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DESCRIPTION OF ADULTS, EGGSHELLS, NESTLING, FLEDGLING, AND NEST OF THE POO-ULI

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ABSTRACT.—The Poo-uli (*Melamprosops phaeosoma*), a Hawaiian honeycreeper discovered on the island of Maui in 1973 and now near extinction, is represented in museums by only two specimens. Based on the first observations of a nesting pair and re-examination of the two specimens, we describe the adult male and female, eggshells, nestling, and fledgling Poo-uli. Poo-uli are sexually monochromatic but males are brighter. The male is brown above, whitish below, and has an extensive black mask bordered with gray on the crown and a distinct white auricular patch. The female differs in having a similar facial pattern not as sharply demarked and in having a grayish wash below. The observed fledgling resembled the adults but was paler brown above and whitish below and had a much smaller black mask and pale mandible. We tentatively assigned both museum specimens to first basic plumage because they resembled the adult female but retained some pale juvenal coloration in the mandible. We also determined from dissection that the holotype was an immature male; we could not determine sex of the paratype. The nest was an open cup of twigs and bryophytes with a thin lining of fern rootlets. The nest contained eggshell fragments with brown-gray speckling against a whitish background. The nests, eggshells, and nestlings resemble those of other Hawaiian honeycreepers. *Received 1 Dec. 1995, accepted 27 May 1996.*

The Poo-uli (*Melamprosops phaeosoma*), discovered on the island of Maui in 1973, is the most recent, and presumably last, described extant

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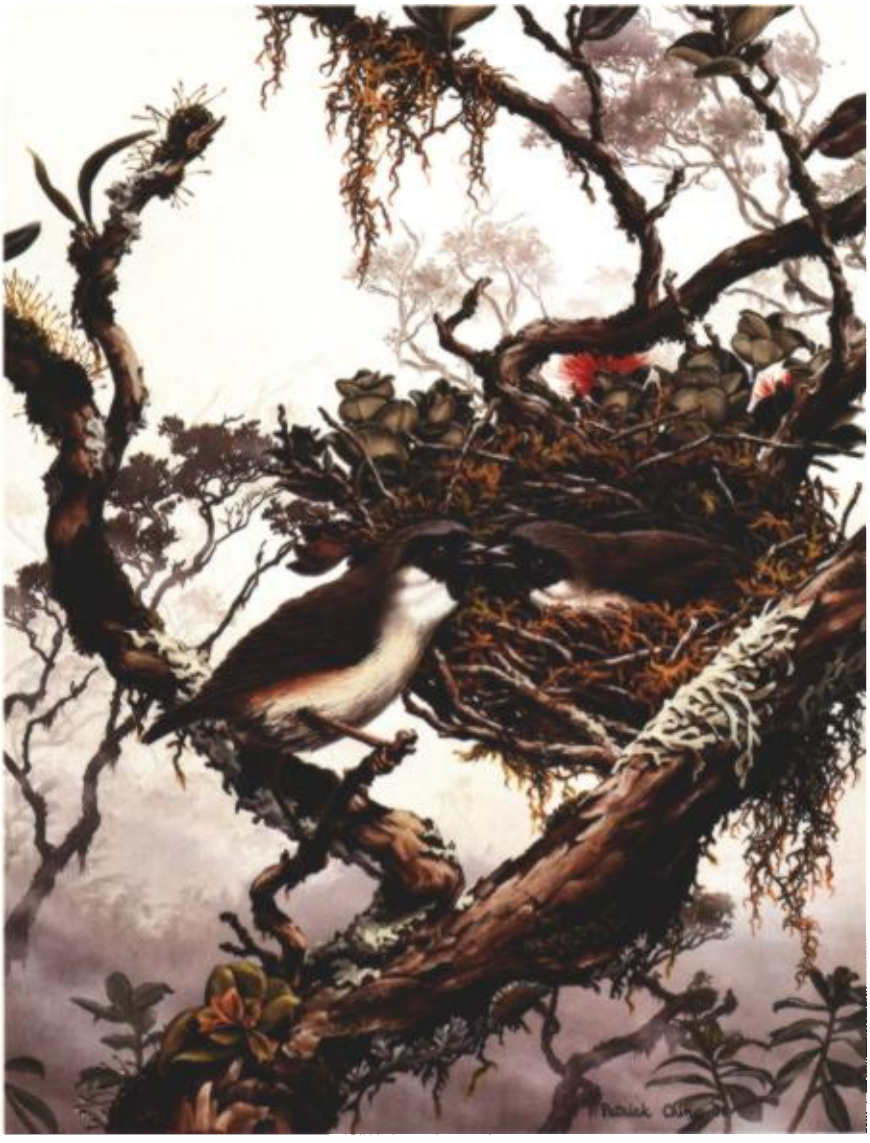

Frontispiece. The frontispiece painting by Patrick Ching has been made possible by an endowment established by George Miksch Sutton.

genus and species of Hawaiian bird (Casey and Jacobi 1974). Despite doubts about its systematic affinities (Pratt 1992), initial genetic comparisons (C. Tarr and R. Fleischer, pers. comm.) suggest placement of the Poo-uli within the Hawaiian honeycreepers (Fringillidae: Drepanidini). Several studies have investigated aspects of the morphology, life history, and conservation status of this endangered bird (Bock 1978, Baldwin and Casey 1983, Scott et al. 1986, Engilis 1990, Mountainspring et al. 1990, Kepler et al. 1996).

The original description of the Poo-uli was based on two specimens of unknown age, identified as "males (?);" no others have been collected. Subsequent field research has not investigated age and sex differences in plumage and soft parts. No nests had been found until recently. In 1986, Kepler et al. (1996) studied two sequential nesting attempts by a pair of Poo-uli in the Hanawi Natural Area Reserve, Maui. This provided an opportunity to describe the adults, nestlings, fledgling, and nests observed. We compare these descriptions with the two museum specimens, with other Hawaiian honeycreepers and, when appropriate, with cardueline finches, the group from which the Hawaiian honeycreepers are thought to have evolved (James and Olson 1991).

METHODS

Details on the study site and nesting events are given in Kepler et al. (1996), and a map of the study area is provided in Moutainspring et al. (1990) and of the nest site in Engilis (1990). Our descriptions of Poo-uli are based on (1) repeated field observations by Engilis and Kepler with color names quoted from written notes and (2) sketches by Engilis and artist Patrick Ching. We observed birds at the nests from distances of 40 m (nest #1) and 18 m (nest #2) through binoculars (Leitz 10×), spotting telescope (Bushnell Spacemaster 20–60×, nest #1) or Questar telescope (80×, nest #2) (Kepler et al. 1996). Though events at nest #2 were photographed, the pictures taken were only marginally useful for plumage description. Both nests were collected and measured on 16 June 1986, treated by Berlese extraction on 16–18 June, and deposited at Bernice P. Bishop Museum, Hawaii, with the catalog numbers of BPBM 162151 for nest #1 and its eggshell fragments and BPBM 162152 for nest #2. We examined the nests and holotype specimen (BBM-X-147112) at Bishop Museum; M. LeCroy examined the paratype (AMNH 810456) at The American Museum of Natural History (AMNH), New York. We also examined two enlarged black-and-white photographs comparing both specimens soon after preparation and held by the AMNH Bird Dept. Library. The photographs lacked identifying numbers.

RESULTS

Adult Male

Of the two adults tending the nest, we assume that the brighter-colored bird was the male parent because it sang and courted the drab bird, fed the drab bird and chicks, but did not incubate or brood. Also, for all other

Hawaiian honeycreepers, male plumage is either brighter than or similar to female plumage (Freed et al. 1987).

Face.—Face with a distinctive black mask. Mask triangular, crisply bordered, extending from the forehead and chin, around the eye, to a point beyond the eye and bounded above by a gray crown and below by a white auricular patch.

Upperparts.—Crown behind mask gray, merging on the nape to dark brown. Back dark brown. Scapulars and wing coverts dark rufous brown. Primaries and secondaries dark brown with blackish shafts, outer margin of primaries buff. Rump and upper tail coverts rufous-brown. Tail dark brown edged rufous, so short as to be mostly hidden by the folded wings, not tapered, notched, the feathers lax and pointed.

Underparts.—Auricular patch distinct, creamy white continuing onto the throat, bordered by gray of the upper flanks. Chin black. Throat white. Breast white, washed with light gray. Belly white, merging with deep cinnamon undertail coverts. Flanks, forward white washed with gray, posteriorly becoming more grayish tinged buff, then cinnamon. Leg feathering cinnamon. Undersides of the primaries silver-gray.

Bill glossy black, appearing bluish at a distance. Iris medium brown. Legs and feet dark pink-brown; foot pads yellowish.

Adult Female

We assume that the drab bird at the nest was the female, because she incubated and brooded but did not sing. She was similar to but duller than the male, differing as follows. Black mask smaller, more grayish. Pale auricular patch suffused with gray and less sharply bounded. Throat white suffused with gray, but breast and sides to anterior belly gray. Flanks more washed with gray, becoming golden cinnamon where they met the primaries. Leg feathering gray. Undertail coverts buff-gray with darker tips. Bill, iris and legs same as the male. Gape black, anterior roof of palate pink. Neither adult showed signs of pox lesions or scars.

Nestlings

Three nestlings were observed, one in nest #1, two in nest #2. We saw nestlings best on 20–22 May at nest #2 when the oldest chick was ca 10–12 days old. Only their heads could be seen, covered with medium gray natal down; we could not see a black mask. The head of the smaller (younger?) chick, when first seen on 21 May, appeared "mottled" black and gray. For both chicks, the iris was blackish and the bill light gray with bright yellow rim and red spot at the corner of the gape; inside the mouth was reddish pink. On 29 May at ca 19 days-old and 2 days prior

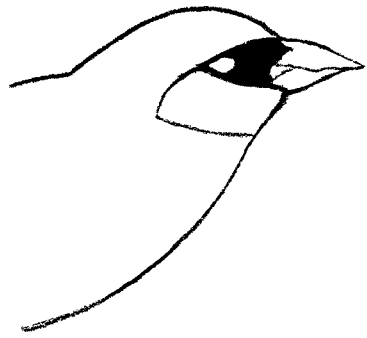

FIG. 1. Detail of Poo-uli chick on 29 May, ca 19 days of age and two days prior to fledging. Note small mask. Tracing from field sketch by A. Engilis, Jr.

to fledging, bill with maxilla slate-gray and mandible underside whitish-cream. Tongue pink.

Fledgling

Of the three chicks observed, one fledged. The fledgling resembled the adults, but its mask was smaller and body plumage paler brown, with less rufous and cinnamon. The small mask was bounded by the dorsal ridge of the bill, distal corner of the eye, and the bill just below the gape, and did not extend onto the chin (Fig. 1). The whitish auricular patch merged ventrally with the darker throat, rather than being sharply outlined. (This description was corroborated on 30 August 1994, when a juvenile Poo-uli being fed by its parents was observed to have a mask "less distinct than the adults, perhaps more gray in color" M. Reynolds and T. Snetsinger, pers. comm.).

Upperparts.—Crown and nape gray-brown, merging with brown back. Back, scapulars, wing coverts medium brown tinged with buff. Rump brown with cinnamon edging, wings and tail dark brown without rufous edging. We did not record obvious wing bars (paler tips of median or greater wing coverts or both), but these could have been indistinct and not noticed or absent altogether.

Underparts.—Inter-ramal space black, chin whitish buff, with some black feathering disconnected to the mask. Throat dingy white. Upper breast gray washed with beige. Belly beige. Vent white. Under-tail coverts cinnamon. Flanks like back, distally becoming cinnamon.

Bill.—Maxilla slate gray, with pale tip. Mandible whitish, with dark edge where the ramphotheca meets the skin. Iris blackish. Gape flange smaller than nestlings', bright yellow, with red spot distally at the corner.

Inside of mouth reddish, with black patch on the roof of the mouth. Legs and feet similar to adults.

Comparison of Observed Birds with Museum Specimens

The holotype and paratype were virtually identical in appearance. Casey and Jacobi (1974) described the paratype as differing from the holotype in (1) its slightly smaller size, (2) somewhat larger mask "slightly mixed and stippled with buff, especially on chin," (3) "upperparts throughout, including crown, duller grayish brown," with less cinnamon, and (4) mandible tipped "only slightly lighter in color, washed with gray rather than shell pink." Photos of the fresh specimens, held by AMNH (one published in Casey and Jacobi 1974), show the paratype's mandible tip as faintly pale and leg color as darker than that of the holotype. LeCroy (pers. comm.) found that the stippling in the mask was caused by pale feathers intermixed with dark ones and that the mandible is now dark throughout.

The adults and fledgling we observed resembled in most respects both the holotype and paratype. In both male and female, the bill was dark throughout in comparison with the pale-tipped mandible of both specimens. The adult male differed most, in its facial pattern of greater contrast and underparts paler, as described above. The adult female differed from the specimens perhaps in having the wings and tail with more cinnamon wash than the paratype (but not the holotype?). The fledgling differed from the specimens in its smaller mask, pale buffy breast, and slate-gray mandible, which in the two specimens was dark with a pale tip. Examination of the two specimens for molt revealed that (1) the holotype either was just completing body molt, with a few new feathers growing on the crown and mask, or was not molting and instead was replacing feathers lost through wear and (2) the paratype showed no evidence of molt and appeared to be in fresh plumage. For the holotype, the distal-most greater wing covert feather on the right wing was buff rather than brown. Flight and tail feathers on both specimens showed little wear.

We add here to the description of the Poo-uli specimens (Casey and Jacobi 1974). We attempted with difficulty to determine the number of flight feathers. There appeared to be nine primaries and nine secondaries for both specimens, and a total of 12 rectrices for the holotype, as in other Hawaiian honeycreepers. We examined flight and tail feathers of both the holotype and paratype for evidence of feather lice, which occasionally are found on other drepanidines, but saw none. Some of the black feathers in the mask of the holotype had brownish centers; the paratype was not examined for this character. The holotype weighed 25.5 g (T. Casey, pers. comm.).

We examined the previously dissected, pickled carcasses of the two specimens. We discovered that the holotype was an immature male by presence of the right testis measuring <1 mm, together with the epididymis leading posteriorly. Sex of the paratype could not be determined by inspection.

Nests

Both nests were open cups and built among the stems of leaf-bearing ohia-lehua (*Metrosideros polymorpha* Gaud.) branchlets (Frontispiece). Distance from the nest base (minus nest tail) to the juncture of the supporting stems measured 60 and 70 mm for nests #1 and #2, respectively. Leafy portions of the stems framed the nests on at least one side and covered the cup of the nests; however, the height and extent of leafy cover was not measured, and cover was cut away from the nests upon collection. For both nests, the branch which joined the supporting stems measured 14.5 mm in diameter below the juncture. Supporting stems incorporated into the frame of the nests were <10 mm diameter and numbered 7 and 6 for nests #1 and #2, respectively.

Dimensions (mm) upon collection for nests #1 and #2 were: (1) outer diameter, 180 by 130 and 180 by 140; (2) outer depth 90 and 110; (3) inner diameter, 70 by 60 and 85 by 60; and (4) inner depth 50 and 40. The body of both nests was constructed of bare twigs of pukiawe (*Styphelia tameameae* [Cham. & Schlechtend.] F. v. Muell.) with coarse mosses filling the spaces between the twigs. Mosses identified from both nests were *Homaliodendron flabellatum* (Sm.) Fleisch., *Thuidium plicatum* Mitt., *Trachypodopsis auriculata* (Mitt.) Fleisch., with nest #1 containing *Aerobryopsis wallicia* (Dozy & Molk.) Fleisch. and nest #2 *Floribundaria floribunda* (Dozy & Molk.) Fleisch. Leaves and stems of graminoids and dicots accounted for <5% of this filling. For the inner 15 mm of nest wall, fern rootlets <1 mm thick replaced pukiawe twigs as the structural frame, with the amount of moss decreasing toward the interior. To the internal surface of this lining was added graminoid fiber, perhaps *Uncinia uncinata* (L. Fil.) Kukenth., 1 mm in thickness. The resulting lining was an open network of fiber. For nest #1, which had been abandoned by the parents three months prior to collection, mosses of the nest body had expanded into the cup, and there were fewer fern rootlets and graminoid fibers. Whether the lack of rootlets and fiber in the first nest is due to differences in original construction, or removal of those materials by the parents or by other birds, is not known. Neither nest contained deposits of fecal matter, supporting the observation that parents removed all feces (Kepler et al. 1996). The nests did not smell of "drepanidine odor" (Pratt 1992) upon collection nor when examined nine years later.

Nest #1 contained eggshell fragments, the largest of which was 9 by 7 mm and, judging from its curvature, may have been from the blunt end of the egg. Though the fragments appeared weathered, they still showed fine, dense, brown-gray speckling against a whitish background.

While the Berlese extraction yielded large numbers of arthropods, no ectoparasitic insects turned up (S. Swift, pers. comm.). Seven diptera larvae and one adult were extracted from nest #1. Most of the mites associated with the nest remain unidentified.

DISCUSSION

Plumage.—Can the age and sex of the two museum specimens now be determined? Given differences in plumage and soft-part colors observed among the sexes and fledgling at the nests, we believe that both the holotype and paratype were hatch-year birds in first basic (post-juvenal) plumage. Dissection confirmed that the holotype was an immature male. Both specimens match most closely the putative adult female, with black mask larger and breast grayer than the fledgling. Both specimens differ from the adults observed at the nest, but resembles the fledgling, in having the mandible not all dark. Both specimens least resemble the putative adult male. We think it very unlikely that either could have been an adult male, especially because adult male drepanidines show little variation within species (Jeffrey et al. 1993, Pratt et al. 1994).

Color of the mandible is important in our determination of the age of the specimens. Unfortunately, the mandible color of the paratype now does not match that in the description and photos of Casey and Jacobi (1974). They described the mandible of the freshly collected paratype as dark with the tip "only slightly lighter in color." The mandible is now dark throughout. The photos show the original description to be correct and that the change occurred post mortem. The slightly darker legs of the paratype in comparison with the holotype evident in Casey and Jacobi (1974: fig. 1) may indicate darkening of the leg color post fledging. However, leg color in life or shortly after death was not noted as different between the two specimens (Casey and Jacobi 1974), and may have either been overlooked, or changed post mortem, or be an artifact of photography. Legs and feet of the observed fledgling were recorded as being similar to those of the adults. This issue can be resolved by future field work.

The specimens fit a presumed plumage sequence for Poo-uli as follows. During the first prebasic molt, juvenal plumage in either sex gives way within a few months of fledging to a female-like first basic plumage, as in many drepanidines. Meanwhile, the mandible color changes from pale to black, with the last vestige of juvenal coloration being the pale tip,

which ultimately darkens. Other drepanidines show a similar change in bill color from light to dark, e.g., Palila (*Loxioides bailleui*; Jeffrey et al. 1993) and Akiapolaau (*Hemignathus munroi*; Pratt et al. 1994). Thus, both specimens show a larger mask than the observed fledgling but apparently still retained the pale-tipped mandible in life. The holotype shows other, less certain signs of first prebasic plumage: a few facial feathers in sheath indicating last stage of molt and a pale brown feather in the greater wing coverts possibly retained from juvenal plumage, as with other drepanidines (Fancy et al. 1993; Jeffrey et al. 1993; Pratt et al. 1994; Lindsey, unpubl. data). For the paratype, the mask shows some pale, perhaps old juvenal, feathers. First prebasic molt is likely to occur in the summer and fall, following breeding, as with other well-studied drepanidines (Jeffrey et al. 1993, Ralph and Fancy 1994). Evidence for seasonality in molt for Poo-uli is lacking. However, the two nests we observed would have or did fledge young in April and June. We add here the above-mentioned observation by M. Reynolds and T. Snetsinger (pers. comm.) of a Poo-uli juvenile on 30 August 1994. The holotype and paratype could have completed prebasic molt prior to being collected in September 1973.

Freed et al. (1987) tentatively characterized sexual chromatism for Poo-uli as monochromatic. We can now modify that to monochromatic with males brighter. In most drepanidines in which the plumage is monochromatic or monochromatic with males brighter, female and first basic plumages approach the bright adult male plumage, whereas juvenal plumages remain distinctly cryptic. Further, in many monochromatic species with males brighter, females show variability, with some females more similar to males than others, e.g., Palila (Jeffrey et al. 1993) and Maui Alauahio (*Paroreomyza montana*; H. and P. Baker, pers. comm.). While Poo-uli are arguably cryptically colored, their most distinctive plumage feature—the black mask with black bill in the center, highlighted behind by the gray crown and white auricular patch—may be a strong intra- and interspecific optical signal (*sensu* Hailman 1977). Viewed head on, Poo-uli provide a striking, unmistakable, and unforgettable image (Fig. 2).

Many drepanidines show a dark loral patch. This patch may have evolved to form an extensive mask in the Poo-uli. Two other, allopatric drepanidines, the Akekee (*Loxops caeruleirostris*) and Hawaii Creeper (*Oreomystis mana*) have independently evolved smaller masks. In all drepanidines with dark lores, including Poo-uli, juveniles show either gray or whitish lores, affirming the importance of dark lores as an adult social signal. Thus, we argue that the mask of the Poo-uli is not a radical departure from the many drepanidine plumage patterns, but instead is noteworthy mainly in degree. If the mask is indeed a strong optical signal, then compared with other monochromatic drepanidines with brighter male

FIG. 2. Poo-uli in first basic or adult female plumage showing bold black mask. Photograph by A. Engilis, Jr.

plumage, Poo-uli also show a convergence of female and first basic plumages with bright male plumage. The difference from other drepanidines is the expression of this character, albeit smaller and grayer, in juvenal plumage as well. Besides the black mask, a likely optical signal and important, ubiquitous field-mark is the cinnamon rump seen as the bird flies away. We encourage other field observers to determine the extent of variation in adult, juvenal, and first basic plumages.

While questioning the systematic position of the Poo-uli, Pratt (1992) claimed "The colors and pattern of the Poo-uli are unlike that of any previously known Hawaiian honeycreeper," and "Thus, plumage color and pattern provide no basis for inclusion of *Melamprosops phaeosoma* among the Drepanidinae." His mis-statement that adult coloration of Poo-uli was gray and white was based on verbal pers. comm. from one of us that we did not have an opportunity to catch in review. Above, we interpret the Poo-uli's black mask as homologous with the black lores or mask of other drepanidines. Brown coloration in immature or adult plumages is shared by five other historical Hawaiian honeycreepers (Akepa, *Loxops coccineus*; Apapane, *Himatione sanguinea*; Greater Koa-Finch, *Rhoda-*

canthis palmeri; Kakawahie, *Paroreomyza flammea*; Ula-ai-hawane, *Ciridops anna*).

Why are Poo-uli brown, an unusual color for a Hawaiian honeycreeper? Mountainspring et al. (1990) document substrate-restricted foraging by Poo-uli on branches where they glean or forcibly excavate invertebrates from bark, lichens, and moss mats. Mountainspring et al. (1990) speculated that Poo-uli also foraged on the ground, partly suggested "by the bird's drab color and stout pedal morphology." They went on to compare Poo-uli coloration with that of ground-foraging antbirds. Poo-uli have seldom been seen at ground level (Mountainspring et al. 1990), but this could result from the difficulty of potentially observing such behavior in the dense understory that prevails in its range. Nevertheless, comparison with other branch-foraging specialists is also appropriate. Passerines specialized for taking insects from bark or epiphytes include members of the Furnariidae and Troglodytidae in Costa Rica (Sillett 1994), Certhiidae in North American alder rainforests (Stiles 1978), and Paradisaeini (Corvidae) in New Guinea (Pratt and Stiles 1985). All share brown plumage (except adult male and some female birds of paradise) and stout pedal morphology. Thus, brown plumage of Poo-uli may have evolved independently as cryptic coloration associated with foraging for invertebrates on branches.

Eggshells and nestlings.—In background color and spotting color and pattern, the Poo-uli eggshells resembled eggs of other drepanidines, e.g., Common Amakihi (*Hemignathus virens*) and Palila. The Poo-uli eggshells, together with eggs of most drepanidines, differ in color from eggs of most cardueline finches in having the background whitish rather than tinged with blue or green (Newton 1972). The Poo-uli nestlings share gray down on the head and a pinkish-red gape with nestlings of nine other drepanidines: Akikiki (*Oreomystis bairdi*), Anianiau (*Hemignathus parvus*), Apapane, Crested Honeycreeper (*Palmeria dolei*), Common Amakihi, Kauai Amakihi (*Hemignathus stejnegeri*), Iiwi (*Vestiaria coccinea*), Maui Alauahio, and Palila (Eddinger 1970; Berger 1981; van Riper 1987; H. and P. Baker, F. Duvall, Jr., pers. comm.; T. Pratt, pers. obs.). The yellow gape flange of Poo-uli chicks matched the flanges of these species, which vary from yellow to cream. However, the red spot in the corner of the gape flange and the dark area observed on the Poo-uli nestling's palate (which may have been due to shading and therefore possibly irrelevant) have not been mentioned for the other species.

Nests.—The Poo-uli nests we collected are similar to open cup nests of other drepanidine and cardueline species. In gross stucture and placement, the two Poo-uli nests resembled nests we have collected and examined of such widely divergent Hawaiian honeycreepers as Apapane,

Common Amakihi, Crested Honeycreeper, Iiwi, Maui Alauahio, and Maui Parrotbill (*Pseudonestor xanthophrys*) in the same habitat on Maui and for the honeycreeper nests studied on Kauai by Eddinger (1970). The Poo-uli nests differed from those of other honeycreepers primarily in the species of plant materials and in size. However, the materials were of plant species common near the nest site, and the nests seemed to fit well within the size gradient of drepanidine nests relative to bird body size. In their loose structure and moss matrix, the Poo-uli nests most closely resembled nests of the slightly larger Crested Honeycreeper. The Poo-uli nests differed most from the smaller Maui Alauahio nests in being less finely and compactly woven and in building materials. Consistent composition between the two Poo-uli nests and their unique component plant materials may be the result of their being built in the same locality by the same pair of birds. A larger sample of nests would probably reveal variability in Poo-uli nest construction and placement. The Poo-uli nests resemble the description of the "commonest type" of nest for cardueline finches in Europe (Newton 1972:175). This type was described as "rather bulky and made of various flexible materials, often with a base of twigs and bents, a main structure of grass and moss, and a lining of hairs and rootlets." The Poo-uli nests differ from this description in their near absence of graminoid leaves and hair, materials rare in the bird's habitat.

Implications for conservation.—We draw attention to the following new aspects of Poo-uli natural history that bear on its conservation. Information on age and sex differences in plumage characters will help investigation of the species' demography. However, because our conclusions are based on very few individuals, other field workers should attempt to further explore variability in characters used for ageing and sexing Poo-uli.

We note the low wing/tarsus ratio of 2.74 and 2.88 and short tail of 38.0 and 36.5 mm, for the holotype and paratype, respectively (measurements from Casey and Jacobi 1974). This ratio and tail length are the smallest for the ten historic honeycreeper species from Maui (from measurements in Amadon 1950). The low wing/tarsus ratio, the short rounded wings, and extremely short tail of the Poo-uli may be clues to its mobility. Poo-uli are capable of short flights only and may be confined to home ranges smaller than those of most Hawaiian honeycreepers.

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