

Rediscovery of *Blackburnia anomala* (Coleoptera: Carabidae), in East Maui, Hawai'i, after a 107-Year Hiatus¹

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Abstract: The highly distinctive and diverse native Hawaiian carabid beetle fauna includes a suite of species not recently observed in nature. These are predominantly historical residents of the mesic *Acacia koa* forest formation. We report rediscovery of one of these species, *Blackburnia anomala* (Blackburn), in the shrubland formation near Palikū Cabin, and in *koa* forest of Kaupō Gap. Prior records of *B. anomala* are limited to the leeward edges of historical *koa* forest near Olinda, on the northwestern slope of Haleakalā. Rediscovery on the far southeastern side of Haleakalā Crater in similar, though conserved, habitats suggests that other long-missing *koa* associates may persist in similar situations on Haleakalā.

THE HAWAIIAN ISLANDS support two speciose radiations within the predaceous beetle family Carabidae. These are classified as species of the genera *Blackburnia* Sharp and *Mecyclothorax* Sharp. The endemic genus *Blackburnia* comprises 131 known species (Liebherr and Zimmerman 2000, Liebherr 2001, 2003), of which 97% are restricted to single islands. Even on the two-volcano island of Maui, only 4 of 47 resident Maui *Blackburnia* are shared between Haleakalā and the West Maui Mountains. The Hawaiian Archipelago has been shown to be a crucial region for preservation of endangered plants, birds, and mollusks (Dobson et al. 1997), and the endemic nature of insect groups such as *Blackburnia* points out that Hawaiian insect distributions warrant a similar conservation effort across the full diversity of insect taxa as modern syntheses of taxonomic information

become available (e.g., Gressitt 1978, Otte 1994, Polhemus and Asquith 1996, Gagné 1997).

As part of a long-term sampling program to document insect diversity and distributions across the complex topography of Maui, we surveyed localities in the eastern reaches of Haleakalā Crater, near Palikū Cabin and along the eastern flanks of Kaupō Gap, during 2001. We report the rediscovery of *Blackburnia anomala* (Blackburn) from these areas. *Blackburnia anomala* was previously collected in 1878 by the Reverend Thomas Blackburn and in 1894 by Dr. R. C. L. Perkins. Blackburn (1878) described the species based on two specimens from "about 5000 ft." on Haleakalā, collected in the vicinity of Olinda. On 31 March 1894, Perkins (1894:10) wrote "I ... went down to Olinda. ... Here were Koa trees of huge size, but all dead, from which no doubt Blackburn had collected ... outside the forest under a dead Koa limb a *Disenochus* different from former specimens [*D. anomalus* probably]." Perkins' total experience with *B. anomala* was based only on observations made on these specimens. No specimens of *B. anomala* have been found since. The area surrounding the type locality was extensively degraded by nineteenth-century logging of *koa* (*Acacia koa* A. Gray) forest, cattle grazing, and associated invasive grasses (Cuddihy and Stone 1990). Invasive arthropods, such as Argentine ant, *Linepithema humile* (Mayr), have also colo-

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nized these disturbed leeward habitats on Maui. Argentine ant presence is associated with reduced populations of native arthropods, in particular carabid beetles (Loope et al. 1986, Cole et al. 1992). Rediscovery of *B. anomala* far across Haleakalā Crater opens the possibility that populations of other long-missing East Maui *koa* associates may persist in the relatively less-disturbed *koa* forests of Haleakalā National Park.

MATERIALS AND METHODS

During May 2001, we surveyed the insect fauna of eastern Haleakalā Crater, collecting near Palikū Cabin (approximately 1950 m elevation) and along the eastern edge of Kaupō Gap at various elevations from 1735 to 1100 m. A variety of collecting techniques was employed, including (1) beating vegetation for approximately 1 hr after sundown; (2) beating vegetation during daytime, associating specimens with various host plants; (3) sifting leaf litter from under trees, either in open savanna vegetation or in closed-canopy forest, and extracting the insects from the siftate by hand; (4) skirting trees with sheets and applying synthetic pyrethrin insecticide to the trunk, driving out insects hiding by day in the bark chinks and epiphytic moss mats.

Specimens have been deposited in the National Museum of Natural History, Smithsonian Institution (NMNH) or the Cornell University Insect Collection (CUIC).

Date-locality information for over 25,000 specimens of Hawaiian *Blackburnia* was summarized as part of a taxonomic revision (Liebherr 2000, Liebherr and Zimmerman 2000). More recently, similar information has been tabulated electronically for 11,000 identified specimens composing taxonomic material for an ongoing revision of the Hawaiian *Mecyclothorax* (J.K.L., unpubl. data). *Mecyclothorax* identifications were confirmed by J.K.L. using type specimens deposited in The Natural History Museum, London, and the B. P. Bishop Museum, Honolulu. Perkins' lot numbers (Anonymous n.d.) were inked onto the bottom of many specimen-mounting cards during initial specimen preparation (Liebherr and Polhemus 1997), permitting

reassociation of *Blackburnia* and *Mecyclothorax* specimens bearing the same lot numbers. Explanations regarding the circumstances of collections were gleaned from Anonymous (n.d.), Blackburn and Sharp (1885), Perkins (1894), and Sharp (1903).

RESULTS AND DISCUSSION

Three specimens of *Blackburnia anomala* were collected in 2001 (Figure 1), each via different means: (1) west of Palikū Cabin, 16 May 2001, 1950 m el., beating *Vaccinium reticulatum* Sm. after dark, D. A. Polhemus (1 ♂, NMNH); (2) Kaupō Gap trail, 18 May 2001, 1495 m el., beating *Diplazium sandwichianum* (K. Prezl) ferns during day, C. P. Ewing (1 ♂, CUIC); (3) Kaupō Gap trail, 17–18 May 2001, 1495 m el., sifting leaf and fern litter under *koa*, J. K. Liebherr (1 ♀, carcass of pterothorax, right meta-leg, elytra, and abdomen, CUIC). GPS coordinates for these sites are, for the first site, 20° 43.27' N, 156° 08.63' W; for the second site, 20° 41.80' N, 156° 08.37' W. Specimens were identified using Liebherr and Zimmerman (2000), with specific identity based on the external anatomical characters confirmed by dissecting the genitalia of the Palikū male (NMNH), and examining the gonocoxae of the female carcass. The male aedeagus conforms to that of an *Olinda* specimen (Liebherr and Zimmerman 2000, fig. 107A), exhibiting an elongate apex, slightly downturned at the tip, a moderate ventral excavation, straight euventral surface basad the ventral excavation, and ovoid patch of darker microspicules on the eudextral surface of the aedeagal internal sac. The female gonocoxae exhibit the longer mesal setae in conjunction with very short, lateral setae on the basal gonocoxite (Liebherr and Zimmerman 2000, fig. 107C), a character state not seen in related species.

The two 2001 male specimens of *B. anomala* deviate from the previously known specimens by being slightly smaller. Standardized body lengths of the nineteenth-century Blackburn and Perkins specimens range from 8.3 to 9.0 mm (Liebherr and Zimmerman 2000). The 2001 Palikū Cabin male measures 7.4 mm, whereas the Kaupō Gap male is 7.5



FIGURE 1. Distributional records of *Blackburnia anomala*: nineteenth-century record (●), twenty-first-century records (■).

mm long. Standardized body length of the female specimen was estimated to be 8.6–8.7 mm by relative comparison with the elytral lengths of the two males. Because this latter figure falls within the range of nineteenth-century specimens, we expand the known body size of *B. anomala* to a range of 7.4–9.0 mm.

The presence of *B. anomala* on *Vaccinium* in the shrubland formation to the west of Palikū Cabin expands our knowledge of the ecological preference for this species, previously known only from R. C. L. Perkins' field notes (Table 1) (Perkins 1894). The drier shrubland habitat 0.5–1.0 km west of Palikū Cabin supports *pūkiawe*, *Styphelia tameiameia* (Cham. & Schlechtend.); *Dubautia menziesiana* (A. Gray); and *'aiakanēnē*, *Coprosma ernodeoides* A. Gray. *Coprosma montana* Hillebrand; *māmāne*, *Sophora chrysophylla* (Salisb.); and *'ōbelo*, *Vaccinium reticulatum*, are found in both the drier shrubland and the

more mesic habitats closer to Palikū Cabin. Mesic-adapted species occurring near the cabin also include *'ākala*, *Rubus hawaiiensis* A. Gray; *'ōbi'a lehua* trees, *Metrosideros polymorpha* Gaud.; *'ōlapa*, *Cheirodendron trigynum* Gaud.; and *'amau'u* fern, *Sadleria* sp. The Palikū male was found on a *Vaccinium* plant very near an isolated *'ōlapa* tree, indicating that the beetle was residing in the relatively more mesic shrubland habitat.

The male specimen from Kaupō Gap, 1435 m elevation, was also found in a situation differing from Perkins' previously recorded microhabitat. It too was found above the ground surface, here on *Diplazium sandwichianum* ferns during the day. The ferns formed thickets growing low to the ground, in small, moist, sheltered side gulches above the primary gulch adjacent to the east *pali* of Kaupō Gap.

Addition of these arboreal records for *B. anomala* brings its habitat preference into

TABLE 1

Species of *Blackburnia* Sharp Historically Resident in East Maui, But Not Observed in Nature since Surveys Reported in the *Fauna Hawaiiensis* (Sharp 1903)

Species	Years of Previous Collections	Previously Recorded Microhabitats ^a
<i>Blackburnia agonoides</i> (Sharp)	1894, 1896	Cavities in <i>koa</i> trunks or branches
<i>Blackburnia anomala</i> (Blackburn)	1878, 1894	Under dead <i>koa</i> limb outside forest
<i>Blackburnia haleakala</i> Liebherr & Zimmerman	1894, 1896	Under dead wood on ground
<i>Blackburnia lenta</i> (Sharp)	1894	Under stones above timberline
<i>Blackburnia octocellata</i> (Karsch)	1872, 1878, 1894, 1896, 1902	Under exfoliating <i>koa</i> bark
<i>Blackburnia sharpi</i> (Blackburn)	1872, 1878, 1894, 1896, 1902	Under stones, logs, or fallen tree fern trunks
<i>Blackburnia terebrata</i> (Blackburn)	1872, 1878, 1894, 1896	Under stones or logs outside <i>koa</i> forest

^a Summarized from Anonymous (n.d.), Blackburn and Sharp (1885), Perkins (1894), Sharp (1903), and Liebherr and Zimmerman (2000).

agreement with its two most closely related phylogenetic neighbors, *B. brevipes* (Sharp) of Molokai and *B. cephalotes* (Sharp) of West Maui, both represented by specimens collected in terrestrial leaf litter, in arboreal moss mats, and climbing on other vegetation. All three species are members of the “big-head carabid” clade, recognized since Sharp’s (1900, 1903) treatment of the group. The basally divergent clade within this group, the adelphotaxa *B. agilis* (Sharp) and *B. medeirosi* Liebherr of Haleakalā, is also characterized by the ability to climb vegetation. Thus we can surmise that the ancestor of the “big-head carabid” clade exhibited the inherent propensity to climb vegetation in addition to residing in terrestrial microhabitats. The remaining two members of the “big-head” clade, the sister species *B. lenta* and *B. terebrata* (Liebherr and Zimmerman 1998, 2000) that compose the adelphotaxon of the *B. anomala*–*B. brevipes*–*B. cephalotes* triplet, are also listed among the Haleakalā *Blackburnia* species not seen for more than 100 yr (Table 1). The extremely limited records for these species are from ground-surface habitats. If these species retained the ancestral “big-head” propensity to climb vegetation, one would predict that they would be found in similar arboreal situations, assuming the species are extant. As such, we suggest that future searches for the long-lost *B. lenta* and *B. terebrata* focus as much on searching arboreal situations in leeward shrubland habitats as on

surveying the ground surface through pitfall trapping or ground-level hand collecting.

Reassociation of species collected syntopically by Perkins on the northwestern slope of Haleakalā shows that *B. anomala* is part of a connected set of species absent from samples made after 1902. One of Perkins’ *B. anomala* specimens is labeled lot 413, “Haleakala, Maui. Disenochus ? under logs in forest... Cyclothorax under bark ... 5,000 ft. III '94 (Anonymous n.d.).” The “Disenochus” (sensu Sharp 1903) in this lot include only *B. anomala* and *B. sharpi*, both missing for the 100 yr preceding this report (Table 1). Two *Mecyclothorax* species, *M. macrops* (Sharp) and *M. molops* (Sharp), compose the “Cyclothorax under bark” of this lot. Both *Mecyclothorax* species were last collected in 1896. The single host record for this pair of *Mecyclothorax* species includes mention of *M. macrops* in Perkins’ lot 362, “Cyclothorax under *koa* bark (Anonymous n.d.).” *Blackburnia terebrata*, another species absent from twentieth-century collections (Table 1), was the only other species to accompany *M. macrops* in lot 362. Although Perkins’ specimens were not completely labeled as to lot (due to no fault of his own because many of the specimens were prepared and labeled at Cambridge University while he was in Hawai‘i collecting birds and insects [Manning 1986]), the existing web of connections among specimens of this suite of highly impacted species is incontrovertible.

The rediscovery of *B. anomala* on the far

side of Haleakalā Crater (Figure 1), in a patch of *koa* forest and shrubland vegetation currently isolated from the historical *koa* forests of the northwestern slope near Olinda, suggests that other species apparently lost from the Olinda *koa* forest habitats may also reside in similar forest habitats. Surveys for these species should be guided by phylogenetic interpretation of behavioral information surmised from past collection records. But, given our limited knowledge concerning the habits and distribution of these rarely encountered *koa*-associated species, we should not be surprised if we find one or more in previously unsuspected situations.

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