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ASPECTS OF FLOCKING BEHAVIOR IN AN ENDEMIC PACIFIC ISLAND WHITE-EYE

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Abstract. The Bridled White-eye is a little-known species endemic to the Mariana Islands in the tropical Pacific. Based on observations of social behavior and on movements of color banded individuals, I evaluated which of four flocking strategies the Bridled White-eye appeared to use: 1) group territoriality, 2) permanent membership flocks, 3) site dependent flocks, and 4) temporary flocks. Banded birds declined in frequency of occurrence from a single banding site and exhibited no clear defense of territorial boundaries. Many banded birds remained in the study area for up to 14.5 months. Small groups of at least three birds were family groups, although larger groups of ca 50 birds also foraged together and then dispersed into smaller flocks. Plotted resightings of individual banded birds suggested that home ranges of individuals were overlapping. These observations lead to the conclusion that the Bridled White-eye exhibited flocking characteristics intermediate between permanent membership and site dependent flocks.

The Bridled White-eye (*Zosterops conspicillatus*) is endemic to the Mariana Islands in the tropical Pacific. Like most *Zosterops* (Gill 1971), it is a highly social, flocking species. It shows no territoriality (Jenkins 1983) except perhaps in the immediate vicinity of the nest (pers. obs.). On the islands of Saipan, Tinian, and Aguijan it reaches among the highest population densities ever reported for land birds (Engbring et al. 1986, Craig et al. 1992, Craig 1996). However, in the remainder of its historic range, it is extinct on Guam (Engbring and Ramsey 1984) due to predation by the introduced Brown Tree Snake (*Boiga irregularis*) (Savidge 1987) and rare on Rota (although this population is probably a distinct species; Slikas et al. 2000), possibly because of predation and harassment by the introduced Black Drongo (*Dicrurus macrocercus*) (Craig and Taisacan 1994). Moreover, data from Guam indicated a decline in flock size as populations declined (Craig 1989). Aside from these limited observations, even the most basic aspects of the life history of this species remain largely unknown. I report here on observations of the flocking behavior of the Bridled White-eye, and provide data which permit assessment of the flocking strategy employed by this species.

Of reported flocking strategies, those potentially used by the Bridled White-eye are: 1) group territories, where flocks of stable membership (i.e. comprised of the same individuals over time) reside in and aggressively defend a common area, 2) permanent membership flocks, which are like group territories in that flocks have a stable membership and a common home range, but differ in that territorial aggression is absent, 3) site dependent flocks, in which individuals with separate undefended home ranges opportunistically flock where home ranges overlap, and 4) temporary flocks, where ephemeral associations of for the purposes of this paper, is defined as a group of two or more individuals traveling or foraging together, and generally in social contact.

Through color banding, following banded individuals, and observing social interactions of these birds, predictions derived from the definitions of these four strategies can be tested. In a color banded population with a banding site intersecting only one

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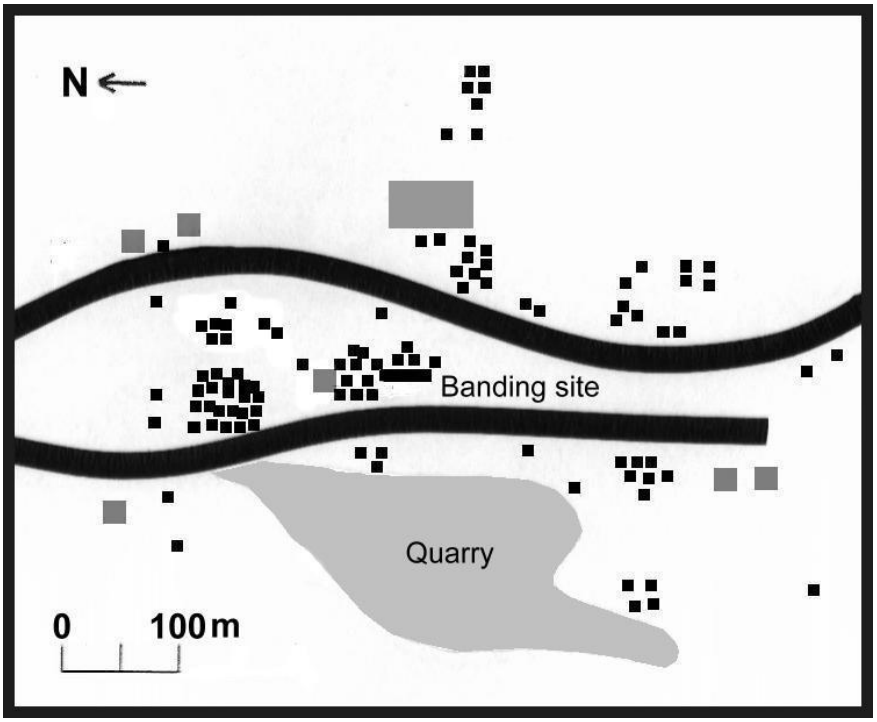

FIG. 1. Resightings (black squares) of banded Bridled White-eyes on Capitol Hill, Saipan. Gray rectangles are buildings and other artificial structures.

territory, banded individuals from a group territorial species might be observed anywhere within the territorial boundary. Hence, a constant proportion of banded to unbanded birds should be observed anywhere in the territory. Outside the territory, no banded birds should be present. In contrast, in permanent membership and site dependent flocks, the proportion of banded birds should decline with distance from a single banding site, because as distance increases more birds with home ranges not overlapping the banding site will be encountered. In temporary flocks, the proportion of banded birds should show little pattern with distance from the banding site, because nomadic birds do not remain in the same vicinity. Moreover, in group territories and permanent membership flocks, flock membership by definition is stable, whereas in site dependent flocks, membership is predictable based on the location of observation (i.e., it consists of birds whose home ranges overlap at particular sites). Membership is unstable in temporary flocks, because birds are nomadic. Aggression should be prevalent at flock boundaries of group territories, whereas it should not be prevalent at these boundaries in other flock types, although aggression might still occur between individuals at various locations due to disputes over food, mates, etc.

STUDY AREA AND METHODS

I studied Bridled White-eyes on Saipan at a central plateau area known as Capitol Hill. Saipan is predominantly a raised coral island 22 km long and 3−10

km wide. Its climate is humid tropical with little temperature fluctuation, and is characterized by a drier, windy season from December to May, and a wetter, calm season from June to November. The study area extended in a 300 m radius surrounding a single mist net station, and included ca 50% alien thickets of tangantangan (*Leucaena leucocephala*), lantana (*Lantana camara*), coconut palm (*Cocos nucifera*), and papaya (*Carica papaya*) interspersed with elephant grass (*Pennisetum purpureum*) and other weed grasses, although copses of native trees (15%), including ironwood (*Casuarina equisetifolia*), fig (*Ficus tinctoria, F. prolixa*), paipai (*Guamia marianne*), cator (*Claoxylon marianum*), false elder (*Premna obtusifolia*), coral tree (*Erythrina variegata*), and Indian mulberry (*Morinda citrifolia*) also occurred. A quarry (20%) and residential areas (15%) were present as well.

I banded birds from February 1992 to June 1993 with combinations of colors that permitted identification of individuals in the field. In May 1993 the frequency of banded birds in the population (a time brief enough to minimize population turnover) was assessed by determining the proportions of banded vs. unbanded birds at 50 m intervals to 300 m from the banding site. From May to July, 1993, I also recorded on a base map made from aerial photos (3.5 cm = 100 m scale) the locations of banded birds observed away from the banding site. Color combinations were observed with binoculars by waiting for birds to appear at locations throughout the study area. Moreover, throughout this period I observed social interactions between flock members and, when possible, mapped movements of entire flocks as they moved through the study area. These observations are supplemented by behavioral data gathered incidentally from 1988 to 1993.

RESULTS

During the study period, 97 birds were color banded. In addition, 16 birds were recaptured at the banding site, with six captures occurring at >6 months from the initial banding (maximum = 14.5 months). From May to July, 1993, I made 135 resightings of birds whose band combinations were distinguishable in the field (Fig. 1), including those of 10 birds which were observed $\geq$5 times. Plotted data from these 10 traced roughly elliptical areas, of which six were ca 200 m maximum diameter, and three were ca 250 m diameter. One was in a 100 m diameter area. The maximum distance a bird was seen from the banding site was 210 m. Six of the 10 birds were found in roughly overlapping areas, whereas two were in areas encompassing but greater than those of the six. The remaining two were located in portions of the areas used by these other birds.

When I assessed the proportion of banded birds in the study area in May 1993, I made 103 sightings of birds, of which 40 were of banded birds. Based on the locations of these resightings, banded birds declined in frequency of occurrence, p, from the banding site in an empirically fitted quadratic relationship ($r^2 = 0.99$):

$$p = 1.47x^2 - 1.21x + 53.82,$$

where x has values from one for the basal zone (0−50 m from the banding site) to six for the outermost zone (251−300 m) (see also Craig 1996 for estimates of population density based on this relationship).

Although I did not attempt to quantify their frequency, qualitative observations demonstrated the occurrence of behaviors which provide additional data relevant to hypotheses about flocking strategies. As with other species of white-eyes (Harrison 1968, Gill 1971, Kikkawa 1987), allopreening was frequent, as was food begging (wing fluttering, crouching, and gaping) by juveniles with no evidence of natal feathers. Moreover, pairs of birds were observed together (foraging, gathering nesting material, responding in pairs to playback of calls), as were family groups of three (apparently a male, female, and juvenile as identified by food-begging). Types of aggression encountered included supplanting of one individual by another at a perch and one bird chasing another. Chases involved bill clattering, and whining calls and wing fluttering appeared to precede attacks (see also Kikkawa 1961). Such observations were typical of not only this study period but of behaviors observed year-round. Aggressive behavior was detected virtually anywhere where flocks of birds were present. I could not clearly relate such behaviors to aggressive territorial encounters except within several meters of the nest; instead, they most frequently appeared to involve disputes over access to food.

Of flocks of birds larger than family groups (ca 3−5 individuals), flock size was typically 10−40 (mean = 17.6, n = 25), although larger flocks of at least 50 were encountered at heavily flowering (particularly coral tree, *Erythrina variegata* and gulos, *Cynometra ramiflora*) and fruiting trees (particularly figs and false elder; see also Craig 1989, 1996). Flocks showed cohesiveness; i.e., members continuously communicated through contact calls and flew between trees (foraging sites) in groups. Flock departure and arrival occurred over a period of seconds rather than simultaneously, however, as individuals completed foraging at one site before moving to the next. In two instances in which I was able to follow larger (ca. 15 birds) foraging flocks, groups remained cohesive for 100−200 m, but then fragmented into groups of 3−5 birds which headed in differing directions.

Although the quantitative phase of this investigation took place over a three-month period, I observed Bridled White-eyes on Saipan for three full years (Craig 1996) and two additional dry seasons (Craig 1989, 1990). During this time, I found that, although adult pairs acted aggressively near and appeared to defended the immediate vicinity of the

nest, flocking was a conspicuous behavior throughout the year and showed little clear change in character. My observations for year-round nesting and inability to find evidence for a pronounced breeding season (Craig 1996) may help explain this uniformity in behavior. Moreover, the intensive phase of this investigation lasted from the end of the dry season into the wet season, yet no behavioral alteration was apparent.

DISCUSSION AND CONCLUSIONS

Banded birds declined in frequency of occurrence from the banding site, which eliminated group territoriality as the social system employed by the Bridled White-eye. Moreover, that I observed no defense of territorial boundaries, although a qualitative observation, corroborated this finding. That birds declined in frequency of occurrence, and that, based on mark-recapture and resighting data, many banded birds remained in the study area for months or years also eliminated temporary flocking as a potential social strategy of these birds.

Additional observations on movements, flock size, and social interactions lead to the conclusion that flocks show characteristics intermediate between permanent membership and site dependent flocks. Small groups of at least three birds were clearly family groups, and may be considered permanent at least to the extent that family groups remain cohesive over time. However, observations of larger groups of ca 50 birds foraging together and then dispersing into smaller flocks is most consistent with the concept of site dependency, where smaller groups opportunistically converge on dense food resources. Although less definitive because of limited samples, data on resightings of banded birds also were consistent with a pattern of independent, overlapping home ranges of individuals or small groups. Again, individuals within such home ranges have the opportunity to converge on attractive food resources and thus form temporary large flocks.

The predominance of year-round flocking in this species contrasted with that of another tropical island *Zosterops*, the Capricorn Silvereye (*Z. lateralis chlorocephala*) of Australia. This population flocks primarily during the dry season, when breeding is minimal, but monogamous pairs defend all-purpose breeding territories during the wet season (review in Kikkawa 1987). Moreover, Catteral et al. (1989) reported that *Z. lateralis chlorocephala* adults flocked less frequently than juveniles. On Saipan, adults attending food begging juveniles was a conspicuous and commonly observed part of flocking activities. However, because Bridled White-eye molt and plumage sequences remain essentially unknown (adults may have averaged yellower than at least birds in juvenal plumage), and even birds of known age (recaptures) were difficult to visually age and sex (see also Marshall 1949), a definitive evaluation of adult and juvenile flocking patterns is not yet possible.

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LITERATURE CITED

CATTERALL, C.P., J. KIKKAWA and C. GRAY. 1989. Inter-related age-dependent patterns of ecology and behaviour in a population of silvereyes. Journal of Animal Ecology 58:557−570.

CRAIG, R.J. 1989. Observations on the foraging ecology and social behavior of the Bridled White-eye. Condor 91:187−192.

CRAIG, R.J. 1990. Foraging behavior and habitat use of two species of white-eyes on Saipan, Micronesia. Auk 107:500−505.

CRAIG, R.J., R. CHANDRAN and A. ELLIS. 1992. Bird populations on Aguiguan: a ten-year update. Proceedings, Marianas Research Symposium 1:8−15.

CRAIG, R.J. and E. TAISACAN. 1994. Notes on the ecology and population decline of the Rota Bridled White-eye. Wilson Bulletin 106:165−169.

CRAIG, R.J. 1996. Seasonal population surveys and natural history of a Micronesian bird community. Wilson. Bulletin 108:246−267.

ENGBRING, J. and F.L. RAMSEY. 1984. Distribution and abundance of the forest birds of Guam; results of a 1981 survey. U.S. Fish & Wildlife Service Office of Biological Service Report.

ENGBRING, J, F.L. RAMSEY and V.J. WILDMAN. 1986. Micronesian forest bird survey, 1982: Saipan, Tinian, Aguijan, and Rota. U. S. Fish and Wildlife Service, Honolulu, Hawaii, USA.

GILL, F.B. 1971. Ecology and evolution of the sympatric Mascarene white-eyes, *Zosterops borbonica* and *Zosterops olivacea*. Auk 88:35−60.

HARRISON, C.J.O. 1968. Allopreening as agonistic

behaviour. Behaviour 24:161−209.

JENKINS, J.M. 1983. The native forest birds of Guam. Ornithological Monographs 31.

KIKKAWA, J. 1961. Social behaviour of the white-eye *Zosterops lateralis* in winter flocks. Ibis 103:428−442.

KIKKAWA, J. 1987. Social relations and fitness in silvereyes. Pages 253−266. In Animal societies: theories and facts (Y. Ito, J. L. Brown, and J. Kikkawa, Eds.). Japan Science Society Pres, Tokyo.

MARSHALL, J.T., JR. 1949. The endemic avifauna of Saipan, Tinian, Guam and Palau. Condor 51:200−221.

MATTHYSEN, R. 1993. Nonbreeding social organization in migratory and resident birds. Current Ornithology 11:93−141.

SAVIDGE, J.A. 1987. Extinction of an island forest avifauna by an introduced snake. Ecology 68:660−668.

SLIKAS, B, I.B. JONES, S.R. DERRICKSON and R.C. FLEISCHER. 2000. Phylogenetic relationships of Micronesian white-eyes based on mitochondrial sequence data. Auk 117:355−365.