5 min. When the incubating pair exchanged places on the nest, the approaching bird usually called and the bird on the nest left nest seconds before the other arrived. The sexes shared incubation nearly equally at two observed nests (incubation observation points = 675 male, 673 female; one-tailed Student's $t = 0.054$, $P > 0.05$) (Stinson and Stinson 1994).

Parental Care

During the nestling period for 1989 nests, both adult birds brought food, brooded the young and removed fecal sacs from a nest. During 232 min of observation, a nestling was fed 13 times and four fecal sacs were removed. The week-old nestling was seen unsuccessfully begging for food from a curious Eurasian Tree Sparrow. The nestling was fed insects exclusively and four of 13 times the food appeared to be green caterpillars. One adult brooded the nestling for 72 min and the other brooded it for 40 min, but the average brooding period was 9.1 min. The nestling fledged 10–12 days after hatching and was seen with both adults near the nest tree on day 16. At that

time, the fledgling appeared to be unable to fly well. Adults stayed with the fledgling (Fig. 5) and noisily chased away other Golden White-eyes that approached (Stinson and Stinson 1994).

DEMOGRAPHY AND POPULATIONS

Population Regulation

From 2008–2018, capture-recapture data from six Saipan mist-netting stations showed that estimates of population growth rate indicated no decline in Golden White-eye populations. Survival probability was the largest contributor to growth rate. There was greater temporal than spatial variation in vital rates; i.e., survival probability, recruitment rate and population growth rate. In a study linking vital rates to rainfall and vegetation greenness, the species had the highest predicted productivity when relative greenness contrasted between wet and dry seasons, such as when especially dry seasons followed especially wet seasons (Saracco et al. 2016).

Causes of Mortality

Nest predators include the native Mariana Kingfisher (*Todiramphus albigilla*), the introduced green tree skink and rats (*Rattus* spp.) (BirdLife International 2024). Differences in rat species occupying Saipan vs. Aguiguan have been suggested to be related to differing population densities on these islands (Amidon et al. 2014), although no empirical evidence supports this possibility. Rats, monitor lizards (*Varanus indicus*) and cats (*Felis catus*) are not known to be major predators of tree nesting birds in the Marianas, although the native Micronesian Starling (*Aplonis opaca*) is documented to prey upon nests of other Marianas forest birds (Sachtleben 2005).

U.S. Fish and Wildlife Service roadside surveys on Saipan conducted over 20 years showed no relationship between Golden White-eye counts and typhoon frequency or severity (Ha et al. 2018). However, populations of other Marianas bird species have shown significant negative population effects associated with typhoons (Ha et al. 2012) and typhoon-related nest failures have been documented for other white-eye species (Amidon 2000). Now that a Golden White-eye population is established on Sarigan, volcanic activity is also a potential cause of mortality, as the nearby island of Anatahan and an undersea volcano are both volcanically active (Brainard 2012).

As part of an effort to establish a captive breeding program for the Rota White-eye (*Zosterops roensis*) in 1993 and 1995, 20 birds were screened for avian pox, avian malaria and other diseases. No evidence of disease was found, although disease has been found in Saipan *Z. conspicillatus*, albeit without obvious effect on populations. A potential threat a45from West Nile virus also exists, as other *Zos-*

terops have proven susceptible to this disease, although to date this virus has not been detected in the Mariana Islands (USFWS 2007).

Population Status

Early reports of the population status of the Golden White-eye on Saipan are conflicting. Stott (1947) found it at only one location even though he made an extensive search for it. Marshall (1949), in contrast, described the species as numerous but absent from the Lake Susupe marshes. Kobayashi (1970) reported that there were generally few birds on Saipan, Bruce (1978) found the Golden White-eye to be locally common, but Pratt et al. (1979) found it to be abundant throughout the island as did Ralph and Sakai (1979).

The first quantitative population survey of Saipan occurred in 1977, when censusing was conducted through 7.7 km of forest to yield a population density estimate of 680 birds/km². The first major survey, which had 14 variable circular plot transects and 244 survey points, was conducted in 1982 (Engbring et al. 1986). Updated computation methodology yielded birds/km² estimates for 1982 of 1287.3 ± 191.0, for 1997 of 995.5 ± 160.0 and for 2007 of 711.8 ± 112.1 (Camp et al. 2009). This suggests that a long-term population decline has occurred, although multiple and differing observers with varying experience and perceptual abilities were employed on these surveys. Hence, the evidence for such a decline is not definitive although a decline is likely given that continued human development is occurring on the island (Camp et al. 2009, Craig 2021b).

In addition to these counts, U.S. Fish and Wildlife Service roadside surveys with 50 stations placed 0.8 km apart along a 40 km route began in 1991 and continued through at least 2010. These showed a pattern of increasing followed by decreasing relative density (Ha et al. 2018), which suggests the presence of population cycles. However, 1991–1993 surveys were conducted by a single observer (Craig 1996) and different observers conducted them thereafter, which again raises questions about the reliability of these patterns.

Quantitative wet/dry season Saipan population surveys through native limestone forest, where densities of the Golden White-eye were by far the greatest, were performed on two transects with 30 survey points. Differences from 1990 to 1993 and between wet and dry seasons were limited and varied from 2073.1 ± 478 to 2661.2 ± 337.4 birds/km² over three wet seasons and 1845.4 ± 403.7 to 2322.6 ± 307.9 birds/km² over three dry seasons. Hence, there were no clear annual or seasonal difference in populations. In contrast to these native forest counts, single 1993 dry season surveys through non-native woody habitats along four transects with 59 survey points yielded 366.0 ± 70.5 birds/km² (Craig 2021b).

On Aguiguan, the first quantitative survey also occurred in June 1982 along four transects with 66 survey points. This yielded 1094 ± 196 birds/km². Subsequent surveys along these transects by differing observers yielded a May-June 1995 estimate of 1901 ± 382 , a March-April 2000 estimate of 2224 ± 396 , a March 2002 estimate of 1693 ± 275 and a June 2008 estimate of 2433 ± 466 birds/km². This suggests that no clear population trend has occurred despite variation in feral goat (*Capra hircus*) numbers during this time (Amidon et al. 2014). A May 1992 dry season census through native limestone forest by a single observer surveying two transects with 32 points yielded an estimate 3121.9 birds/km² (Craig 2021b). A second observer surveying along two different transects produced an estimate of 5556 birds/km², which demonstrates observer effect in producing density estimates (Craig et al. 1993a).

CONSERVATION AND MANAGEMENT

Conservation Status

The Golden White-eye is listed as endangered on the IUCN Red List due to its small range and possible decline of the Saipan population due to human-caused habitat loss. Moreover, the potential introduction of the brown tree snake to islands in its range could result in rapid elimination of populations. Based on the most recent estimates from transect counts, the current total Saipan and Aguiguan population is 43,806–96,857 (BirdLife International 2024). The species is not federally listed as endangered, however, and evidence from capture-recapture studies demonstrate no Saipan population decline (Saracco et al. 2016).

Effects of Human Activity

Habitat loss and degradation. Habitat loss has been cited as a cause of the Golden White-eye's possible Saipan decline. Since the 1980s, considerable uninhabited land on Saipan has been developed for residential, commercial and tourist-related purposes (Camp et al. 2009, Craig 2021b). In contrast, on uninhabited Aguiguan, where agricultural land has reverted to thickets and secondary forest, the population appears to be stable (Amidon et al. 2014). Despite the potential for forest cover reduction to influence populations, the species' ecological versatility (Pratt et al. 1979, Craig 1990) suggests that it is likely to persist in the face of such change, albeit at reduced densities.

Changing climatic conditions related to fossil fuel consumption might also affect populations, as wet and dry seasons are predicted to be wetter and warmer in the western tropical Pacific (BirdLife International 2024). Given that the Golden White-eye had the highest predicted productivity when relative

greenness contrasted between wet and dry seasons (Saracco et al. 2016), such a change could yield lower productivity.

Effects of invasive species. Perhaps the most ominous threat to face Golden White-eye survival is the potential for introduction of the brown tree snake (Rodda and Savidge 2007). Once the snake became established on the southernmost Mariana island of Guam in the 1940s, most endemic landbirds declined to extinction within ca. 40 years (Savidge 1987, Wiles et al. 2003). Accidental introduction via cargo ships and planes has been the primary dispersal mechanism from Guam. All goods received in the Northern Mariana Islands are shipped through Guam, with most arriving on Saipan. There have been over 70 reports of brown tree snakes on Saipan, including sightings away from port areas (Rodda and Savidge 2007, MAC Working Group 2014). Saipan was feared to have an incipient population, but there have been no confirmed records for 20 years (BirdLife International 2024). In contrast to Saipan, the risk of snake introduction to Aguiguan or Sarigan is low, as they are uninhabited.

Management

Conservation areas. Protected areas have been established on Saipan (BirdLife International 2024) and Aguiguan is set aside as a reserve (Engbring et al. 1986).

Conservation measures and habitat management. A captive breeding and translocation program has been developed for the Golden White-eye, with 24 brought into captivity in 2007 and another 24 added in 2008. Successful breeding has occurred at four of 10 participating institutions, although chick mortality has been reported (MAC Working Group 2014, BirdLife International 2024). In addition, on 20 and 22 April 2011, 38 Golden White-eyes were mist netted in the Marpi region of Saipan for translocation to the northern Mariana island of Sarigan and for inclusion in a captive breeding program at the Honolulu Zoo. After capture, birds were transported to a holding facility and maintained on a mix of local papaya, meal worms, fruit-blend pellets, insectivore pellets and nectar supplement. Most were weighed daily to track health and the status of acclimation to captivity. To treat health issues and to prevent transmission of disease to Sarigan, fecal scans were examined and birds wormed if necessary. Birds to be translocated were banded with aluminum leg bands and given a unique combination of two color bands. Of the captive Golden White-eyes, 24 were translocated to Sarigan on 28 April and 12 were transported to the Honolulu Zoo. Selection of individuals for translocation was based on indicators of gender and adaptation to captivity. Post-translocation monitoring was planned but not carried out (Radley 2011).

On 21 and 23 April 2012, additional birds were captured at Marpi. The same capture and handling

protocols were followed as in 2011. To facilitate post-translocation monitoring, all were again color banded and fitted with radio-transmitters. Post-translocation monitoring of 24 Golden White-eyes on Sarigan was conducted between 1 and 7 May. Radio tracking was largely unsuccessful but at least five color banded birds were re-sighted, four of which were introduced in 2011. These birds were paired and building nests. Golden White-eyes were heard singing at multiple locations on the island (Radley 2012).

From 18–24 April 2018, 51 birds were captured at Marpi, banded and prepared for translocation using procedures similar to those used previously. On 7 May, these birds began transportation via ship to Alamagan, where they arrived and were released on 8 May (Newland et al. 2018). During 27 April–4 May 2019, 43 additional birds were captured at Marpi and prepared for a second release on Alamagan. On 7 May, the birds began transportation via ship to Alamagan, where they were released on 8 May. During the release, unbanded Golden White-eyes were observed, indicating successful establishment of a population (Newland et al. 2019).

An issue not given sufficient consideration in translocation plans is the order of species translocation. The Golden White-eye is generally socially dominant to the Bridled White-eye and, likely, the Rota White-eye, as well as the Micronesian Rufous Fantail, although the Micronesian Myzomela appears to dominate the Golden White-eye (Craig 1990, 1996, 2021). It is conceivable that a large population of a socially dominant species could interfere with the successful establishment of a translocated subordinate species although, to date, this has not occurred. The Golden White-eye has succeeded in establishing itself on Sarigan even though a large population of the Micronesian Myzomela is present there. However, in this instance, there is limited ecological overlap between these species (Craig and Beal 2001), which likely limits social interaction between them.

To prevent establishment of the brown tree snake on Saipan, cargo arriving from sea and at airports is checked for snakes. Moreover, traps have been installed to catch any snakes that are missed and barriers have been constructed at docks to allow escaping snakes to be contained. Sniffer dogs have been trained to detect snakes at Saipan airport. Port officers have been trained in prevention of snake establishment and educational programs have been developed to increase awareness among the population of the importance of reporting sightings (MAC Working Group 2014).

Regular quantitative population monitoring with variable circular plot and roadside survey procedures began on Saipan in 1990 (Craig 1996) and continue to the present (Camp et al. 2009, Ha et al. 2018). In addition, a regular capture-recapture program, the Tropical Monitoring of Avian Productivity

and Survivorship program, has provided a more detailed view of population productivity and survivorship (Saracco et al. 2016).

PRIORITIES FOR FUTURE RESEARCH

1. The highest priority is continued monitoring and implementation of interdiction efforts at ports to prevent the establishment of brown tree snake populations on other Mariana islands.
2. As the highest densities of the Golden White-eye are attained in native limestone forest, a second priority is the preservation of this habitat by setting it aside from any encroachment by agriculture, residential or commercial development. In addition, much of secondary forest that is presently dominated by alien species, particularly that adjacent to seed sources in native forest, have the potential to be revegetated by native forest species (Craig 1994). Native birds and Mariana fruit bats (*Pteropus mariannus*) are major dispersers of native seeds (Caves et al. 2013), so further research into facilitating conversion of alien forest into that dominated by native species is needed.
3. High feral goat densities on Aguiguan are interfering with reproduction of native trees in the forest and goat reduction efforts yield improvement in native seedling development (Rice and Stinson 1993). Hence, ongoing management of feral goats on Aguiguan is required to maintain high densities of the Golden White-eye and other native bird species.
4. Expand translocation efforts to additional Mariana islands. The northern Mariana islands of Guguan, Agrihan and Asuncion, all of which have apparently suitable areas of native forest habitat, are also candidates for translocation of the Golden White-eye. However, these islands are presently slated for Tinian Monarch (*Monarcha takatsukasae*) and Rota White-eye translocation, so there are no plans to translocate it to these islands. However, considering the fact that similar species prehistorically co-occurred on Tinian, translocation of all these species to these islands appears to be feasible (MAC Working Group 2014).
5. In addition to northern uninhabited islands in the Marianas chain, Tinian and Rota should be considered as translocation destinations. Both prehistorically supported populations of the Golden White-eye. Moreover, as Tinian and Rota are near Saipan and are readily accessible by plane, such efforts would be comparatively low cost, would receive little human interference as the populations on Tinian and Rota are small and follow-up monitoring of birds would be comparatively easy to conduct.

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FIG. 6. A painting from life of the Golden White-eye, by Barbara A. Lussier, ca. 1991.