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A REMARKABLE NEW MICROPTEROUS *NYSIUS* SPECIES FROM THE AEOLIAN ZONE OF MAUNA KEA, HAWAI'I ISLAND (HEMIPTERA: HETEROPTERA: LYGAEIDAE)[1]

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Abstract. A new species of predator-scavenger, *Nysius wekiuicola,* is described from the summit of Mauna Kea, Hawai'i Island. This micropterous species appears to be dependent upon moribund and dead arthropods, especially those found in the aeolian ecosystem on the summit.

Since Usinger's 1942 monograph, several shorter papers on the orsilline lygaeids of Hawai'i have appeared; these were reviewed by Ashlock (1966). Recently, the most unusual species of the orsilline genus *Nysius* yet found was collected for the first time by F.G. Howarth, S.L. Montgomery and W.P. Mull on Pu'u Wēkiu, the summit cinder cone of Mauna Kea on the island of Hawai'i. Here lichens and mosses are the only conspicuous plants successfully growing. The only other potential food available is insects and organic debris blown up from lower elevations. The discovery of this remarkable insect was reported at the March 1980 meeting of the Hawaiian Entomological Society (Howarth 1983). Further information on the ecology of the insect was provided by Howarth & Montgomery (1980). This insect has gained international attention, e.g., Anon. (1981).

In 1980, the common name "Wēkiu bug" [wēkiu is a Hawaiian word meaning "tip, top, topmost, summit" (Pukui & Elbert 1971)] was given to this unusual insect by M.E. and W.P. Mull of Hawai'i Island. The Mulls have become especially interested in the biota of the summit of Mauna Kea and the conservation of its recently discovered and unique aeolian ecosystem. M.E. Mull (1980) has provided some recommendations to conserve what remains of the undisturbed habitat of the Wēkiu bug and other arthropods found there in view of planned expansion of astronomy facilities on the summit. Conventional wisdom, even among some of the scientific community, is that "it's [Mauna Kea's] summit is a lifeless, red-black jumble of lava blocks and clinkers . . ." (Waldrop 1981). With this paper we wish to again demonstrate (see Gagné & Howarth 1982) that this impression is mistaken and hope that the existence of life adapted to extreme terrestrial environments, such as Mauna Kea's summit, will not again be so easily dismissed.

All body measurements that follow are in millimetres.

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Nysius wekiuicola Ashlock & Gagné, **new species** Fig. 1

Head, length 0.78, width 0.75, slightly elevated between eyes, lightly rugose, clothed with appressed white hairs, hairs erect on apex of clypeus, anteocular length 0.40, nearly 2× length of eye, eye 0.22, interocular space 0.47; buccula low, gradually tapering without abrupt change in width to base of head; labium just attaining apex of hind coxae, 1st segment nearly reaching base of head, segment lengths from base 0.52, 0.52, 0.40, 0.35; antenna long and slender with basal and apical segments only slightly thicker than segments II and III, segments I, II, and III with white semierect hairs slightly longer than diameter of segment, segment IV densely covered with semiappressed hairs, with occasional longer semi-erect hairs, segment lengths from base 0.42, 0.80, 0.60, 1.17. *Pronotum* densely clothed with white, mostly appressed pubescence; disc sparsely punctate, punctures large, separated by more than diameter of a puncture except behind callosities, where punctures nearly contiguous; sides slightly constricted just behind middle; length 0.55, width 0.83. Scutellum with appressed white hairs except at midline; with an obscure Y-shaped carina; length 0.35, width 0.55. *Hemelytron* micropterous, scarcely attaining abdomen; clavus distinct from corium, both dull, impunctate, and with appressed and semiappressed white hairs, costal margin with a few semi-erect hairs, lateral margin of corium straight, curving in at base and apex, clavi not touching, without claval commissure, veins of corium and clavus not evident; length corium 0.63, membrane basal length to level of apices of coria 0.13, apical length from corial apices 0.06; hind wing a mere flap, shorter than clavus. *Color.* Head black, with pale reddish-brown median bar from base of head to just short of anterior eye margin; buccula black, with pale edge nearly to base; pronotum black, with narrow anterior margin and posterior lobe dark brown; scutellum black; hemelytron dark grayish brown; abdomen black with lateral margin pale. Prosternum anteriorly, all acetabulae, and scent gland pale yellowish white. Appendages black.

Measurements. Holotype ♂, length 3.5. ♂: length 3.4–4.0, width 1.0–1.3. ♀: length 3.7–4.9, width 1.6–1.8.

Types. Holotype ♂ (BPBM 12,729), HAWAI'I: Mauna Kea, summit cone Pu'u Wēkiu, 13,790 ft [4200 m], 2.IX.1979, under stones (F.G. Howarth). Paratypes: 4♂,5♀, same data as holotype; 3♂,2♀, same data except (S.L. Montgomery); 2♂,2♀, 1N, same data except Mauna Kea, Pohakuloa, 13,800 ft [4203 m], IX.1979 (S.L. Montgomery); 12♂,6♀, same data except summit, 27.IX.1979 (S.L. Montgomery); many adults and nymphs, same data except N slope Science Reserve (Pu'u Wēkiu), 3900–4100 m, 12.VII–11.VIII.1982, pitfall traps (F.G. Howarth & P.C. Banko); many adults and nymphs, Pu'u Wēkiu, 4130–4170 m, 12.VII–10.VIII.1982, pitfall traps (F.G. Howarth, D. Bishop & F.D. Stone).

MODIFICATION OF USINGER'S (1942: 85) KEY AT COUPLET 5′

Micropterous, with hemelytra exposing all abdominal segments; all appendages unusually long and thin, antennal segment IV much longer than width of head including eyes ... (Hawai'i I, summit of Mauna Kea) ..... **Nysius wekiuicola, n. sp.**

Macropterous, not exposing any abdominal segments dorsally; appendages normal, not especially long and thin; antennal segment IV not longer than width of head including eyes 5

DISCUSSION

Finding the closest relative of so peculiar and highly derived an insect as *Nysius wekiuicola* presents a problem. Comparison of external features is useless. The spermatheca, removed as it is from immediate environmental adaptations, is a more

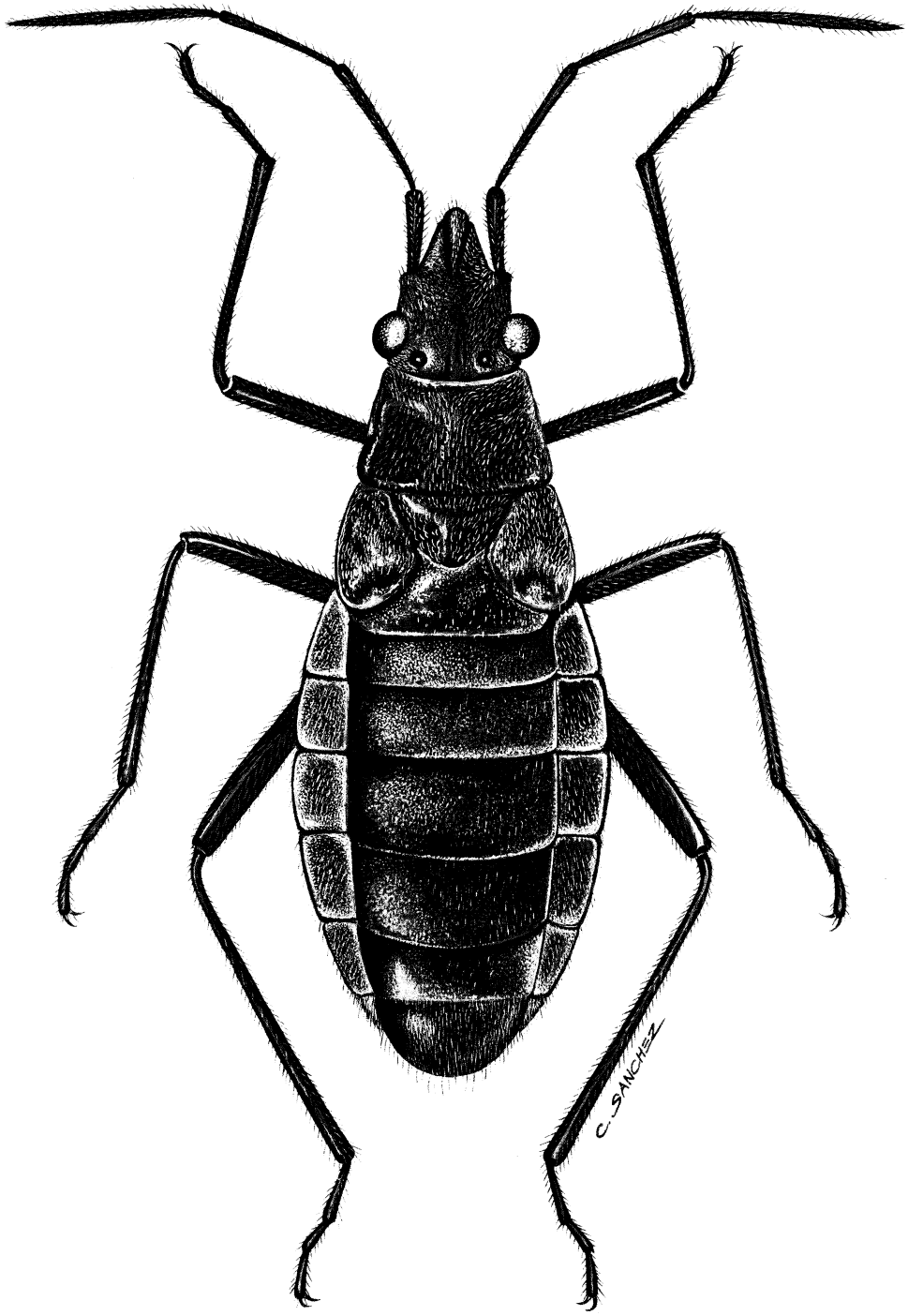

FIG. 1. *Nysius wekiuicola.*

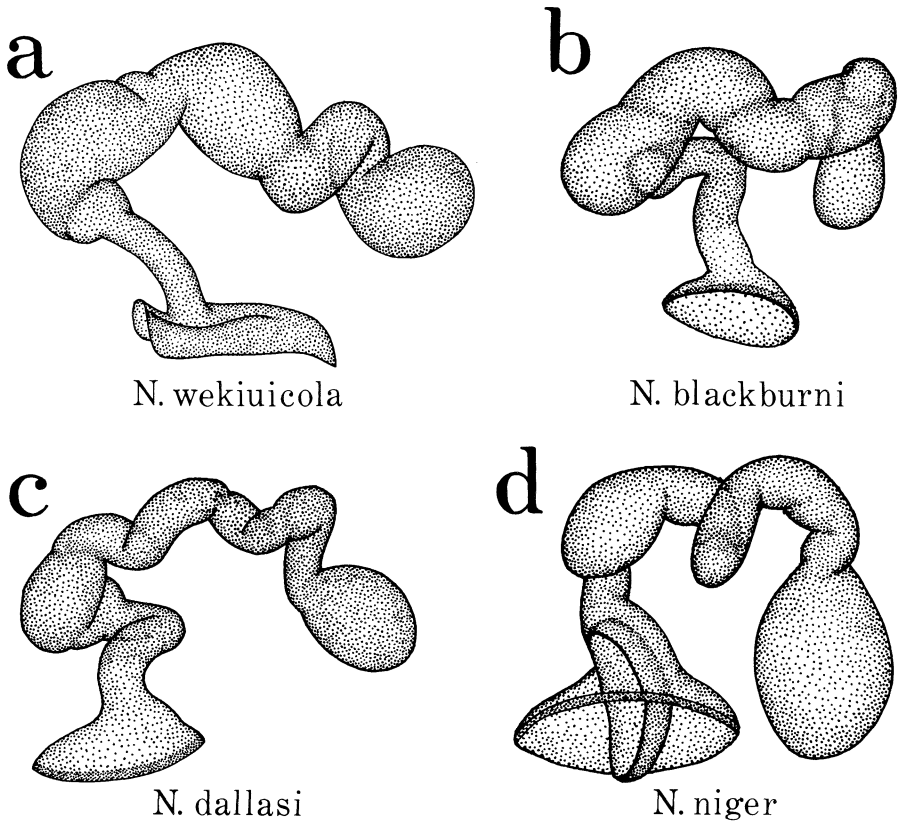

FIG. 2. Spermathecae of the named species of *Nysius*: **a–c,** Hawaiian; **d,** North American.

suitable character to use. One of us (PDA) has investigated (unpubl.) most of the spermathecae of Hawaiian species of *Nysius,* as well as those of many species from outside the islands, and found that the Hawaiian members of the genus lack an invagination of the basal part common in extra-Hawaiian members of the genus (for example, Fig. 2d, *Nysius niger* Baker, a widespread North American species). It would seem, Usinger (1942: 162) notwithstanding, that Hawaiian members of the genus are a monophyletic unit, representing a single introduction into the archipelago (*Nysius caledoneae* Distant is a recent introduction from commerce). Thus, the closest relative of *N. wekiuicola* should be found within the Hawaiian fauna.

A typical Hawaiian *Nysius* spermatheca, such as that of *N. dallasi* B. White (Fig. 2c), consists of a broad base with a relatively thin stalk. Beyond the stalk is a more or less coiled region that is relatively robust basally but that typically becomes much narrower apically until the spermatheca ends in a relatively enlarged terminal bulb. The spermatheca of *N. wekiuicola* (Fig. 2a) differs from the more typical Hawaiian species in that the coiled region is relatively thick throughout and nearly as thick as the diameter

of the terminal bulb. *N. blackburni* B. White (Fig. 2b) alone shares this feature among Hawaiian species of *Nysius*. Thus, it is possible that the closest relative of *N. wekiuicola* is *N. blackburni*. The latter species is known from lower montane areas of Maui and Hawai'i islands, where it likely feeds on plant seeds. At the time of Usinger's (1942) monograph, its host plant(s) was still unknown.

N. wekiuicola is yet another natural wonder of the Hawaiian Islands. Of the 106 species of the genus *Nysius* now known worldwide, it is the most unusual. It is the only micropterous member. The only micropterous orsilline relatives are members of the genera *Nithecus* Horváth of Europe, *Hudsona* Evans of New Zealand, and *Lepionysius* Ashlock of Australia (Ashlock 1967). Another Hawaiian species, *Nysius hardyi* Ashlock, is beetlelike and flightless and has reduced membranes in the fore and hindwings (Ashlock 1966). *N. wekiuicola* as an adult or nymph has by far the longest, thinnest appendages in relation to body length of any orsilline in the world, and the most elongate head as well.

Biology and ecology

A most outstanding feature of this bug is the scavenger-predator niche that it occupies on the highest peak (Pu'u Wēkiu) of Mauna Kea, which represents the highest elevation (4200 m) in the Hawaiian Archipelago, well above the vegetation line. As documented by Howarth & Montgomery (1980) (see also Howarth 1983), *N. wekiuicola* is found under rocks and cinders, where diurnally it preys upon moribund and dead insects blown from lower elevations. All other members of the genus *Nysius* and all other orsillines, where something is known of their biology, are primarily seed feeders, though some species also feed on plant tissues. Indeed, the family Lygaeidae has been given the common name "seed bugs" by Sweet (1960). The predators in the group are few, including some members of the Geocorinae, which also feed on seeds, members of the rhyparochromine tribe Cleradini, and a few isolated members of other groups within the family.

The presence of high altitude arthropods on Mauna Kea has been noted for over 50 years (Bryan 1923, 1926; Swezey & Williams 1932; Wentworth et al. 1935; Usinger 1936; Gagné 1971), but no one found or recognized *N. wekiuicola* and other arthropods (spiders, mites, Collembola) as resident predator-scavengers there until Howarth (1983), Howarth & Montgomery (1980), and Mull & Mull (1980) drew attention to them.

Papp (1981) observed *N. wekiuicola* feeding on adult coccinellids, and one of us (WCG) observed the bug feeding on recently dead adult syrphids adjacent to the snow fields in June 1980. They have not yet been observed feeding on other live resident arthropods. Somewhat surprising to us, the bugs were found to be active during the winter months. Adults and nymphs were observed moving beneath rocks on frost and adjacent to the snow pack in early January 1982. At 1200 h these rocks had a surface temperature 21 °C; a few centimetres beneath the surface, the volcanic ash was 1.5 °C (Howarth, pers. commun.).

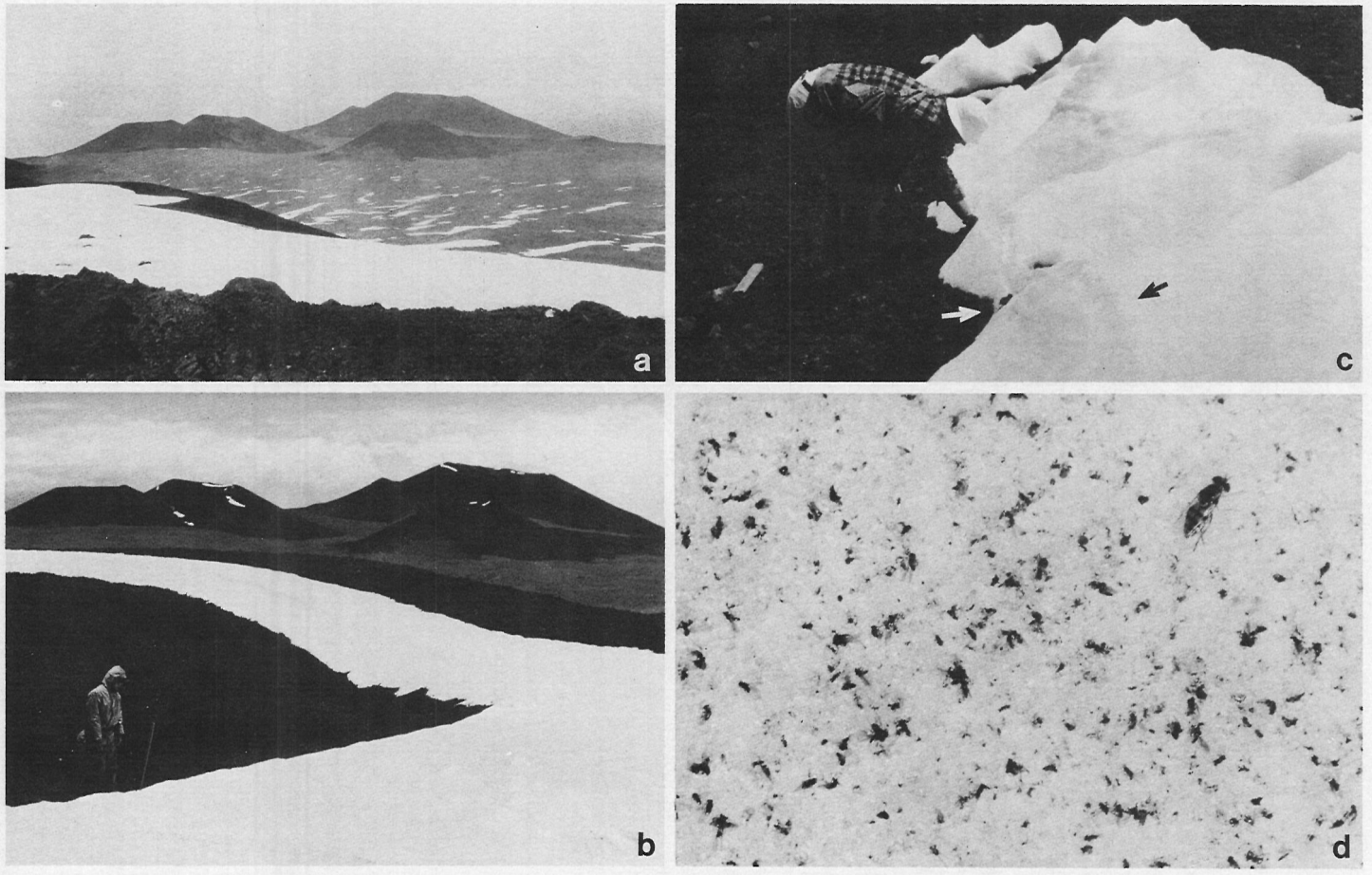

FIG. 3. *Nysius wekiuicola* habitat and food source: **a,** Mauna Kea summit area adjacent to Pu'u Wēkiu looking eastwards (photo, Marie Neal, May 1923, Bishop Museum Negative #79846); **b,** same view showing general similarity of shape of late spring snow pack in photos taken 57 years apart (photo, W. Gagné, June 1980); **c,** snow drift with dark band of aeolian-derived insects (black arrow) and major *N. wekiuicola* activity area (white arrow) (photo, W.P. Mull); **d,** close up of area indicated by black arrow in previous photo; largest insect is probably *Ischiodon grandicornis* (Macquart) (Diptera, Syrphidae) and numerous small flies are mostly *Hydrellia tritici* Coquillett (Diptera, Ephydridae) (photo, W.P. Mull).

Collectors have not been successful in finding *N. wekiuicola* much below the immediate vicinity of the summit of Mauna Kea. If they are truly restricted to the higher elevations, we hypothesize that these insects have some obligatory association with snow and/or permafrost, the former aspect especially for food, and the latter especially for year-round moisture. As Macdonald & Abbott (1970: 234–35) note ". . . snow sometimes persists on Mauna Kea through the summer and as late as September and A.H. Woodcock (see Woodcock 1974) has recently shown that permanent ice exists in the cinder of the summit cones a few feet below the surface." These insects appear susceptible to dehydration. After feeding, their abdomens are physogastric. The abdomens of all dry-mounted adult specimens invariably collapse. Other Hawaiian *Nysius* species do not share this feature, for example, *N. terrestris* Usinger and *N. lichenicola* Kirkaldy adults that were collected alive with *N. wekiuicola* during September 1979 by S.L. Montgomery.

Further details on the distribution, abundance and seasonality of *N. wekiuicola* are being investigated by F.G. Howarth and colleagues in conjunction with the preparation of an Environmental Impact Statement for the construction of an observatory within the summit Science Reserve.

N. wekiuicola, or closely related species, may live in a similar habitat on the summit of Mauna Loa. Paradoxically, the early entomologist H.B. Guppy observed ". . . parasitic . . . bugs collected while they fed upon the bodies of dead butterflies . . ." (1897: 21). Later, Bryan (1916) found 3 wingless bugs ("nymphs?") (p. 295) there also. Papp (pers. commun. to W.P. Mull) observed bugs on the summit of Mauna Loa in the late 1970's, but, unfortunately, did not collect voucher specimens. One of us (WCG) collected a long-legged lygaeid nymph that closely resembles nymphs of *N. wekiuicola* at 3505 m on the north slope of Mauna Loa in January 1982. This specimen was found near some shrimp (or bacon) chips from hikers' litter on a young 'a'a flow. Several other arthropods, namely *Geocoris pallens* Stål (Heteroptera, Lygaeidae), *Sepsis thoracica* (Robineau-Desvoidy) (Diptera, Sepsidae), and an anystid-like mite were also associated with this litter; the nymph may have been preying on these rather than scavenging in the litter. The closest snow patches were then about 120 m higher up the mountain and at least 2 km distant. These month-old snow patches were already peppered with dead and moribund flying insects, especially Diptera (e.g., *Drosophila*), Homoptera, and Hymenoptera. W.C.G. and B.H. Gagné searched there in vain for *N. wekiuicola*-like bugs on and near these snow patches. This suggests that a Mauna Loa lygaeid may be associated with the neogeoaeolian (sensu Howarth 1979a) ecosystem there. If this is so, these insects could easily be secreting themselves in the relative vastness of the new 'a'a and pahoehoe flows on Mauna Loa. The remarkable story on these and other high (Papp 1981) and lower elevation (Howarth 1979a,1979b) aeolian-associated arthropods is still unfolding.

Indifference to invertebrates thriving in Hawaii's high alpine environments has had detrimental consequences for earlier observatories built there. A coronagraph that was constructed on the summit of Haleakala on nearby Maui Island in the early

1960's had to be moved to Mauna Loa when the flight activities of several *Nysius* species emanating from alpine plants in surrounding Haleakala National Park interfered with studies of the sun's corona (Beardsley 1966). The presence of arthropods in abundance in the alpine zone of Mauna Kea should also caution those intent on installation of sensitive optical equipment there.

Acknowledgments. Mr S.L. Montgomery, Dr F.G. Howarth and Mrs Mae E. Mull sent or drew attention to germaine articles that were not otherwise readily available. Mr C. Sanchez of the University of the Philippines College of Science and Humanities drew the dorsal view of *N. wekiuicola.* Dr Howarth and Mr W.P. Mull loaned slides of the Wēkiu bug habitat used in Fig. 3, as credited. Ms Lynn Davis, Photoarchivist at the Bishop Museum, permitted reproduction of the historic Neal photograph also used in Fig. 3. Other individuals who helped search for Wēkiu bugs during the winter months were Mr P.G. Banko, Ms Y. Ching, Mr W.P. Mull, Mr R. Jones, Mr F. Stone, Mr F. Howarth, Mr F. Warschauer and Mrs B. Harrison-Gagné.

LITERATURE CITED

Anonymous. 1981. Oceans: life on lava flows. *Oryx* **16**(1): 24–25.

Ashlock, P.D. 1966. New Hawaiian Orsillinae (Hemiptera-Heteroptera; Lygaeidae). *Pac. Insects* **8:** 805–25.

1967. A generic classification of the Orsillinae of the world (Hemiptera-Heteroptera: Lygaeidae). *Univ. Calif. Publ. Entomol.* **48:** 1–172.

Beardsley, J.W. 1966. Investigations of *Nysius* spp. and other insects at Haleakala, Maui during 1964 and 1965. *Proc. Hawaii. Entomol. Soc.* **19**(2): 187–200.

Bryan, E.H. 1923. Insects from the summit of Mauna Kea. *Proc. Hawaii. Entomol. Soc.* **5:** 287–88.

1926. Additional notes on the insects occurring on Mauna Kea and Mauna Loa. *Proc. Hawaii. Entomol. Soc.* **6:** 280–82.

Bryan, W.A. 1916. Mauna Loa insects. *Proc. Hawaii. Entomol. Soc.* **3:** 295.

Gagné, W.C. 1971. Notes and exhibitions: *Psylla uncatoides* (Ferris & Klyver). *Proc. Hawaii. Entomol. Soc.* **21**(1): 25.

Gagné, W.C. & F.G. Howarth. 1982. On Mauna Kea 'desert' entomologists discover new life. *Ka'Elele, Bishop Mus. Newslett.* **9**(2): 1, 6.

Guppy, H. 1897. The summit of Mauna Loa. *Nature* **57:** 20–21.

Howarth, F.G. 1979a. Neogeoaeolian habitats on new lava flows on Hawaii Island: an ecosystem supported by windborne debris. *Pac. Insects* **20:** 133–44.

1979b. Notes and exhibitions: *Hodegia apatela* Walsingham. *Proc. Hawaii. Entomol. Soc.* **23**(1): 14.

1983. Notes and exhibitions. *Proc. Hawaiian Entomol. Soc.* (in press).

Howarth, F.G. & S.L. Montgomery. 1980. Notes on the ecology of the high altitude aeolian zone on Mauna Kea. *'Elepaio, J. Hawaii. Audubon Soc.* **41**(3): 21–22.

Macdonald, G.A. & A.T. Abbott. 1970. *Volcanoes in the sea: the geology of Hawaii.* The Univ. Hawaii Press, Honolulu. 441 p.

Mull, M.E. 1980. Conservation and Mauna Kea. *'Elepaio, J. Hawaii. Audubon Soc.* **41**(11): 156.

Mull, M.E. & W.P. Mull. 1980. Perspective: the marvelous mountain. *Hawaii Tribune-Herald.* Sunday, Jan. 27; Sect. B 5.

Papp, R.P. 1981. High altitude aeolian ecosystems in the Hawaiian Islands. *Proc. 3rd Conf. Nat. Sci., Hawaii Volcanoes Natl. Pk., Coop. Natl. Pk. Resources Studies Unit.* Univ. Hawaii, Manoa. p. 259–64.

Pukui, M.K. & S.H. Elbert. 1971. *Hawaiian dictionary.* Univ. Hawaii Press, Honolulu. 598 p.

Sweet, M.H. 1960. The seed bugs: a contribution to the feeding habits of the Lygaeidae (Hemiptera: Heteroptera). *Ann. Entomol. Soc. Am.* **53:** 317–21.

Swezey, O.H. & F.X. Williams. 1932. Insects from the summit of Mauna Kea. *Proc. Hawaii. Entomol. Soc.* **8:** 191–92.

Usinger, R.L. 1936. The genus *Geocoris* in the Hawaiian Islands (Hemiptera, Lygaeidae). *Proc. Hawaii. Entomol. Soc.* **9:** 214–15.

1942. The genus *Nysius* and its allies in the Hawaiian Islands (Hemiptera, Lygaeidae, Orsillini). *B.P. Bishop Museum Bull.* **173:** 167 p., 12 pl.

Waldrop, M.M. 1981. Research news. Mauna Kea (I): halfway to space. *Science* **214:** 1010–13.

Wentworth, C.K., J.W. Coulter & C.E. Hartt. 1935. MS. The Mauna Kea Expedition of 1935: Hawaii Academy of Science. 95 p. MS located at B.P. Bishop Museum library.

Woodcock, A.H. 1976. Permafrost and climatology of a Hawaii volcano crater. *Arct. & Alp. Res.* **6**(1): 49–62.

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