

Biological Interrelationships in Mud-Dauber¹ Nests with Special Reference to *Osmia cordata* Robt.

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The mud nests constructed by the sphecids wasps, *Sceliphron caementarium* (Drury) and *Trypoxylon politum* Say, are commonly observed in outbuildings, under bridges and other protected places. The life history of each of these species has been recorded numerous times in the literature with the works of Rau (11, 13) on both species and that of Shafer (17) on *S. caementarium* being most inclusive and most pertinent to this study. A more complete listing of species biology was given in Muesebeck, *et al* (9).

Both mud-dauber species mass provision their cells with spiders. Whether the wasps develop and emerge as adults or fall victims to parasites or predators during their development, there is a residue of animal parts in each cell. Thus, there develops in nearly every nest a scavenger fauna (cabinet beetles, spider beetles, psocids, etc.). Linsley (7) has presented an excellent discussion of this fauna. In some instances, these scavengers enter a nest before the wasps have emerged and destroy the wasps in the role of predators rather than as scavengers. Completing this interesting, interrelated complex of nest inhabitants, there are certain wasps and bees which utilize the mud-dauber nests as sites for their own nests. Among this latter group are two species of mason bees, *Osmia cordata* Robertson and *Osmia lignaria* Say, the former species utilizing the nests of mud-daubers almost to the exclusion of other sites.

Osmia cordata, A Review

O. cordata was described by Robertson (14) from Carlinville, Illinois. Cockerell described the species in 1906 (1) from Boulder, Colorado under the names, *O. hesperella* and *O. coloradella*, and in 1907, that author (2) described the species as *O. ramaleyi* from Boulder. Later, he (3) expressed the opinion that the three names applied to a single variable species and in 1928 (4) indicated this in key form. In 1935, he (5) described *O. figginsi* from Elbert, Colorado. In 1939, Sandhouse (16) placed all of Cockerell's names in synonymy of *O. cordata*.

The distribution of the species as given by Sandhouse (16), was: Illinois, Missouri, North Dakota, Colorado and New Mexico.

Rau (12) has published on the life history of *O. cordata* and of *O. lignaria*, a species occupying similar nest sites but appearing earlier in the spring and of much more common occurrence. A brief summary of the life history of *O. cordata*, as recorded by Rau (12) follows:

Both sexes overwintered as adults within a cocoon and emerged at approximately the same time (April 22-May 2). Mating occurred upon

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emergence and females began nidification in some appropriate site, usually mud-dauber nests. Cells were fashioned by partitioning existing galleries with chewed leaf pulp. It was observed that females developed in cells of a larger size than those in which males developed. In 1930, the first adult emerged May 2 and cocoon formation of the developing brood was complete on June 4. Adults were present in the cocoons in late summer or early fall. The flight period of the species was from five to six weeks with a single generation per year. The sex ratio (based on 1926 emergence data) was recorded at 29 males and 12 females.

Rau (12) recorded *Monodontomerus montivagus* Ashmead as a parasite of *O. cordata* and Hicks (6) recorded *Sapyga emarginata* Cresson as parasitizing this species in Colorado.

Reference to the nesting sites of *O. cordata* are relatively numerous and these are summarized in Table 1.

TABLE 1
Nest Sites Utilized by *O. cordata* Robt.

Site	Locality	Reference
Holes in wall	Boulder, Colo.	Cockerell (3)
<i>Sceliphron</i> nests	St. Louis, Mo.	Turner (19), Rau (10)
<i>Sceliphron</i> and <i>Trypoxylon</i> nests	—do—	Rau and Rau (13)
<i>Xylocopa</i> gallery	Kirkwood, Mo.	Rau (11)
<i>Sceliphron</i> nests	White Rocks, Colo.	Hicks (6)
Tunnels of <i>Anthophora abrupta</i> and <i>Melitoma taurea</i>	St. Louis area	Rau (12)
<i>Xylocopa</i> tunnels	—do—	—do—
<i>Sceliphron</i> and <i>Trypoxylon</i> nests	—do—	—do—
<i>Polistes</i> nests	—do—	—do—
Key holes in house	—do—	—do—
Artificial galleries (trap nests)	—do—	—do—
<i>Sceliphron</i> and <i>Trypoxylon</i> nests	Friendship, Ind.	New record
<i>Polistes</i> nest	—do—	—do—
Cerambycid galleries in building timbers	—do—	—do—
Trap nests (elderberry stems)	—do—	—do—

Flower visitation records are few, there being more records of nests and nest sites than of field captures. Table 2 summarizes these records with the number and sex of each bee collected in parenthesis.

Development of the Study

For a number of years this writer had observed mason bees utilizing the nests of mud-daubers, the nests occurring in great numbers in a tool and grain storage shed on the W. S. Lemon farm at Friendship, (Ripley County) Indiana. In 1956, several nests of *Sceliphron caementarium* were collected and series of *Osmia cordata* and *O. lignaria* re-

TABLE 2
Flower Visitation Records of *O. cordata* Robt.

Flower Species	Locality	Reference
<i>Cardamine bulbosa</i> (♂)	Carlinville, Ill.	Robertson (15)
<i>Rubus canadensis</i> (♀)	—do—	—do—
<i>Trifolium hybridum</i> (♀)	—do—	—do—
<i>T. pratense</i> (♀)	—do—	—do—
<i>T. repens</i> (♀)	—do—	—do—
<i>Astragalus goniatius</i> (♀, ♂)	Boulder, Colo.	Cockerell (2)
<i>A. tenellus</i>	Bowman, N. D.	Stevens (18)
<i>Aesculus glabra</i> (♂)	Carlinville, Ill.	Robertson (15)
<i>Phlox divaricata</i> (♂)	—do—	—do—
<i>Gilia calcaria</i> (♂)	Elbert, Colo.	Cockerell (5)
<i>Lithospermum canescens</i> (♂)	Carlinville, Ill.	Robertson (15)
<i>Salvia officinalis</i> (♀)	Tippecanoe Co., Ind.	Montgomery (8) ¹
<i>Pentstemon hirsutus</i> (♀, ♂)	Carlinville, Ill.	Robertson (15)
<i>Taraxacum taraxacum</i> (♂)	Boulder, Colo.	Cockerell (2)

moved from their cocoons. During the winter of that year, a nest of *Polistes fuscatus pallipes* Lepeletier was removed from the outbuilding and returned to the laboratory. The nest contained a number of empty polistine cells, nine of which had been sealed over with leaf pulp and one cell which had been sealed with mud. The nest was held in the laboratory until the bees emerged. From the cells capped with leaf pulp, nine individuals of *O. cordata* emerged. The sexes and dates of emergence in 1957 were: March 11 (♂), 12 (♂), 13 (♂), 16 (2♂♂), 18 (♀), 22 (♂♀), 23 (♀). A female of *O. lignaria* emerged from the mud cell during this period.

At various intervals during the 1957 season, occasional nests of *S. caementarium* and *T. politum* were removed from this outbuilding. Examination revealed that a very high percentage of the cells of *O. cordata* were being entered by the larvae of *Trogoderma* spp. The larvae of *Trogoderma* destroyed the pupa or adult in every cell entered and appeared to be a major factor in keeping the *O. cordata* population at a low level.

The Nest Environment of *O. cordata*

On May 6, 1958, prior to the emergence of *O. cordata*, a large number of mud-dauber nests were removed. Table 3 is a summary of this study.

From Table 3, it can be seen that less than half (44.7 percent) of the cells constructed by *O. cordata* females gave rise to adults. Predators and parasites destroyed developing individuals in 40.4 percent of the cells of which species of *Trogoderma* accounted for the destruction of 34 percent. Diseases, dessication and unknown factors were responsible for the failure of bees to develop in 14.9 percent of the cells.

A second factor of importance in considering the scarcity (as observed by this writer) of the species is the unequal sex ratio super-

¹ Reported as *O. coerulescens* (L.). All references, except one female, do apply to *O. coerulescens* including the records on *Salvia*.

TABLE 3

Summary of the Development of *O. cordata* in Mud-Dauber Nests
(Friendship, Indiana, May 6, 1958)

Nest ²	No. <i>O. cordata</i> cells	No. adults emerged	No. destroyed by <i>Trogoderma</i>	No. other parasites or predators	No. died from other causes
1	10	10	0	0	0
2	3	0	2	0	1
3	1	0	0	0	1
4	6	3	3	0	0
5	9	2	4	2 ³	1
6	6	2	4	0	0
7	3	1	2	0	0
8	5	2	0	1 ⁴	2
9	1	1	0	0	0
10	3	0	1	0	2
Totals	47	21	16	3	7
Percent	100	44.7	34.0	6.4	14.9

imposed upon an already small population. Rau (12) noted this disproportion of sexes in the St. Louis area where he recorded the ratio as about 2.5:1 (29♂:12♀). As previously mentioned, the sex ratio of individuals of *O. cordata* which emerged from the nest of *Polistes fuscatus pallipes* was 2:1 (6♂:3♀). Of the 21 individuals which emerged from the mud-dauber nests (Table 3), the ratio was again 2:1 (14♂:7♀). If it is assumed that the cells found in each nest are the product of a single female (and this appears to be true), then from a total of 10 nests in 1958, only seven females emerged, a population decrease of 30 percent.

Rau (12) noted that the population of *O. lignaria* increased during the years in which he observed this species. The population of *O. cordata*, during this same period, remained low throughout. A similar condition has been observed during this study. There are evidences that may account for these observed differences:

1. *O. lignaria* emerges 4-6 weeks before *O. cordata* and, therefore, has the advantage of site selection.

2. The sex ratio according to Rau (12), is nearly equal in *O. lignaria* (203♂:200♀) or slightly in favor of males (11♂:7♀). Observations of this writer on *O. lignaria* show about a 1:1 ratio. The sex ratio of *O. cordata*, as stated previously, favors males 2.5:1 to 2:1.

3. *O. lignaria* uses mud for cell construction and/or partitions. These hardened mud partitions appear to be effective barriers against predators and parasites, especially against the depredations of *Trogoderma*.

² Nests 1-9 were those of *S. caementarium*; nest 10 of *T. politum*.

³ *Ptinus hirtellus* Sturm.

⁴ Hymenopterous parasites—no adults remained for determination.

O. cordata uses leaf pulp and tends to partition existing spaces without constructing cells. The pulp partitions are readily penetrated by predators and parasites.

4. *O. lignaria* thoroughly cleans the mud-dauber gallery before provisioning. *O. cordata* also cleans the galleries, but in the case of *Trypoxylon* nests, the females will utilize the broken cocoons of the wasp, cleaning only the inside of the cocoon and leaving living *Trogoderma* larvae in the area surrounding the cocoon.

5. *Trogoderma* spp. are almost always present in the nests of both mud-dauber species if the nest is imperfectly constructed, broken or cracked, or following the emergence of a wasp or its parasites from the nest.

Summary and Conclusions

Studies of nests of *O. cordata*, which were constructed within the nests of mud-daubers, *S. caementarium* and *T. politum*, showed that adult bees emerged from only 44.7 percent of the cells constructed. Predators and parasites destroyed the bees in 40.4 percent of the cells and diseases, dessication and unknown factors were responsible for the failure of 14.9 percent. The depredations of *Trogoderma* spp. were alone responsible for destroying 34 percent of the cells.

In 1958, from a series of 10 nests, each assumed to be the product of a single female, a total of 7 females emerged. Reasons cited which may contribute to the low local population were given as: 1) interspecific competition for nest sites, 2) disproportionate sex ratio favoring males, 3) ineffectiveness of leaf pulp as a barrier to predators and parasites, 4) failure to clean galleries or the tendency to use contaminated cells, and 5) the omnipresence of scavengers which act as predators upon the developing bees.

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