

*Hylaeus pubescens* and Associated Arthropods  
at Kilauea, Hawaii Volcanoes National Park  
(Hymenoptera: Apoidea and Chalcidoidea;  
Mesostigmata: Ameroseiidae)

HOWELL V. DALY and ROLLIN E. COVILLE<sup>1</sup>

ABSTRACT

The nest and larva of the endemic bee *Hylaeus pubescens* are described. Nests are constructed during the winter and spring months. The larva is the first of the subgenus *Nesoprosopis* to be described. The mite *Afrocypholaelaps africana* is phoretic on the bee and recorded for the first time in Hawaii. Taxonomic notes and mating behavior are given for the encyrtid parasitoids *Coelopencyrtus kaalae* and *C. sexramosus*.

This paper reports observations on the endemic Hawaiian bee, *Hylaeus pubescens* (Perkins, 1899): its nest structure and larva, and arthropods for which it serves as host. Included is the first record of the ameroseiid mite *Afrocypholaelaps africana* (Evans, 1963) in the Hawaiian Islands and additional records of the encyrtids *Coelopencyrtus kaalae* (Ashmead, 1901) and *C. sexramosus* (Timberlake, 1922). Taxonomic characters are given for the identification of these wasps.

*Hylaeus pubescens* was described from the Kona, Puna, and Kau Districts of the island of Hawaii at elevations of 2-4000 feet (610-1219 m). It is a member of the subgenus *Nesoprosopis*, to which belong probably all of the native bees of the archipelago. *Nesoprosopis* is one of the groups of insects that radiated extensively in the islands and includes more than 50 species (Zimmerman, 1970). The subgenus is known elsewhere from Japan and Europe (Hirashima, 1977).

*H. pubescens* superficially resembles the larger native wasps *Ectemnius* sp. and *Odynerus* sp. in the study area. All are black with brownish-black wings and 8-12 mm in length. All are possibly members of a Müllerian mimicry complex. Both sexes of *H. pubescens* may have a thin, transverse ivory stripe on the dorsum of the prothorax. The stripe may be interrupted or missing entirely. The inconspicuous pubescence is yellowish white, becoming brownish apically on the abdomen and reddish on the inner surfaces of the tarsi. The cuticle of the male is yellowish brown on the innersides of the fore femora and tibiae and has additional ivory marks on the lateral edges of the dilated antennal scapes, basally on the middle and hind tarsi, and basally on the hind tibia. The second sternum in both sexes is the longest, inscribed anteriorly by a distinct gradulus, and is convex to tuberculate medially. Apically on the fifth sternum of the female is a crescent shaped area that is probably the opening of a gland. The structure of the eighth sternum of the male, illustrated by Perkins (1899), is diagnostic for the species. The apex of this sternum may be visible without dissection as a pair of laterally directed, half-moon shaped lobes, each fringed with long setae.

<sup>1</sup>University of California, Div. of Entomology and Parasitology, Berkeley, CA 94720.

Our observations on *H. pubescens* were made in the forests of Kipuka Puauulu (4000 feet or 1219 m elevation); Kipuka Ki (4250 feet or 1295 m); Crater Rim trail near the Thurston tube (3800 feet or 1158 m) and at the Hawaii Field Research Center (3850 feet or 1173 m), all near the Kilauea Caldera. An additional collection of 2 ♂♂, 12 June 1978, was made by R.P. Papp from a nest in a beetle burrow in the exotic *Leptospermum scoparium*, Olaa Forest Reserve, 5 km NE Volcano (3000 ft. or 914 m).

On 16 September 1977 (3 ♂♂ 1 ♀) and 25 June 1980 (2 ♀♀) at Kipuka Puauulu, bees were seen flying near and crawling on a sunlit, reclining dead log of the endemic *Acacia koa* about 1 m diameter by 6 m long. Old nests with the membranous lining characteristic of colletids were found in beetle burrows beneath the loose bark in soft, red-rotten wood. In 1977, both sexes of bees were seen heavily infested with mites on the thorax and anterior part of the abdomen. These were identified by Dr. P. Elsen as *Afrocypholaelaps africana*, previously known from flower-visiting wasps in Angola, Zaire, Kenya, and Australia. On 25 June 1980 (4 ♂♂ 5 ♀♀) at Kipuka Ki bees were also found in an open, sunny glade flying near four Koa trunks, each about 0.5 m in diameter, that had been blown down during a storm several months previously. A female was collected here on the exotic weed *Hypochoeris radicata*. On 19 September 1981, bees were not seen at the Kipukas but 1 ♂ 1 ♀ were caught sunning on leaves near the Thurston tube. At all sites flight activity was limited to sunny areas in the forest and during midday periods without clouds.

#### Trap-nests and nesting activity

In June 1980, 10 bundles of trap-nests were hung horizontally, 1-1.5 m above the ground in trees around the yard of the Research Center. The nests were made of wood blocks 16.5x2x2 cm and bored 15 cm deep with either a 6.4 or 4.8 mm bit. Smaller blocks, 10.5x1x1 cm, were bored 8.5 cm deep with a 3.2 mm bit. Except for the end with the entrance, the blocks were immersed in hot paraffin to reduce absorption of moisture in the field. Expansion of the wood usually reduces the actual diameter of the boring. Two blocks of each of the three boring sizes were bound together in a bundle, making 60 traps. Of the 21 traps recovered about a year later, 5 nests of *Hylaeus pubescens* were found in traps with 6.4 mm borings and 1 nest in the 4.8 mm boring. The eumenid wasp *Odynerus cyphotes* Perkins (1899) occupied 4 traps with 6.4 mm borings. No bees or wasps were in the smallest borings.

On 17 September 1981, 14 bundles were placed around the yard of the Research Center. Each contained 2 traps of each size of the two larger borings and, in addition to the paraffin treatment, each bundle was provided with a plastic roof.

Of two traps recovered 18 February 1982, one 4.8 mm boring had a spider egg case and the other, a 6.4 mm boring, contained 5 brown-eyed pupae of *H. pubescens*. Three female pupae (antennae not reaching tips of fore tarsi) were in the innermost cells followed by 2 males (antennae reaching tips of fore tarsi) in the outermost cells. These emerged together on 2 March. One male was placed in a petri dish and given every few days a fresh cotton ball soaked with sugar water or dilute honey. At 20-23 °C the male was diurnally active and lived 74 days.

Of two traps recovered 25 March, one 4.8 mm boring contained a dead female just beginning a nest and the other, a 6.4 mm boring, contained 7 cells of which the inner 6 had postdefecating larvae. The outermost cell was sealed but the egg had died. The two innermost cells later contained female pupae and the three outermost cells contained male pupae (the remaining larva was preserved). The duration of the pupal instar was about 21 days at 20-23 °C. The adults remained in their cells for about 5 days before escaping from the nest. Both sexes took sugar water shortly after emergence. The males attempted copulation, but the females did not appear receptive.

The nests recovered thus far indicate that nesting activity in the area takes place over a long period, especially during the winter and spring months.

#### Nest of *Hylaeus pubescens*

Williams (1927) sketched a nest of *H. pubescens* in decayed wood of *Metrosideros polymorpha* at Kilauea. The nests observed by us are similar to those of other *Hylaeus* sp. in trap-nests as described by Krombein (1967). Each cell is lined by the parent female with a clear, single-layered membrane, which according to Batra (1972) is secreted by the mandibular glands and is similar to silk in chemical composition. In our trap-nests the membrane is largely free from the wall of the trap, but loosely attached by abundant silk threads. A transverse diaphragm closes the cell at both ends, that toward the exit has two appressed membranes with loose threads in between. The cells are separated by partitions of shredded wood fibers from the walls of the burrow. Average dimensions of 5 cells in one trap-nest are 12.26 mm  $\pm$  0.21 mm long by 5.3 mm in diameter and with fiber partitions averaging 2.72 mm  $\pm$  0.54 mm in length. A yellow-green, fine-grained pollen provision remained in a nest of 4 cells where the larvae died. The pollen appears to be derived from a single species of plant. In cells from which adult bees emerged, dark, discrete fecal pellets of the larva form a layer about 0.7 mm thick on the bottom diaphragm. The dark feces is topped by several white pellets (uric acid?) and in turn, the larval and pupal exuviae. An additional, two-layered diaphragm is placed just inside the entrance to the burrow, enclosing a long vestibule in front of the last fiber partition. No live mites were seen in the nests, but a few dead mites were embedded in the nest membranes.

#### Larvae of *Hylaeus pubescens*

One dead fully-fed, predefecating larva and head capsules from 3 large parasitized larvae, and 6 postdefecating larvae were recovered from the trap-nests. These are the first larvae of *Nesoprosopis* to be collected. The larvae possess the distinctive features of the Hylaeinae as enumerated by McGinley (1981): produced labiomaxillary region, no salivary lips, anterior tentorial pits low in position, and epistomal depression arched dorsad to level of antennae (Fig. 1). In comparison to his diagnosis of *Hylaeus*, *H. pubescens* has the characteristic flat antennal discs and dorsal abdominal tubercles (in the postdefecating larvae), but the labral tubercles are notably very small and poorly distinguished from apicolateral swellings.

A character by character comparison of *H. pubescens* with the 126 characters analyzed by McGinley for *H. alcyoneus* and *H. modestus* reveals agreement in

most of the character states that the latter two species share in common. *H. pubescens* differs in having: (character 5) maxillae not spiculate on dorsal and inner surfaces; (35) labral tubercles poorly defined; (37) labral tubercles pointed; (73) labial division into prementum and postmentum weak; (76) labial palpus subequal in length to maxillary palpus; (113) anus apical; and (118) atrium not produced above body surface. For those characters that *H. alcyoneus* and *H. modestus* do not share in common, *H. pubescens* has: (10) frontal swellings absent; (16) posterior thickening of head capsule well developed; (17) median portion of posterior thickening of head capsule curving forward; (24) pleurostomal ridge well developed; (27) parietal bands indistinct; (29) antennal disc large; (43) mandible base in adoral view narrow; (51) mandible apex attenuate; (52) mandibular cusp well defined; (55) minute teeth on dorsal apical edge of mandible; (67) cardo and stipes weakly sclerotized; (69) maxillary palpus short; (70) maxillary palpus slender; (72) galea absent; (75) labial palpus length subequal to width; (94) body form moderately robust; (114) spiracle size moderate; (117) atrium subglobular; (119) atrial wall not ridged; (120) atrial wall without spines or spicules; and (126) subatrium absent. In addition, *H. pubescens* exhibits bilateral frontal depressions just above the epistomal depression. These are probably associated with muscle attachments.

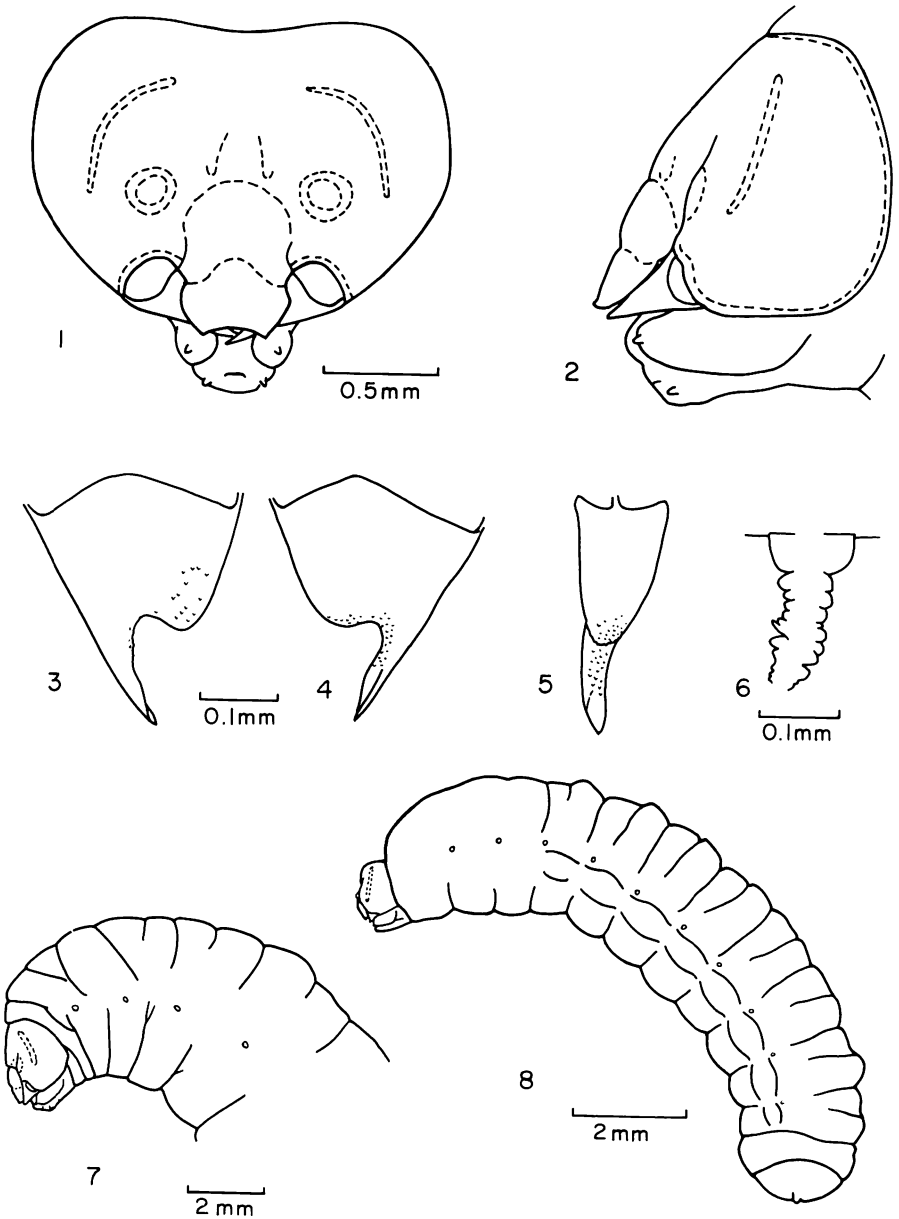
#### *Coelopencyrtus kaalae* (Ashmead)

This encyrtid was reared from a 6.4 mm x 15 cm trap nest containing 5 cells and punctured diaphragm. The nest was opened 1 June 1981. An adult female bee emerged on 22 June from the first (lowermost) cell. The other cells contained four fully grown bee larvae each completely consumed by the encyrtids. The parasitoids died before emergence in the second cell. The other parasitoids emerged during 16-22 June. The sex counts in their cells were: 38 ♀♀ 3 ♂♂; 1 ♀ 52 ♂♂; 68 ♀♀ 3 ♂♂. Mating behavior was observed to begin shortly after the wasps escaped from the host's cadaver. The male 1) approaches from the rear; 2) clasps the female's overlapping wing tip between his antennal scapes and his face; 3) while holding the wing tips he stroked the female's abdominal apex alternately with each pectinate antenna; 4) occasionally thrusts forward with his head; and 5) attempts to couple. Unreceptive females resist by keeping the wings together and held low toward the substrate which prevents the male from lifting the wings. Females also kick with their hind legs. Females may be courted by more than one male, the second of which may engage the wings of the first male. In the cell with nearly all males, similar courtship and attempted coupling among 2 and 3 males were observed. The antennae of the courting male do not reach the abdominal apex of the courted male.

*C. kaalae* is known from Oahu, Molokai, and Hawaii and is recorded as a parasitoid on several species of the subgenus *Nesoprotopis* (summary by Beardsley, 1976: 209).

#### *Coelopencyrtus sexramosus* (Timberlake)

This encyrtid was reared from a 6.4 mm x 15 cm trap-nest containing 4 cells and a punctured entrance diaphragm. The nest was opened 1 June 1981. Each cell had a fully grown bee larva that was parasitized. Wasps had emerged and mingled together in the first two cells resulting in a total of 63 ♀♀ 6 ♂♂. The third cell had 51 ♀♀ 4 ♂♂. The wasps had escaped from the fourth cell.



**FIGURES 1-7.** Predefecating larva of *Hylaeus pubescens*: 1, head capsule, frontal view; 2, head capsule, lateral view; 3, right mandible, dorsal view; 4, right mandible, ventral view; 5, right mandible, adoral view; 6, spiracle, sagittal view; 7, anterior segments.

**FIGURE 8.** Postdefecating larva, entire lateral view.

*C. sexramosus* was described from a single male collected in the Kau Desert at 3800 feet (1158 m) elevation near Kilauea. In comparison to the original description our specimens in alcohol agree except that: 1) they are larger, wing length  $1.31 \pm 0.32$  mm (N = 8); 2) the fore tarsi are brown and only slightly paler than the fore legs; and 3) the apical fourth of the mid tibia and spur and the very apex of the hind tibia are yellowish-brown like the respective tarsi. Timberlake (1922:140) had a single female, taken from a steam crack at Kilauea, that he chose not to name. Judging by his notes the female was *C. sexramosus*. The following information is provided here for the females: In comparison to the generic description of Burks (1958:23), our female specimens (one was measured for proportions) agree but with these comments: 1) labial palp with 3 segments, not 2; 2) mouth opening, 0.38 mm: maximum width of head, 0.64 mm; 3) malar space, 0.26 mm: height of eye, 0.28 mm; antennal club, 0.14 mm; funicle, 0.18 mm; dorsal length of thorax, 0.82 mm: dorsal length of gaster, 0.90 mm. In comparison to our specimens of *C. kaalae*, the females of *C. sexramosus* (all in alcohol) are similar in size, winglength  $1.46 \pm .0312$  mm (N = 10) versus  $1.44 \pm .009$  mm for *C. kaalae*, but differ in their: 1) 3-segmented labial palp; 2) more extensive yellow-brown markings on the legs, including the apices of the fore and hind tibiae, the apical half to three-quarters of the mid tibia, and all tarsi; and 3) visibly shorter ovipositor, the portion exceeding the hypopygium being 0.08 mm (N = 3) versus 0.13 mm (N = 3) for *C. kaalae*.

#### ACKNOWLEDGMENTS

We wish to thank Dr. Charles Stone, Research Scientist, and Mr. Dan Taylor, Management Ecologist, of Hawaii Volcanoes National Park, for arranging the permits for this study. Mr. Taylor helped us place the trap-nests in the field and periodically checked on their inhabitants. We are also indebted to Mr. Cliff Davis, Entomologist, who freely shared with us his extensive knowledge of the insects and plants in the park. Mr. Davis and Mr. Taylor read the manuscript and offered useful comments. Special thanks go to Dr. John W. Beardsley, University of Hawaii at Manoa, who confirmed our identification of the encyrtids, and to Dr. P. Elsen, Institut de Medecine Tropicale "Prince Leopold" in Antwerp, who identified the mites. Dr. Ronald J. McGinley, Harvard University, kindly reviewed our description of the larva. Finally, we are grateful to Mrs. Barbara Boole Daly who inked the illustrations.

#### REFERENCES CITED

- Ashmead, W.H. 1901. Hymenoptera Parasitica. Fauna Hawaiiensis 1(3):277-364.
- Batra, S.W.T. 1972. Some properties of the nest-building secretions of *Nomia*, *Anthophora*, *Hylaeus* and other bees. J. Kansas Entomol. Soc. 45:208-218.
- Beardsley, J.W. 1976. A synopsis of the Encyrtidae of the Hawaiian Islands with keys to genera and species (Hymenoptera: Chalcidoidea). Proc. Hawaii. Entomol. Soc. 22:181-228.
- Burks, B.D. 1958. A recharacterization of the genus *Coelopenyrtus*, with descriptions of two new species (Hymenoptera: Encyrtidae). J. Washington Acad. Sci. 48:22-26.
- Evans, G.O. 1963. The genus *Neocypholaelaps* Vitzthum (Acari: Mesostigmata). Ann. Mag. Nat. Hist. 6(13):209-230.
- Hirashima, Y. 1977. Revision of the Japanese species of *Nesoprosopis*, with descriptions of two new species (Hymenoptera, Colletidae, *Hylaeus*). Esakia 10:21-43.
- Krombein, K.V. 1967. Trap-nesting wasps and bees: life histories, nests, and associates. Smithsonian Press, Washington, D.C. 570 pp.
- McGinley, R.J. 1981. Systematics of the Colletidae based on mature larvae with phenetic analysis of apoid larvae (Hymenoptera: Apoidea). Univ. California Publ. Entomol. 91:1-307.

- Perkins, R.C.L. 1899. Hymenoptera Aculeata. *Fauna Hawaiiensis* 1(1):1-115.
- Timberlake, P.H. 1922. Descriptions of new genera and species of Hawaiian Encyrtidae (Hymenoptera), III. *Proc. Hawaii. Entomol. Soc.* 5:135-167.
- Williams, F.X. 1927. Notes on the habits of the bees and wasps of the Hawaiian Islands. *Proc. Hawaii. Entomol. Soc.* 6:425-464.
- Zimmerman, E.C. 1970. Adaptive radiation in Hawaii with special reference to insects. *Biotropica* 2:32-38.