OBSERVATIONS ON THE NESTING BEHAVIOR OF MIMESA (MIMESA) BASIRUFA PACKARD AND M. (M.) CRESSONII PACKARD (HYMENOPTERA: SPHECIDAE)

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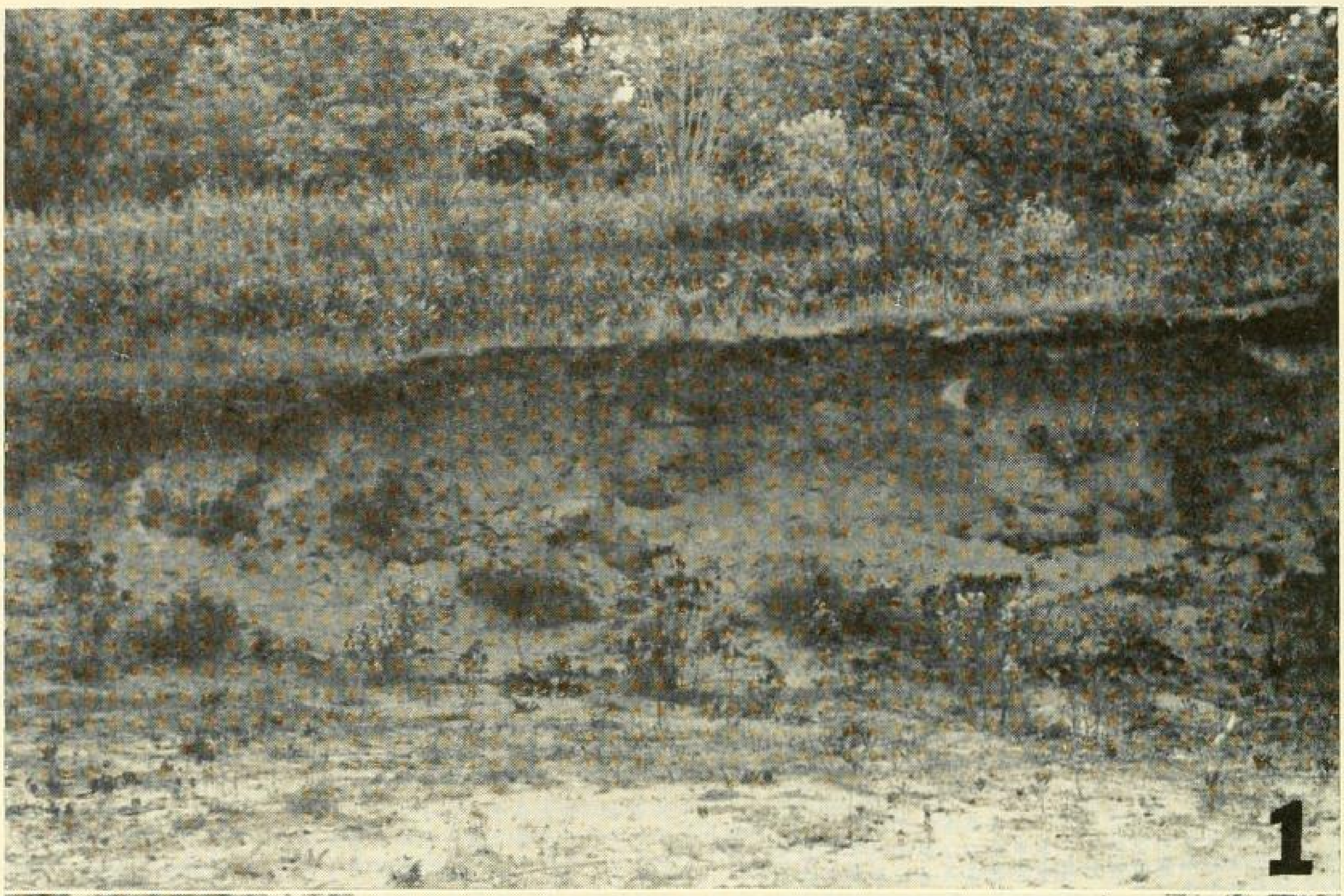
ABSTRACT—Observations on the nesting behavior of *Mimesa* (*Mimesa*) *basirufa* Packard and *M.* (*M.*) *cressonii* Packard are presented with reference to detailing distinguishing components. Important species differences include flight period, nesting-site, presence or absence of a turret around entrance, shape of rearing cell, provisioning and storing times, kinds and sizes of prey, and position of egg-bearing prey in the cell. These differences and other features of the nesting behavior are discussed in relation to finding ethological components of potential importance in *Mimesa s. str.*

The genus *Mimesa* contains only two subgenera, *Mimesa* and *Mimumesa*, in North America north of Mexico. *Mimesa* are true ground nesters, constructing their own nests, whereas species of *Mimumesa* occupy ready made burrows in woody stems, timber, and rotting wood (Spooner, 1948). Although the genus was erected by Shuckard in 1837, little information is available regarding the ethology of the group. Williams (1914) described aspects of the nesting behavior of *Mimesa* (*Mimesa*) *ezra* (Pate) (as *M. argentifrons* Cresson). He noted that it nested in sandy soil, constructing "a cone of agglutinized grains of sand" around the entrance. He reported that the prey, *Exitianus exitiosus* (Uhler) (Cicadellidae), were small compared to the wasps and were transported in flight, but he did not detail the components of prey carriage. The nest was "nearly vertical, and at least eight inches deep."

Spooner (1948), in his paper on the British Psenini, described the nesting parameters of three Palaearctic species of *Mimesa s. str.* [*M. equestris* (Fabricius), *M. rufa* (Panzer), *M. shuckardi* Wesmael]. All three species nested in sandy soil on either sloped or level ground. *M. shuckardi* occasionally selected vertical banks. Burrows of *M. shuckardi* and *M. equestris* extended vertically downward for a short distance and then turned sharply in a horizontal direction. The excavated sand was pushed upward, where it accumulated in a "crater-like pile" around the entrance. *Mimesa rufa* and *M. equestris* were observed provisioning with both adult and nymphal cicadellids, whereas *M. shuckardi* utilized only adult females. Adlerz (1903) reported that *M. equestris* transported its prey in flight, the leafhopper being carried head forward, ventral side up, and held by the wasp's middle legs.



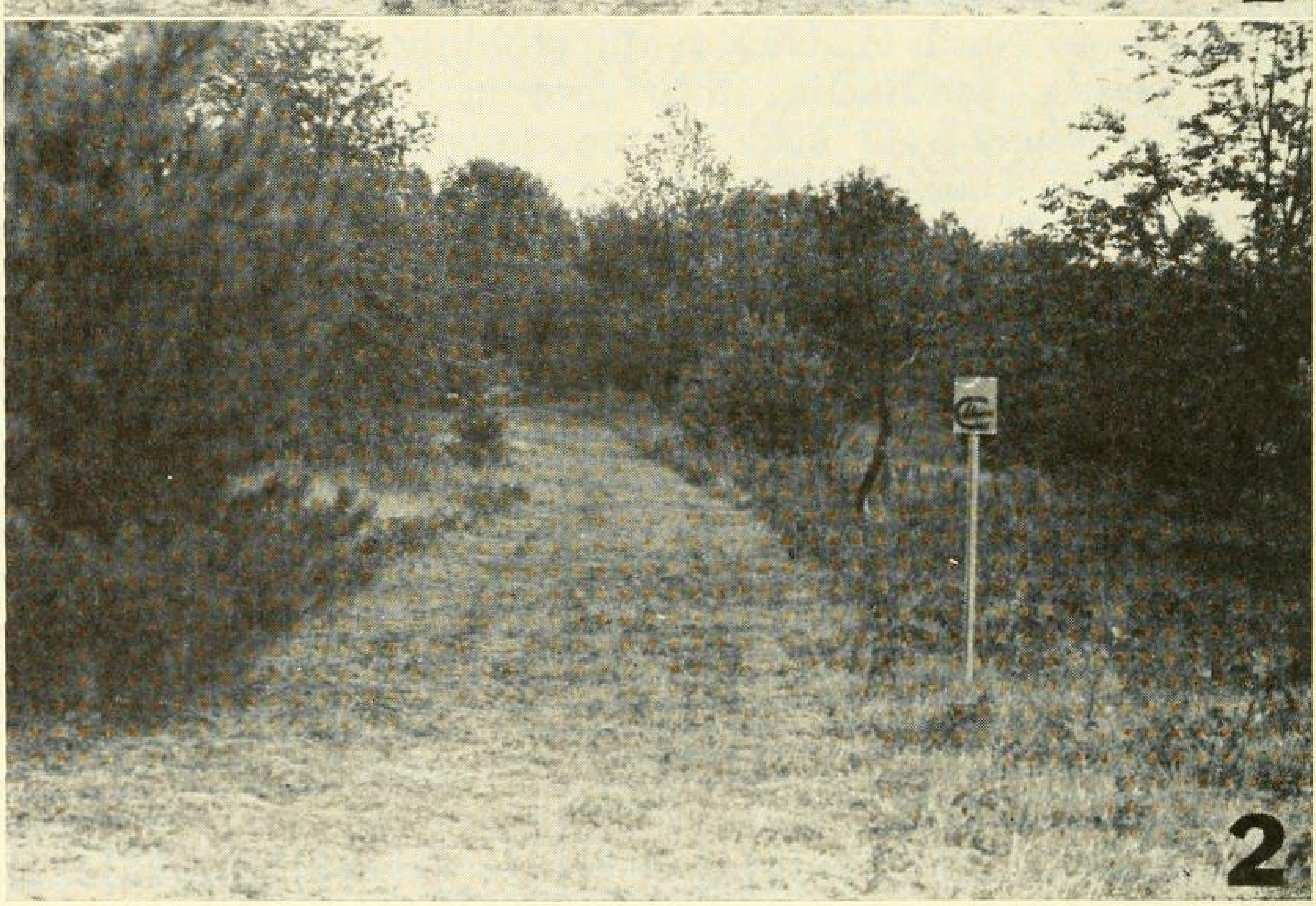


Fig. 1, 2. Nesting sites of *Mimesa basirufa* and *M. cressonii*, respectively, at Selkirk Shores St. Pk., N.Y.

Krombein (1961) noted females of the Nearctic *M. basirufa* Packard nesting during June in a flat sandy area in Maryland. He reported two prey taken from wasps in transport. Both were cicadellids, one an adult *Macropsis viridis* (Fitch), the other a nymph of *Idiocerus*. One burrow went down at a steep angle with several "angulations," although no cells were found.

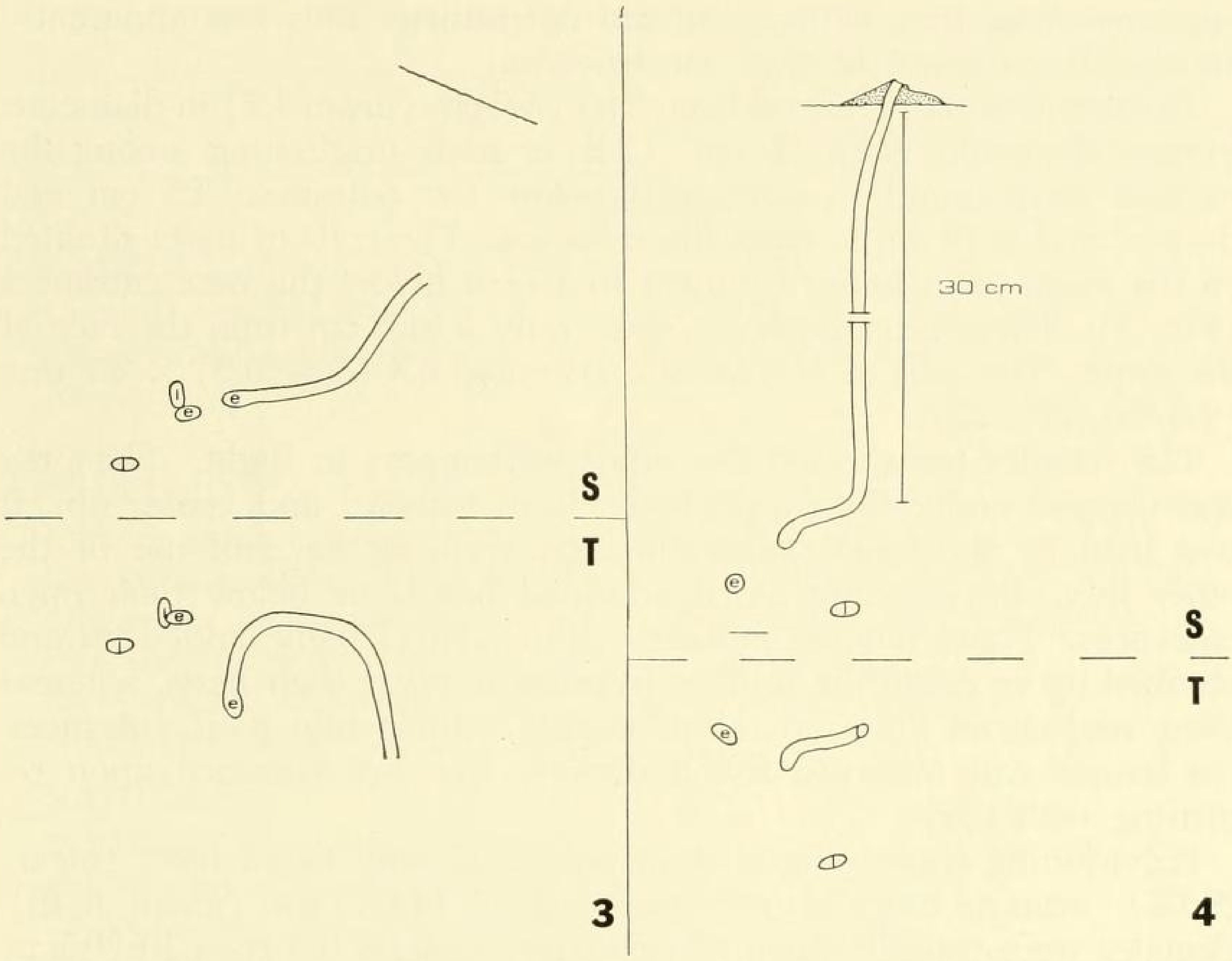


Fig. 3, 4. Nest structures of *Mimesa basirufa* and *M. cressonii*, respectively as seen in side (S) and top (T) views. Cell contents are as follows: (e), egg; (l), larva. Empty cell in Fig. 4 is incompletely provisioned. Scale applies only to Fig. 4.

Mimesa (*Mimesa*) *basirufa* Packard

Our observations on the nesting behavior of *Mimesa* (*Mimesa*) *basirufa* Packard were made from 20 June to 17 July 1972 at Selkirk Shores State Park, Oswego Co., New York. Females nested in the vertical bank of a sandpit (Fig. 1). The bank, 5 feet high, is composed of sand, except for the upper 30 cm of organic soil which is interwoven with dead rootlets. Most of the nest entrances were found among the rootlets. However, two females nested on a sandy slope below the vertical bank. One nest was located at the base of a small plant, the other under a clump of sand. Attempts at tracing the proximal portions of the burrows originating either among the rootlets or in the bare sand were largely unsuccessful. All of these burrows extended downward into pure sand.

Digging behavior was observed only once. A female which had been randomly searching in entrances and cavities among the rootlets entered an inactive bee burrow. Several seconds later, she pushed soil out of the entrance and reentered the burrow. Minutes later she appeared head first, exited, and did not return. This was apparently an abortive attempt at nest construction.

The nest entrances ranged from 3.5 to 5.0 cm (mean 4.5) in diameter; burrow diameters were 3.0 cm. Cells of nests originating among the rootlets were found in sand well below the entrances, 25 cm and deeper, and 6–19 cm in from the entrance. The cells of nests situated on the slope were found from 8.5 to 15 cm below the nest entrances (Fig. 3). These cells, however, were only 3 to 6 cm from the face of the slope. The cells of *M. basirufa* averaged 8.4 (5.5–10.0) × 5.7 mm (4.0–6.0, N = 23).

The females transported the small leafhoppers in flight. The prey was clasped under the wasp's body, head forward and venter up. It was held by the female's middle legs, allowing her full use of the other legs. Provisioning females landed beside or below their open entrances. Those females nesting in the vertical bank landed on and climbed up or down the rootlets in order to enter their nests, whereas those nesting on the sandy slope simply walked into their entrances. No female was observed flying directly into her entrance upon returning with prey.

Provisioning times ranged from only 2:25 min. to an hour (mean, 26:02). Storage times ranged from 3:15 to 14:05 min. (mean, 6:46). Females were usually observed provisioning nests between 10:30 a.m. and 4:00 p.m.; however, one female with prey was noted at 7:10 p.m. while another was observed searching in entrances at 8:00 p.m.

The prey of *M. basirufa* consisted of Cicadellidae (Table 1). Cells contained either all nymphs or all adults, and individual females provisioned their nests with either nymphs or adults. A fully provisioned cell contained, on the average, 3 (2–6, N = 21) leafhoppers. Only two leafhoppers were found in nine of the cells. The females were often noticeably larger than their prey. Individual prey weighed from 4.70 to 9.57 mg (mean, 6.63, N = 16). One female weighed 9.19 mg. The total prey weight in a single cell ranged from 11.32 to 34.55 mg (mean, 24.85, N = 5).

Prey were placed either venter up or venter in. In many of the cells that contained only two prey the leafhoppers were placed venter up, while in those cells containing more than two prey they were usually placed venter in. The position of the egg-bearing leafhopper in cells with several prey was on top of the other prey.

The wasp's egg, 1.8 × 0.5 mm, creamy white and evenly curved, was affixed longitudinally on the venter of the thorax of the leafhopper and extended from just below the eye to the hind coxa. Although the position of the egg is relatively fixed, wasps may oviposit on either side. One larva was found feeding on the left side, between the neck and front coxa, while another larger larva was found attached to a leafhopper's right forewing.

Table 1. Families and species of prey of species of *Mimesa.*

Species of prey	Number of specimens: Adults	Number of specimens: Immatures
M. basirufa		
CICADELLIDAE		
Oncopsis variabilis (Fitch)	13♀, 3♂	
Oncopsis sorbrius (Walker)	6♀, 1♂	
Idiocerus sp.		62
M. cressonii		
CICADELLIDAE		
Doratura stylata (Boheman)	112♀, 120♂	
Diplocolenus configuratus (Uhler)	15♀, 6♂	2
Athysanella longicauda Beirne	1♀, 2♂	
Polyamia compacta (Osborn & Ball)	5♀	
Laevicephalus melsheimeri (Fitch)	11♀, 10♂	
Scaphytopius sp.?		4
DELPHACIDAE		
Delphacodes campestris Van Duzee	1♂	
Delphacodes sp., prob. *campestris* Van Duzee	1♀	1
Laccocera vittipennis Van Duzee	1♂	
Liburniella ornata (Stål)	1♀	
PSYLLIDAE		
Craspedolepta sp.	1♂	

Some cells situated in the vertical bank were attacked by small red ants. No maggots were found in any of the cells. A female of *Nysson melanopus* Pate was observed entering and exiting from one of the nests on the slope, but no evidence of parasitism was found in this nest.

Mimesa (*Mimesa*) *cressonii* Packard

Our observations on the nesting behavior of *Mimesa* (*Mimesa*) *cressonii* were made from 17 July to 1 August and from 28 August to 1 September 1972 at the same locality. Females nested in a sandy field utilized as a snowmobile path during the winter (fig. 2).

Many of the nest entrances were surrounded by turrets (fig. 5), which were the result of soil pushed up the burrow. Several double turrets were noted; broken turrets, lying across and concealing entrances were also observed. The double turret could be the result of a second turret being built after the first toppled. Turret height ranged from 0.2 to 3.5 cm (mean, 1.2, N = 17). Recent turrets were higher than older ones, indicating the activities of the wasps and weathering. Turret diameter averaged 0.6 cm (0.4–1.0, N = 17) at the top and 2.7 cm (0.7–4.0, N = 29) at ground level.

Wind and rain frequently removed the outer soil of the turret, leaving only the agglutinated center. One female was noted depositing sand outside her entrance. She backed out, exposing only the thorax and abdomen, and quickly transferred pellets of sand from the front to the hind legs while anchoring the middle legs ventrolaterally against the entrance walls. The hind legs scratched away the pellets, where they accumulated at the bottom of the turret.

Six nests were excavated. Burrow diameters were 3.0 cm. Cells were unearthed between 12.6 and 54.5 cm (mean, 29.7, N = 30) below the ground surface (fig. 4). All of the cells were found in moist sand below the organic layer. The first cell was built furthest from and later cells progressively closer to the entrance. The cells represented the enlarged ends of the burrow, and oviposition occurred after the full complement of prey had been collected by the wasp. The female would then close off the cell, move up the burrow, and construct a new cell at the end of a horizontal burrow. Cell size averaged 7.7 (5.0–10.0) × 7.0 mm (4.5–9.0, N = 26).

Although females of *M. cressonii* transported their prey in the same manner as those of *M. basirufa*, they did not pause beside the nest entrance upon returning. Rather, they flew directly into the nest with the prey (fig. 6).

Provisioning times ranged from 1 to 14:29 min. (mean, 6:41). Storage times varied between 0:15 and 1:10 min. (mean, 0:40). Females were observed provisioning between 11:00 a.m. and 4:00 p.m.; however, a few females were noted hunting as early as 9:25 a.m.

The fully provisioned cells contained from 9 to 17 prey (mean, 14.7, N = 19). Cicadellidae, Delphacidae, and Psyllidae were preyed upon, with adult *Doratura stylata* (Boheman) (Cicadellidae) comprising most of the provisions (Table 1).

The females were considerably larger than their prey. Individual prey weighed from 0.36 to 3.56 mg (mean, 1.80, N = 242), whereas females weighed from 5.9 to 9.0 mg (mean, 7.6, N = 5). The total weight of prey per cell ranged from 14.65 to 39.70 mg (mean, 27.26, N = 16).

Several incomplete cells were found at the ends of the burrows. The prey in these cells were ill-arranged, whereas those in fully-provisioned cells were neatly arranged, usually head-inward and facing away from the burrow. Most prey were placed venter-up, although some at the top of the cell were positioned dorsum-up.

The egg-bearer was laid at the innermost end of the cell, head inward and usually venter-up. The wasp's egg, 1.2 × 0.3 mm, was affixed ventrally near the base of the front coxa and extended longitudinally backward beyond the base of the hind coxa. Eggs or

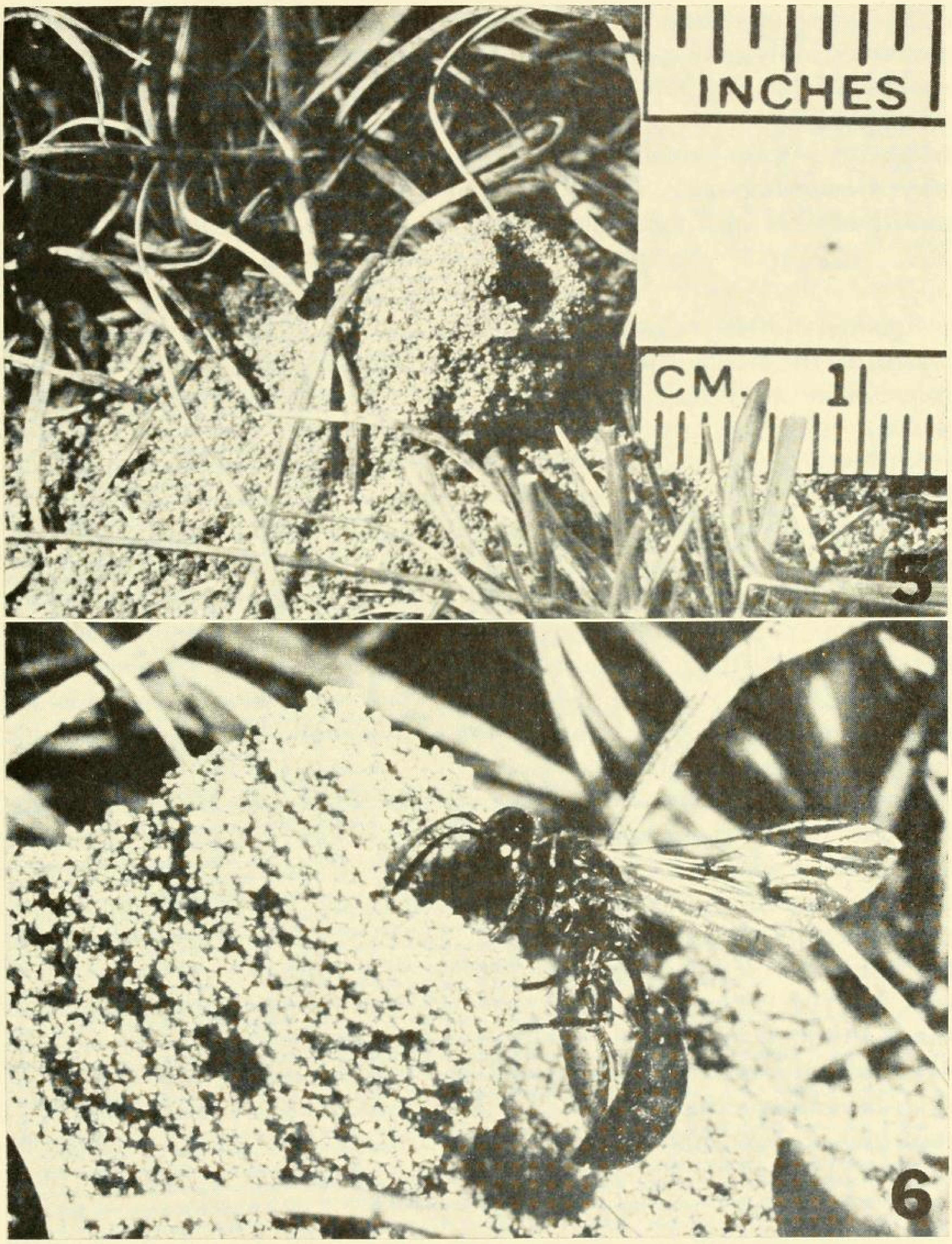


Fig. 5, 6. *Mimesa cressonii.* 5, Turret and entrance to nest. 6, Female entering nest with prey.

larvae were found on either side of the prey. Two cocoons, each 7 mm long, were found. They consisted of silk and oral secretions, with sand grains and prey parts adhering to the surface.

Six of 27 cells were destroyed by small red ants. All six cells were from one nest and were situated close to the organic layer. Three cells were parasitized by Miltogramminae (Sarcophagidae), but each contained only a single maggot. The maggots, 3 to 7 mm long, were not found in any particular position within the cell. Two maggots were placed in vials containing damp sand, and one adult *Senotainia trilineata* (Wulp) eventually emerged. Females of this fly were observed entering nests in an apparent attempt to larviposit. Female mutillids were also noted investigating entrances.

Discussion

Spooner (1948) distinguished *Mimesa s. str.* from other psenine wasps on the basis of provisioning with small Cicadellidae, excavating burrows in sandy soil, and carrying the prey ventrally with the middle pair of legs. Because the subgenus *Mimesa* has not been studied from the standpoint of comparative behavior and, therefore, little information is available on the nesting behavior of the various species, a comparison of *M. basirufa* and *M. cressonii* will serve to delineate some ethological components of potential value.

M. basirufa and *M. cressonii* may be separated temporally at Selkirk Shores, N. Y. However, there is probably some overlap between the two species in July. We were unable to observe either species in late summer and early fall in order to ascertain whether or not there are second generations. Krombein (1963) believed that *M. basirufa* is "usually univoltine" in Maryland.

Although *M. basirufa* nested in a sand cliff and *M. cressonii* inhabited a sandy field at Selkirk, Krombein (1961) reported the former species occupying level sand in Maryland. It would be enlightening to know whether or not *M. basirufa*, when nesting in flat sand, constructs a turret around its entrance as does *M. cressonii*. According to Williams (1914) and Spooner (1948), *Mimesa* (*Mimesa*) *ezra* and *M.* (*M.*) *equestris* construct turrets around entrances in level sand, although the turret structures were described variously.

Despite the fact that Spooner (1948) categorized species of *Mimesa s. str.* as constructing their own nests in sandy soil, observations on *M. basirufa* suggest that the females may select and utilize portions of other suitable-sized insect burrows for the proximal portions of their nests.

Although nests of *M. basirufa* were exceedingly difficult to excavate and, despite the fact that this species nested in sand cliffs, the burrow architecture of the multicellular nests of the two species is similar. The main burrow of *M. cressonii* enters the ground perpendicularly and this is related to building deep nests in level sand. As in many sphecids, the first cell built in *M. cressonii* is further from the entrance than subsequent cells. The rearing cells of *M. basirufa* are slightly longer and narrower than those of *M. cressonii*, possibly reflecting differences in the number and size of prey and how they are positioned in the cell. The more circular cell of the latter species may, in fact, be related to the storage of many smaller prey.

We could not discern differences in the manner in which the provisioning wasps transport their prey to the nests even though *M. basirufa* utilized larger prey than *M. cressonii*. According to Spooner (1948), *Mimesa s. str.* can be distinguished from the subgenus *Mimumesa* during prey transport by the manner in which the females grasp their prey. Females of the latter subgenus hold their very small prey with the mandibles, whereas those of the former use the middle legs. Manner of entry into the nest could serve to distinguish *M. basirufa* from *M. cressonii* as the former invariably landed nearby before entering while the latter always plunged directly in while holding the prey. However, this apparent distinction may be habitat-related and *M. basirufa*, when nesting in flat sand, may enter its nest directly.

Mimesa cressonii brought prey to the nest much more quickly than *M. basirufa* and took much less time in storing them. This could be related to the proximity of the hunting grounds, and/or to the size and abundance of prey. Miller and Kurczewski (In Press) have demonstrated an inverse relationship between size of prey and individual provisioning times in the crabronine genus *Lindenius*. This correlation may hold up for other groups of wasps.

There were distinct differences in the kinds and sizes of prey utilized by the two species of *Mimesa*. *Mimesa basirufa* provisioned with larger cicadellids of only a few genera and stored few prey per cell, whereas *M. cressonii* captured and stored not only different genera of cicadellids but also delphacids and psyllids and stocked each cell with many small prey. Even though females of *M. basirufa* were slightly larger and weighed more than females of *M. cressonii*, the range and mean of total weights of prey per cell for the two species were almost the same.

In some cells of *M. basirufa* the egg-bearing leafhopper was placed uppermost in the cell, whereas in *M. cressonii* the egg-bearer was often innermost. This might reflect the different sizes of the individual prey within the small confines of the cell. The placement of the wasp's egg was rather uniform in both species and might serve as a genus-specific character. In many other genera of solitary wasps, with few exceptions, placement of the egg is often uniform within the genus if the species prey upon the same group of insects.

Although *M. cressonii* was more afflicted with ants and parasites than *M. basirufa*, this might simply reflect a difference in nesting site. Several workers on solitary bees and wasps have suggested that nests built in sand cliffs, because of the "atypical" habitat, are less attacked by the customary parasites, predators, and scavengers than those constructed in level sand.

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