Nest Descriptions and Associates of Three American Bees of the Genus "*Anthocopa*" Lepeletier

(Hymenoptera: Megachilidae)

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"*Anthocopa*" Lepeletier is a large group of megachilid bees found in North America, Eurasia, and Africa. This group has been treated as a genus in North America, but European authors have included *Anthocopa* in *Hoplitis* Klug. Recently Michener (1968) suggested that *Anthocopa* be synonymized with *Hoplitis*. For the purposes of this paper, I an using *Anthocopa* because of its familiarity and its current usage in the catalog of Hymenoptera of America (Muesebeck et al. 1951).

The North American species of *Anthocopa* are grouped into 4 subgenera containing 34 species. The nesting habits of the Nearctic species are undescribed, but Parker and Bohart (1966, 1968) recorded 2 species from trap stems. This paper describes nests of 3 species including the 2 from trap stems. Although these reared species belong to different subgenera and all have dissimilar nesting habits, I feel it is premature to propose that these behavior patterns are indicative of subgeneric categories because so few species are known biologically.

ANTHOCOPA (EREMOSMIA) HYPOSTOMALIS Michener

(Figs. 1–6)

Nesting Site: All nests (98 containing 305 cells) were recovered from prebored elderberry trap stems each with a bore diameter of 6–3mm (¼–⅛ in.); only the end holes were utilized though side holes with similar diameters were present on the same stems. The trap stems selected by these bees were placed in the following localities in southern California following the procedures of Parker and Bohart (1966): Deep Canyon and White Water Canyon, Riverside Co.; Kramer Hills, San Bernardino Co.; Palm Canyon (Anza-Borego State Park), San Diego Co.; and Glamis, Imperial Co. The best trapping site was White Water Canyon where 92% of the nests studied were recovered. In 1964, this species occupied 28% of the recovered trap stems; the next season it utilized 53%.

Nest Construction: Nests were made by building complete cells one on top of the other (Fig. 1); nests averaged 3.1 cells with a range of

1–9. Each cylindrical cell was made by combining gravel and masticated plant parts and lining the burrow walls with this material. In smaller holes, the cells were long and narrow (5 × 13mm) and placed vertically. In larger borings, the cells were stout (8 × 9mm), and the cell series was oblique. Pith was removed from the sides of the burrow to accommodate the oblique cells. Also, because of the softness of the pith in the stems, the drilled holes were occasionally larger than the size stated earlier. The inner cell walls were smooth, polished, and composed of finely masticated plant parts combined with a salivary substance. The outer cell surface was roughened by protruding particles of sand and pieces of plant material (Figs. 2, 3). The cell cap was composed of a thin disc of masticated plant parts with a layer of sand appressed to the outer surface. The cap was concave and smooth initially; but later the concave area was filled with small pieces of gravel stuck together with masticated plant parts. The inside of the cell cap was rough and without any apparent design or openings. The nest entrance and burrow above the cells were plugged with fine gravel. The gravel in the entrance was held together with a salivary substance. One stem was plugged with a thin disc of resin, but this plug may have been applied by another species of bee.

Provisions: The size and shape of the pollen mass was not recorded. Hurd and Michener (1955) listed *Dalea* and *Cryptantha* as host plants for *A. hypostomalis*. Pollen found in the reared cells was Leguminosae, probably *Dalea*; but one sample contained pollen from a hydrophyllaceous flower.

Feces: The walls of the cells were lined with feces; those at the top were loose, but those on the sides were flattened against the cell walls. The dark, loose fecal particles were fairly uniform in length (0.5mm), tapered, and oblong; there was a faint linear depression on one surface.

Cocoons: The cocoons were formed by lining the cell walls from the bottom to nearly the top with finely spun silk. In shorter cells, the cocoon filled the cavity; in longer cells, it filled the lower ¾ of the cell (Fig. 4). The cocoon was thick, dark brown, and oval and had a nipple at the top (Fig. 4). The outer lateral surface of the cocoon below the nipple usually possessed several rings of loosely spun silk that in some cells extended to the cell walls. The nipple was loosely spun and of various shapes; but the inner cocoon surface opposite the nipple always had many strands of loose silk. The cocoon was tightly appressed to the cell walls.

Sex Ratio: More females than males emerged, and the ratio females to males was 1.2:1.0. The ratios of females to males in each cell

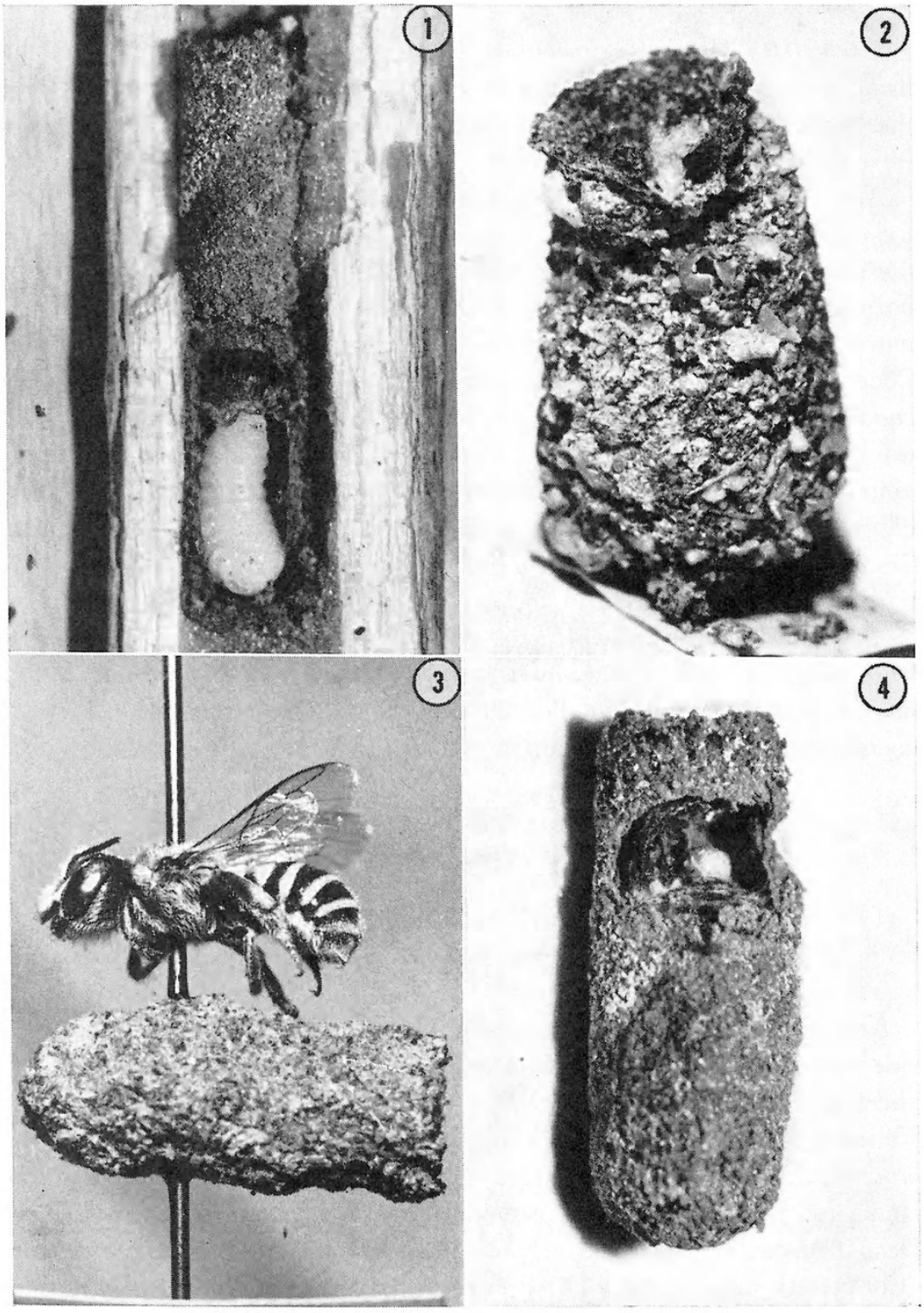


FIG. 1. Two cells of *A. hypostomalis* in a trap stem, bottom cell with larva.

FIG. 2. Cell of *A. hypostomalis* showing material used to construct the cell. The nest entrance plug is attached to the top of the cell.

FIG. 3. Female and cell of *A. hypostomalis*.

FIG. 4. Cell B in fig. 1 opened to illustrate the white nipple at the top of the cocoon. Note rings of silk at the top.

beginning with the first (bottom) cell was 1.6, 1.3, 1.0, 1.0, 0.5, 1.3, 1.0, 0.4, 0.0. Thus, the placement of the sexes in the cells followed the usual pattern of females at the bottom and males above; but in 7% of the nests, the sexes were intermixed, and in another 10% only males were present.

Nest Associates: The four insect species associated with nests of *A. hypostomalis* accounted for a 15% cell loss. An undescribed species of the parasitic bee, *Stelis* (Megachilidae) (Fig. 5), was the most common parasite, and it accounted for 62% of all parasitism. Like its host, more females than males (ratio 1.5:1) of this parasite emerged. Cocoons of *Stelis* also possess nipples (more elongate than the *Anthocopa*), but these cocoons are smaller and lack the rings of silk at the top (Fig. 6). A clerid beetle, *Cymatodera* sp., was the second most abundant nest associate. Larvae of these beetles destroyed 28% of the depredated cells, and as many as 3 cells in a series were entered and destroyed by one larva. *Leucospis affinis* Say, a common chalcid parasite of bees, was found in 2 cells, and a male mutillid, *Sphaeropthalma amphion amphion* (Fox), was reared from one cell. Two nests were destroyed by an unknown species of woodpecker, and cell losses due to unknown causes totalled 23.2% with 13.7% occurring in the pre-cocoon stages and 9.5% in later stages.

ANTHOCOPA (HEXOSMIA) COPELANDICA (Cockerell)
(Figs. 7–9)

Two of the 3 recognized subspecies of *A. copelandica* were reared. The observations recorded below apply to both subspecies except where differences are noted.

Nesting Site: Nests of this species were collected from prebored elderberry stems set out at 6 western localities. At 3 locations, Boca and Carnelian Bay (Nevada Co.), California, and Craters of the Moon National Park (Butte Co.), Idaho, 32 nests of the subspecies *c. albomarginata* (Cockerell) were found. At 3 southern Californian localities, Brown Canyon, Kramer Hills (San Bernardino Co.), and Deep Canyon (Riverside Co.), 20 nests of the subspecies *c. arefacta* (Cockerell) were found. Three sizes, 6, 3, and 1.5mm (¼, ⅛, 1/16 in.) of end and side holes were utilized by these bees.

Nest Construction: The species was versatile in nest building. In wide burrows (6mm), cells were grouped with cell walls fashioned mostly from nest building material (Fig. 7); in narrow holes (2–4mm), only thin partitions (1–2mm) separated the cells. Cell size ranged from 4–9mm long and 3–4mm wide. The placement of cells in burrows

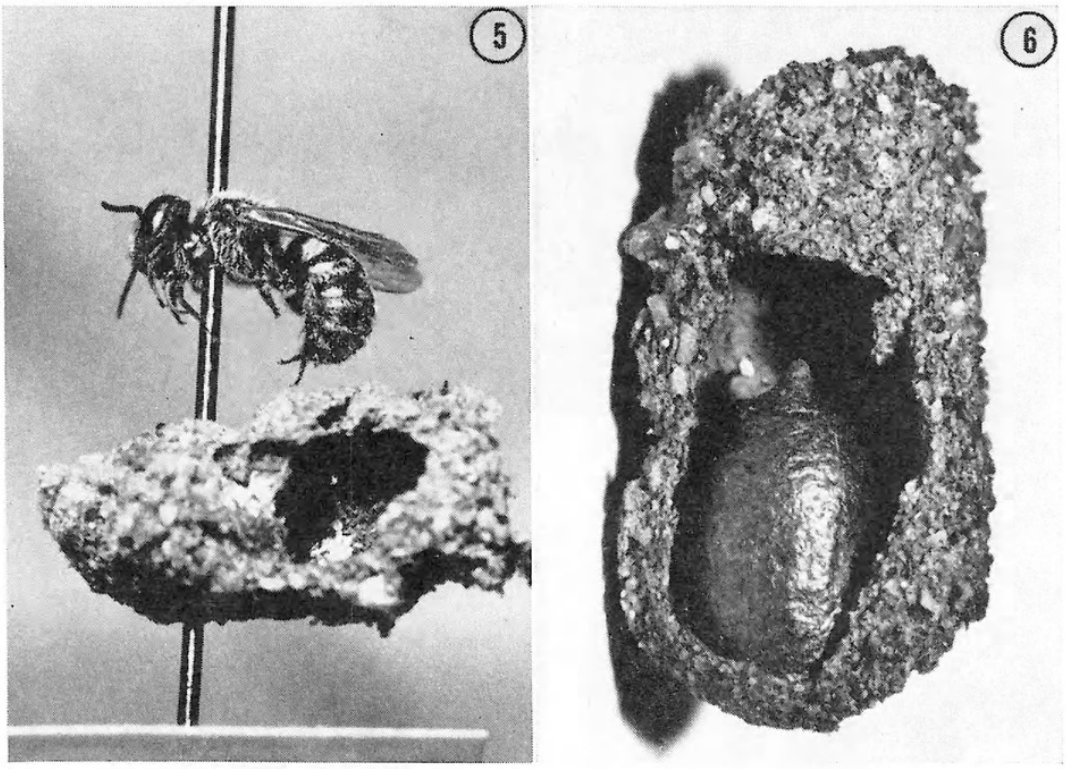
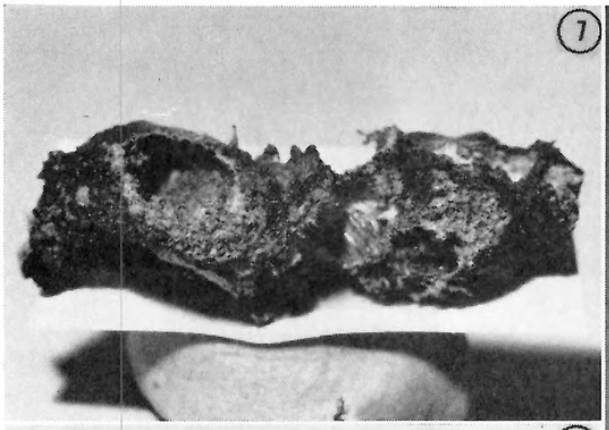


FIG. 5. A male of *Stelis* sp., a parasite of *A. hypostomalis*.
FIG. 6. Cocoon of *Stelis* sp. in cell of *A. hypostomalis*.

was highly variable, but there was often an empty space (avg length 28mm) between the last cell and the entrance plug, usually enough space for more cells. Nest building material was coarsely chewed plant parts; but in most nests of *c. arefacta*, sand and masticated plants were used in cell partitions and entrance plugs. Cell partitions were formed into thin discs, and the edge of some partitions were bent downward. In larger burrows, some of the upper partitions were partially constructed (except for the small entrance hole) prior to cell provisioning. The cell partitions were smooth above and roughened below. Nests were capped with discs of chewed plant parts, but occasionally some pith from the sides of the stem was incorporated into the plugs, which averaged 2–9mm long. Some plugs were composed of as many as 8 compact discs, and they were often situated below the nest entrance (avg 4.5mm). Thirty-two nests of the subspecies *albomarginata* were examined; they held 79 cells (1–10, avg 2.4/nest). Twenty nests of the subspecies *arefacta* were recovered; they held 87 cells (1–11, 4.3/nest).

Provisions: Shape and size of pollen masses were not recorded. Pollen samples in cells from Idaho were all Hydrophyllaceae.

Feces: The feces were light tan in cells of *c. arefacta* (Fig. 8) and dark brown in cells of *c. albomarginata* (Fig. 9). Neither had surface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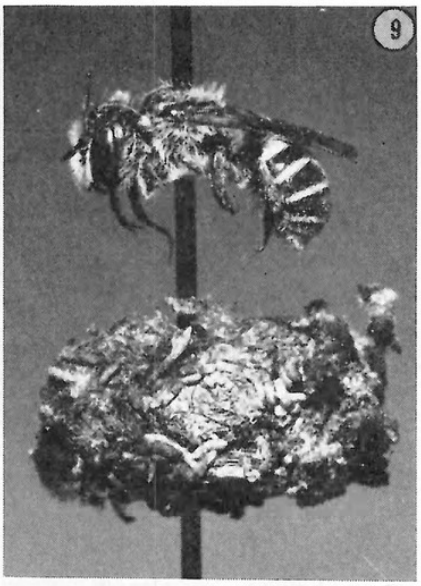
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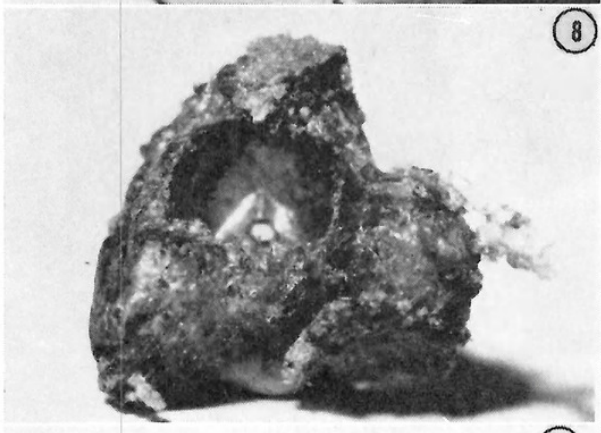
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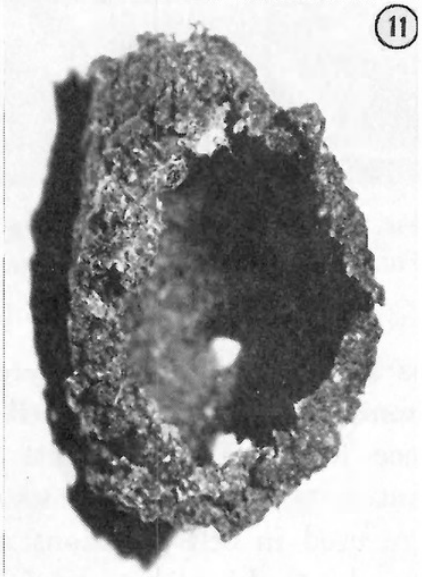
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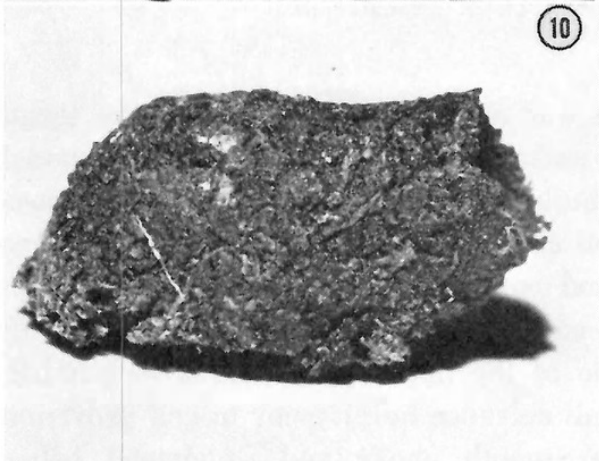
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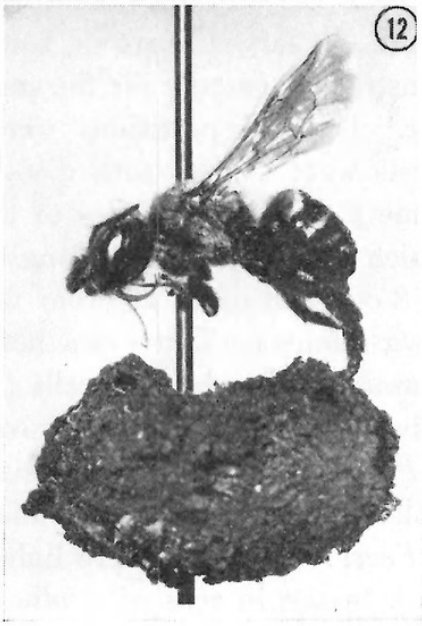
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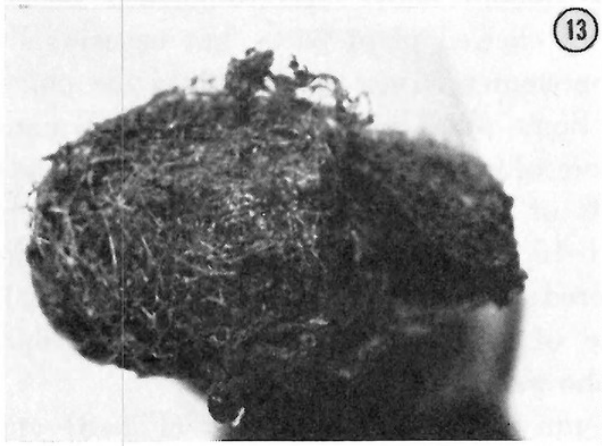
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depressions, and some particles were tapered and others were blunt. Most particles were deposited at the top of the cell or around the walls, but often they were flattened against the sides.

Cocoon: The cell wall was lined by thick layers of transparent silk that fit snugly against the wall. Inside this layer but closely attached to it a dark amber cocoon was spun. The amber cocoon was often smaller than the outer one in longer cells (⅔), but in shorter cells it filled the transparent cocoon. The cocoon did not have a protruding nipple, but at the top it was slightly raised with many strands of loose silk. The inner surface of the cocoon was shiny, but the silk strands were evident.

Sex Ratio: More females than males emerged, 2.4:1, and only 2 nests contained series with the sexes mixed. In all other nests, the females were at the bottom, and the male cells were above.

Nest Associates: Five species of parasites and predators were recovered from *A. copelandica* cells. Total parasitism was low, only 6.6%. The most common parasite was the chrysidid, *Chrysura sonorensis* Cameron, which occupied 6 cells of *c. albomarginata*; another wasp, *Sapyga pumila* Cresson, was found in 2 cells of this subspecies. The other 3 parasitized cells each contained one of the following species: a male leucospid wasp, *Leucospis affinis* Say, from a *c. arefacta* cell; a pteromalid, *Epistenia* sp., and a meloid beetle, *Nemognatha scutellaris* LeConte, each from a *c. albomarginata* cell. Three cells in one nest of *c. arefacta* were destroyed by a clerid larva belonging to the genus *Cymatodera*. Cell mortality due to unknown causes was 4.8%.

ANTHOCOPA (ATOPOSMIA) ABJECTA (Cresson)
(Figs. 10–13)

Nesting Site: Nests of *A. abjecta* were found attached to the under surface of flat stones at 2 locations above 8,000 ft in Cache County,

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FIG. 7. Nest of *A. c. albomarginata* showing composite cells. Some cells were almost completely lined with macerated plant parts.

FIG. 8. Cocoon of *A. c. albomarginata* from a wide burrow. The shape of the cocoon followed the walls of this irregular cell. Pith from the trap stems was incorporated into the plug at the top of the cell.

FIG. 9. Female and cell of *A. c. arefacta.*

FIG. 10. Leaf part cells of *A. abjecta.*

FIG. 11. Leaf part cells of *A. abjecta*, ventral view.

FIG. 12. Female and cell of *A. abjecta.*

FIG. 13. Top of cocoon of *A. abjecta*, showing the coarse silk strands.

TABLE 1. Comparative biology of *Anthocopa* species.

Species	Nesting site	Provisions	No. cells/nest	Nesting material			Cocoon	Associates	No. nests
				Entrance plug	Cell partitions	Cell walls			
hypostomalis	trap stems	Leguminosae Hydrophyllaceae	1–9 avg. 3.1	gravel and masticated plant parts	gravel and masticated plant parts	gravel and masticated plant parts	dark with nipple	*Stelis* sp. *Cymatodera* sp. *Leucospis affinis* *Sphaeropthalma amphion*	98
c. albomarginata	trap stems	Hydrophyllaceae	1–10 avg. 2.4	masticated plant parts	masticated plant parts	occasionally with masticated plant parts	amber w/o nipple	*Chrysura sonorensis* *Sapyga pumila* *Nemognatha scutellaris*	32
c. arefacta	trap stems		1–11 avg. 4.3	masticated plant parts and fine gravel	masticated plant parts and fine gravel	not lined	amber w/o nipple	*Leucospis affinis* *Cymatodera* sp.	20
abjecta	under stones	*Penstemon*	1–16	masticated plant parts	masticated plant parts	masticated plant parts	dark w/o nipple	*Stelis* sp.	5 +

Utah. One habitat was near the summit of Wellsville Mountain, and the other was along Beaver Creek near the Idaho-Utah state line.

Nest Construction: Cell walls were constructed entirely from dark masticated plant material and shaped into domes about 9mm long and 8mm wide (Figs. 10, 11, 12). The rock surface was used as the base. Cells were capped with the same nest building material that was shaped into discs—smooth on the outside and roughened on the inside. The inside of the cell walls was slightly smoothed. When cells were adjacent, only one wall sometimes separated the cells. The number of cells found was not recorded because many were old and constructed during previous seasons. However, one nest contained 16 cells.

Provisions: Hurd and Michener (1955) listed species of *Penstemon* as the host plant for *A. abjecta.* Seven of the cells from which *A. abjecta* emerged contained traces of *Penstemon* pollen. One cell was partially filled with a white vile smelling liquid.

Feces: In most cells, feces were flattened against the walls, but in some they were at either end. The links were dark brown, of uniform length, and without surface markings.

Cocoon: The coarse matlike dark brown strands (Fig. 13) that formed the cocoon closely lined the cell walls. The strands were loosely spun on the outside, but inside the cocoon was polished with many strands visible. The top of the cocoon did not have a nipple.

Sex Ratio: Only females emerged from the cells examined. I did not find any parasitized cells at the Beaver Creek locality, but at Wellsville Mountain where only old cells were found, many had been parasitized by an unknown species of *Stelis.*

DISCUSSION

Nesting habits of *Anthocopa* species are indicative of the close relationship between these bees and other genera such as *Hoplitis* and *Osmia.* Some of the more important nesting patterns among *Anthocopa* and related North American genera are: (1) cells made entirely of masticated plant parts [*A. abjecta, Hoplitis biscutellae* (Cockerell)], (2) cells made primarily with fine gravel (*A. hypostomalis, Hoplitis anthocopoides* Schenck), (3) cell partition and plug of masticated plant parts (*A. copelandica, Osmia kincaidii* Cockerell), (4) cocoon with nipple (*A. hypostomalis*, most spp. of *Osmia*), (5) cocoon without nipple (most spp. of Osmiini except *Osmia*), (6) cocoons composed of 2 distinct layers (*A. copelandica, Osmia kincaidii* Cockerell), (7) nests in pre-existing holes (*A. hypostomalis, A. copelandica,* most species of *Ashmeadiella, Hoplitis, Heriades, Chelostoma, Proteriades,* and

some *Osmia*), and (8) nests under stones [*A. abjecta*, *Osmia* spp. (*tanneri* Sandhouse, *longula* Cresson, *integra* Cresson)].

Table 1 summarizes the biology of the *Anthocopa* species considered in this paper.

ACKNOWLEDGMENTS

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