The nesting habits of *Macropis* Pz.
(Hym. Apoidea)

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(Láms. II-III.)

The solitary bees of the genus *Macropis* Pz. occupy a very isolated position among other bees, and it is supposed that they represent only remnants of a group once rich in species and at the present time near its extinction. Besides three European species there are in North America five other species of this genus (Friese, 1923).

These bees have long since attracted the notice of investigators chiefly by a singular peculiarity: they moisten the flower pollen that they carry on their hind legs (H. Müller, 1872). Such a habit has placed the *Macropis* in a special position amongst solitary bees, and on account of this habit they were considered as related with the social ones. Moreover, the close connection of these bees with the *Lysimachia* flowers *(Primulaceae)* was evident. Indeed, not only in Europe, but also in America the *Macropis* manifest a great predilection for the flowers of *Lysimachia*, though they visit sporadically a few other plants, as well (*Rhus*, *Rubus*, *Heracleum*, *Cirsium*, *Oryganum*, *Alisma*, *Leucopus*, *Lythrum*).

Not having found any nectar glands in the flowers of *Lysimachia vulgaris* H., Müller made a suggestion that these bees pierce the tissue of the blossoms to get the juice needful for the moistening of the pollen. However, soon after this, the American naturalist Patton (1879, p. 286) happened to observe a female *Macropis*, sucking the nectar from sumach flowers. Starting from this and also from the fact, that the nectar glands on the stamen of *Lysimachia*, are numerous, Patton declares that *Macropis* moistens the collected pollen just with the nectar. On the ground of his personal observations Bouwman (1920) deems

it probable that the pollen is collected by the *Macropis* from the *Lysimachia* and the nectar from other plants (see p. 8).

In spite of the interest thath as been aroused in regard to these bees there existed in literature till the latest time no data based on facts concerning their nesting habits. I cannot say, on what Friese (1891) founded his statement, that these bees nestled in the ground, but I consider this to be right. In fact, nests built in ready cavities, also in wood and pithy plants or on open places, have so many chances of being discovered, that, were it really so, they hardly could have remained unknown to the present time. On the contrary, nests built in the ground under certain conditions prove to be so well concealed, as to escape even the experienced eye of a naturalist. Later Bouwman (1920) has made the suggestion, that *Macropis*, like all the solitary bees carrying the pollen on their legs (*Podilegidae*), must nest in the ground. However, this assertion cannot be considered wholly convincing, since in our fauna, not to speak of the fauna of the tropics, there are bees carrying the pollen in the legs and yet not nesting in the ground (*Ceratina*, *Xylocopa*). However, my actual observations have afterwards shown, that *Macropis* nest indeed in the ground.

The rare cuckoo-bee *Epeoloides caecutiens* F. is considered the parasite of these bees.

Macropis fulvipes F.

In the area of my summer works, in the southern part of the government of Kursk, near the village Borisovka, I succeeded in finding only two species of *Macropis*, *M. labiata* Pz. and *M. fulvipes* F. Both of them are to be found in the vicinity of Borisovka only in single specimens and in certain places, namely on flowers of *Lysimachia*. Under such conditions it was no easy matter to discover the nest of these bees.

At the end of the summer of 1926 together with my assistants I undertook a special excursion to small groups of *Lysimachia vulgaris*, growing on the bank of the river Vorskla, where the *M. labiata* could be mostly found. A careful exploration of all the nooks and corners of the bank that seemed at all suitable for these bees, as well as the

observation of their almost noiseless flight, have not led to any positive results. Neither have we succeeded in discovering spots visited by *Macropis* where *Lysimachia* did not grow.

The state of the *Lysimachia* flowers, however, proved, that the flight of our bees was already drawing near its end. Such being the state of things, it was preferable to put off the research till the next summer, in order to begin anew, at the proper time, our observations on the development of the *Lysimachia* and the appearance of the *Macropis*.

In the meantime I had received a letter from Dr. H. Friese, in which the most eminent expert in bees of the world suggested that I should attempt to clear up the biology of *Macropis*. I could only answer that this problem has long since greatly interested me, but that till now I was at a loss to solve it.

The following summer has, however, brought favourable results. On the 20th of June, 1927, while examining the collection of wasps and bees brought by a pupil of mine Miss E. A. Pessotsky from a distant excursion, to a place called Krassyevo, I found among them two males of *Macropis fulvipes*, but there was no female of this species with them. My first question was: where and under what conditions had she caught them? It appears that they had been caught not upon flowers but on their flight over an earth-bank enclosing the Krassyevo forest seedling plots. Since the males of solitary bees are generally to be found either upon flowers, or in places where the females build their nests, the flight of the males of *M. fulvipes* over the above mentioned earth-bank gave me some hopes of finding their nests also there. Therefore we decided upon going to Krassyevo at the first opportunity. On the 27th of June, having arrived there, we proceeded straight to the place, where a week before the males of *M. fulvipes* had been caught.

Soon one of them could be seen flying above the bank evidently in search of the female. Here we stopped, waiting for the appearance of the female. The earth-bank near which we stood was in itself a low elevation running from North to South along the West side of a shallow ditch. The locality all around was very low and in some places swampy; therefore the ditch was nearly full of water. Tall vegetation consisting of *Lythrum salicaria, Malachium aquaticum*, etc., had over-

grown nearly the whole surface of the bank, so that no place of uncovered ground considerable enough to attract one's attention was to be seen.

However, we had not long to wait: soon we noticed one, in a little while yet another shiny black bee carrying yellow pollen on its hind legs. These were females of *M. fulvipes* that came flying to their nests with a full load of their harvest and now enjoying the habitual rest of the solitary digger bees before entering their nests. A moment more - and one of the females disappeared in the vegetation covering the earth-bank. In order to find the spot I crossed the ditch and lay flat upon the grass, while my companion, standing on the opposite side of the ditch, watched the flight of the bee from above. Nevertheless this was not sufficient: I had to cut the grass with scissors to uncover the ground and only then the entrance of the nest was found. Only 20 minutes were required after our arrival to the place in order to find the secret spot, and that at a distance of 17 kilometers from home. Our confidence in the males has been, after all, wholly justified: they have betrayed the nests of their females. Surely, it would have been impossible to find their nests by an accident in the conditions they proved to be.

The earth-bank, that had given shelter to *M. fulvipes*, was composed of damp, extremely friable, peaty earth with an admixture of a great quantity of dead stems and rotten dung. In some places only little clayish lumps were to be found; these last formed on the surface of the bank various projections of the size of the palm of the hand or smaller. Just in these projections and hillocks more or less overgrown with short moss did the *Macropis* nestle.

A year later, when the present paper had been already written, we succeeded in discovering a new place of nestling of *M. fulvipes*. It was in the nearest vicinity of Borisovka, in a forest ravine, on the brink of a shallow gully, thickly overgrown with *Lysimachia nummularia*, *Geum*, *Fragaria*, *Scrophularia*, moss and other plants (pl. II, fig. 1).

Here, as in Krassyevo, the nests of the *Macropis* were disposed near one another, at a distance of 3-5 cm. This circunstance points to the fact that *M. fulvipes* are inclined to settle in colonies. In fact, when digging here, many old cells were discovered in close proximity to each other. The colonies that we found, were, however, very

small—having hardly more than half a dozen nests in each. However, the very character of the soil at Krassyevo with its separate clay lumps was not favourable to the formation of large colonies, but the grey forest argillous soil of the vicinity of Borisovka seems to offer more favourable conditions for that.

The entrance holes of the nests were almost invariably situated either on the projections of the ground or just on the brink of the gully. Near them in most cases one could not notice any byworks; one could only observe a small friable hillock on the more level places at the lower edge of the entrance hole (pl. II, fig. 2). The artificial solidification of these hillocks by water has shown that almost daily a small quantity of friable earth appeared on their surface. It is evident, that *M. fulvipes*, when building its nest, throws out very little earth each time, but repeats the process several times.

Thus the entrance itself was surrounded mostly only with moss and therefore hardly perceptible. Its diameter did not exceed 6 mm. More or less characteristic was the fact, that at the beginning of the tunnel on the walls of the burrow there could usually be seen traces of yellow pollen, evidently dropped by the bee on its return to the nest when carrying home its harvest. From the entrance hole the burrow runs almost horizontally with a slight slope downwards and often deviates sideways from the straight direction. It was difficult to discern in it the usual parts of the burrow of the digging bees, only a comparatively more sloping entrance tunnel about 3 cm. long could be better perceived.

The sides of the burrow were carefully smoothed on the inside, but they were not polished and were not coated with anything except a thin layer of worked up earth. The general length of the burrow, considering the position of the cells, did not exceed 8-10 cm. However, most of the cells were placed at a distance twice or three times nearer to the surface of the ground.

The burrow ended, as is usually the case with the digging bees, by a cell dug in the ground, placed in a slightly inclined position. The inner coating of the cell of *Macropis*, however, proved to be a peculiar one. Owing to this coating the interior of the cell had a dark olive tint with a faintly shiny slightly rugose surface. At the place of fracture of the cell the inner coating was feebly perceptible, but it lay

over the whole cell and even reached its vestibule. A drop of water introduced in the inside of the cell is not absorbed by its wall and conserves a sharp outline in places where it comes into contact with the wall, which is best noticeable on cells previously dried up; hence one can conclude that the inner coating of the cell is waterproof.

When a previously prepared and dried up half of a cell is placed in a salt-cellar and water is carefully poured under it by means of a pipette, the earth on the outer side of the cell immediately becomes dark and thereupon falls down so abundantly that the cell floats on the surface of water like an earth shell glazed inside.

When the water is carefully heated to the point of boiling (in a tea-spoon on a spirit lamp), the shell breaks into rather large bits. The inner coating of these fragments rising like thin yellow foam, is not to be dissolved in water and, when cooled, looks like hardened froth. If observed through a binocular the inner coating now reminds one exceedingly of hardened yellow wax. This frothy substance easily melts and spreads almost without leaving any residue, when the fragment of the shell is subjected to the heat of a flame.

Under the action of ether and chloroform this frothy substance rapidly swells and falls in flakes, slightly tinging the fluid with its colour and thus manifesting yet stranger indications of dissolution.

When the cell is soaked in chloroform, the inner coating immediately breaks into small yellowish flakes, the shell of the cell itself remains whole and is not deformed. After having been soaked in chloroform during 24 hours, the shell, when dried up, loses its characteristic lustre and colour and only here and there dull yellowish spots can be feebly discerned on its inner surface. The drop of water introduced in this shell is now absorbed and the outer layer of the shell darkens far beyong the limits of the drop. After the action of chloroform the shell of the cell evidently becomes water permeable, though the process of the absorption of water by its walls proceeds somewhat slowly.

After the experiment just described, when the shell had been again dried up and I dipped it in sulphuric ether, the result remained the same: the shell did not break in fragments and the absorption of water in it proceeded somewhat slowly. Then one could see that the inner yellow polishing of the cell had disappeared and only its outer earth

wall remained smoothed inside, of a dull-grey colour and water permeable.

The action of caustic potassium (KOH) on the wall of the cell was different. A part of the wall of the cell taken out of the substratum and washed in water had been steeped in a solution of caustic potassium for 24 hours at a room t°. The result was that the yellowish tinge of the inner coating had entirely disappeared, though the coating itself had been preserved and after drying up had become now of a bluish-white colour. In a wet state it was very tender, could be easily folded and divided into fragments. Here and there it was quite detached from the outer earth layer, so that it could be easily transfered to a salt-cellar containing water. After having been dried up it became, as has been stated, of a bluish-white colour, if small dark specks that could be seen in some places, were not taken into account. By its appearance, in this state it reminded one of the inner coating of the cell of *Anthophora*, grown white under the action of time.

In the course of this experiment a thin cut of yellow wax of the honey bee and a piece of glassy resin from the cell of the *Trachusa serratulae* Pz. were placed for comparison in the salt-cellar with KOH. The result of this was that the wax remained whole but had lost its yellow tint and had become white and the resin had grown soft and subsequently dissolved.

On the ground of the above stated we are led to the conclusion that the inner coating of the cell of *Macropis* is not of a silk-like type, as with most of the digging bees, but *wax-like*, as with *Melitta* and *Anthophora* (Malyshev, 1923 and 1925).

M. fulvipes gathers its provision chiefly from the flowers of *Lysimachia nummularia*, which is abundantly found on our forest slopes and ravines. However, I happened to observe this bee also on the flowers of *Malachium aquaticum* and *Scrophularia nodosa;* but a microscopical investigation of the provision, extracted from the cells at Krassyevo, proves that *M. fulvipes* gathers pollen also from some other plants, which have round pollen grains with a few projections on them.

By means of a binocular it is easy to observe on the fresh flowers of *L. nummularia* a bright fluid between the glands at the base of the

stamens. This fluid tinges a piece of filtering paper with a lemon-yellow colour. Evidently *M. fulvipes* uses this nectar when visiting the flowers of *L. nummularia*. In fact, if one touches with filtering paper the pollen paste, which *M. fulvipes* carries on its legs, the edge of the paper also gets tinged with lemon-yellow colour.

The gathered pollen is brought by the bee in a very moist state on the tibiae and metatarsi of its hind legs (pl. III, fig. 3); a small part of it likewise can be seen on the tibiae of the middle legs. It is interesting to note, that the pollen paste is disposed in the case of *Macropis* not only on the outer side of the hind leg, but encircles the leg all round somewhat like the case of the «muff-carrying» bee, *Melitturga clavicornis* Latr. (Malyshev, 1925). The clod of pollen paste, brought on the leg of *Macropis*, is nevertheless not whole—it is divided into two unequal parts: a large one, corresponding to the tibia, and a smaller one, to the metatarsus (pl. III, fig. 2).

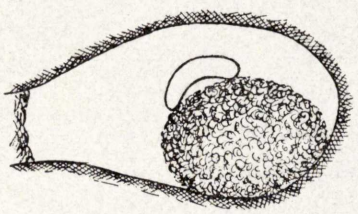

Fig. 1.—Scheme of a stored cell of *Macropis fulvipes*.

The provision, stored in the cells, is formed by *M. fulvipes* in the shape of an oblong yellow loaf, lying loosely in the hind part of the cell (fig. 1 and pl. III, fig. 3). The lower somewhat convex surface of the loaf is very rough and rugose. Evidently it consists of insufficiently worked up clods of pollen paste, brought on the legs. The upper surface of the loaf is, on the contrary, rather smooth, kneaded enough and, judging by its more delicate consistence, contains some slight admixture of honey. I have measured four such loaves; they were from 5,8 to 6,5 mm. long by 4 to 4,3 mm. wide.

The bow-shaped egg of the *Macropis* leans loosely by both its ends on the upper surface of the loaf in its fore part. At the slightest push it falls sideways.

The lid shutting the cell stored with provision and egg is solid, earthen, unpolished and strongly concave on the inside. The spiral arrangement of the particles, that constitute it, is well discernable here. In this spiral one could count up to 4 turnings.

On account of the close proximity of the burrows and partly of the above described properties of the soil in Krassyevo it was difficult

to investigate the arrangement of cells in the nest of the *M. fulvipes*. I succeeded only in observing that the nests were of *a lineal branching type* and the cells were placed near one another at a distance of only 1-2 cm. Two cells usually were disposed along one tunnel—evidently, the principal and the supplementary one, separated from each other by a massive earth stopper. Altogether I have opened about a dozen nests taken from several colonies.

On the 27th and 28th June, when the cells were opened, eggs and the still feeding larvae were observed, besides the stores of provisions (pl. III, fig. 3). Larvae, having terminated their feeding period, were not to be seen. The hatched larva at first remains in the place of the egg, on the loaf, and later embraces the loaf with its body. Having finished feeding the larvae cast out half liquid excrements.

At the first excavation of the nests of *M. fulvipes* old, solid cocoons were found in the neighbourhood of cells; these cocoons had the form and the size, corresponding to the cell of *Macropis*. As these cocoons were placed in cells still retaining their special walls, I began to suspect that the larvae of *Macropis* spun cocoons. Direct observations have confirmed this surmise.

Two larvae that I placed in artificial cells have emitted a great quantity of redish-brown, rather rough threads, and one of them, left in its own cell, had spun a real cocoon. Later I found many characteristic cells of these bees, containing cocoons in clods of earth, brought by me from the nesting places of the *M. fulvipes*. These cells mostly contained an old cocoon, from which the bee had emerged and which was now filled with earth; only a few of the cocoons were inhabited.

The cocoon of *Macropis* (pl. III, fig. 4) fills in the entire cell and therefore has the form of its cavity, being sharply truncated in front correspondingly to the lid of the cell. It is feebly glued to the walls of the cell and can be easily extracted. It is rather hard to the touch, of a dark-brown colour, almost black in the case of old cocoons. The front third of it is visibly narrower and covered here with a rough netting of reddish-brown threads.

In the walls of the cocoon one can easily distinguish three chief layers: a solid outer one, only in the fore third concealed under the above mentioned rough netting; the middle one, grained, mainly con-

sisting of worked up excrements of the larva and nearly absent at the fore end of the cocoon, and, lastly, the inner one, that covers the cocoon on the inside like a very thin cobweb with a mother-of-pearl shine.

On the 14th of May, 1928, when the cocoons that had wintered in an uninhabited room, were dissected, I discovered in them still resting larvae (pl. III, fig. 5). Thus *M. fulvipes* spends the winter in the stadium of a resting larva, lying loosely in the cocoon. Its dull-white body has sharp projections of segments at the sides of the back; the larva is curved in the shape of a comma, so that its head touches the abdominal surface.

On the 22nd of May, 1928, larvae kept in my room began to change into pupae, and three weeks later (13th of June) an adult female bee emerged from the control pupa. At the same time the two first males had changed into the stage of imago. The wings of all the three bees had developed defectively.

In natural conditions the process of development of *M. fulvipes* evidently proceeded simultaneously. On the 21st of June the first flowers of *L. nummularia* were found in the forest ravine, and on the 27th of June the first individuals of *M. fulvipes* have been caught. The coincidence between the two events—the beginning of the flowering of *L. nummularia* and the appearing of the *M. fulvipes* is worthy of attention.

Macropis labiata F.

According to the observations of B. E. Bouwman (1920, pp. 3-9) this species is fairly common in Holland in damp places, for instance, along ditches, where *Lysimachia vulgaris* (gele wederik) and other plants visited by this bee habitually grow. As the earliest date for the flight of this bee this author names the 21st of July, 1907 (near Breda).

In order to find out the nests of this bee Bouwman selected a solitary group of *L. vulgaris* and commenced to observe the flight of the bees loaded with pollen, by means of a field-glass. Soon he perceived three bees flying over the grass on one of the walks previously investigated and considered suitable for the *Macropis*. However, it would

have been impossible to discover the nest, if the bee itself had not shown the way there.

In fact, «the entrance hole was very well concealed. It was situated on the edge of the path under overhanging grass». «One decimeter deep in the ground»—the investigator further states—, «I found two cameras: one with a young larva in it and other with a more developed one. Both larvae were busy each with a lump of pollen. The lumps of provision were of a dark-brown colour, darker than the food of *Andrena* and *Halictus*... There was yet another pair of nests in the neighbourhood, that I left undisturbed».

The investigator does not mention all such important peculiarities of the nesting habits of the *Macropis*, as their use of a wax-like substance for the coating of the cells and the preparation of a cocoon by the larva, but one can suggest that these are proper to this species, as well.

At the end of the summer of 1928 I happened to investigate one nest of this species (pl. III, fig. 6). It was found on the 21st of August near Borisovka, on the bank of a small hollow thickly overgrown with *Lysimachia vulgaris*, *Lythrum salicaria* and other vegetation of damp places.

The little friable hillock was hardly visible among the dense turf, which covered the ground rich in rotten dung. The slightly curved burrow sank down into the ground to 3 cm. deep, and then ran on as a horizontal lateral tunnel about 1 cm. in length, terminated by a still open cell. Judging from the disposition of the other cells, the lateral tunnels, that led to them, were, however, much longer, and two of them reached 4,5 cm. The cells of the *M. labiata*, considering their construction, did not differ in any essentials from the cells of the former species and like them were lined from inside with a yellowish wax-like substance.

Four cells were discovered in the nest. The two first cells contained young larvae and lumps of provisions; the third—provision and an egg, and the fourth—a little quantity of provision yet unformed, which was deposited near the very botton of the cell.

During the night of the 25th August the larva hatched from the egg, which was in the third cell. One must take into account, that on the 21st of August the bee was still observed gathering provision,

as appears precisely for the third cell, and on the 23rd August this nest was taken out; so the egg stage had lasted about 3 days.

Summary.

The first individuals of *Macropis fulvipes* appear near the village of Borisovka (governm. Kursk, Russia) in the second half of June (20.VI.27; 27.VI.28), almost synchronically with the beginning of the blossoming of *Lysimachia nummularia*. In choosing a place for nestling this bee shows an obvious preference for damp clayish soil and here settles in colonies (pl. II, fig. 1). The nest hillock is mostly absent or is very small (pl. II, fig. 2). The burrow runs almost horizontally, only its entrance part is more sloping. The general length of the burrow does not exceed 8-10 cm. It ends by a cells dug in the ground and disposed in a slightly inclined position. The inner coating of the cell of *Macropis* is of a *wax-like type* (not silk-like).

M. fulvipes gathers its provisions chiefly from the flowers of *Lysimachia nummularia*. The gathered pollen is brougt by the bee in a strongly moistened state on the tibiae and metatarsi of its hind legs (pl. III, figs. 1 and 2). The provision, stored in the cell, is formed in the shape of an oblong yellow loaf, lying loosely in the hind part of the cell (fig. 1 and pl. III, fig. 3).

The bow shaped egg of *Macropis* leans loosely by both its ends on the upper surface of the loaf in its fore part.

The lid, shutting the cell, is solid, earthen, unpolished and strongly concave on the inside. The spiral disposition of the particles that constitute it is well discernible.

Two cells are usually disposed along one tunnel, and the nests themselves are of a *linear branching* type.

The larva of *M. fulvipes* spins a cocoon which wholly coats the entire cell and therefore has the form of its cavity (pl. III, fig. 4).

The bee spends the winter in the stadium of a resting larva; loosely lying in the cocoon (pl. III, fig. 5). The stadium of the pupa lasts three weeks.

M. labiata also coats its cells from the inside with a wax-like substance.

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Explanation of Plates II and III.

PLATE II:

Fig. 1.—A forest ravine near Borisovka, where a colony (×) of *Macropis fulvipes* was found.

Fig 2.—Two nest hillocks of *M. fulvipes* amidst flowering stems of *Lysimachia nummularia*.

PLATE III:

Fig. 1.—*Macropis fulvipes* with load on its hind legs.

Fig 2.—The hind leg of *M. fulvipes* with a full load of pollen paste.

Fig. 3.—A cell of *M. fulvipes* dissected from the side. The store of provision and an only just hatched larva on it can be seen.

Fig. 4.—A cocoon of *M. fulvipes* not quite extracted from the cell.

Fig. 5.—A larva of *M. fulvipes*, that had wintered, in its natural situation; the cocoon is dissected.

Fig. 6.—A preparation of the *M labiata*'s nest (25.VIII.28; Borisovka).

Fig. 1.—A forest ravine near Borisovka, where a colony of *Macropis fulvipes* was found.

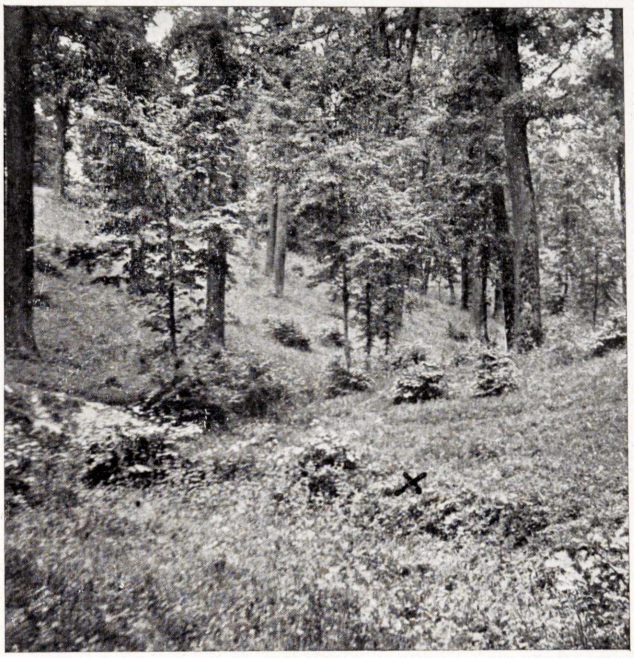

Fig. 2.—Two nest hillocks of *Macropis fulvipes* amidst flowering stems of *Lysimachia nummularia*.

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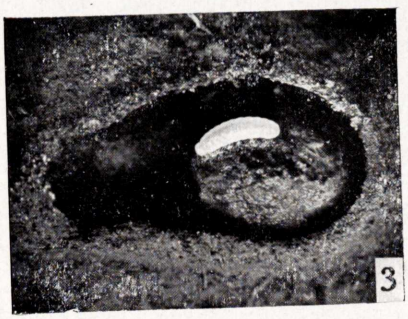

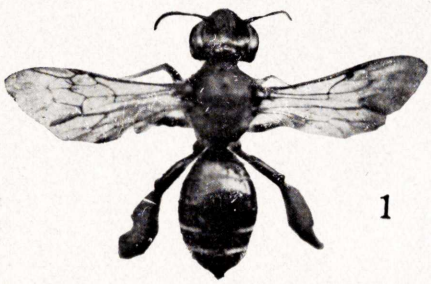

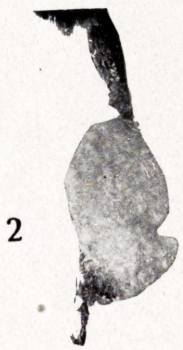

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