Etizenia

Occasional Publication of the Biological Laboratory
Fukui University, Japan

No. 41.

GLEANINGS ON THE BIONOMICS OF THE EAST-ASIATIC NON-SOCIAL WASPS (HYMENOPTERA)

IV. Some species of Bembicini, Stizini, Gorytini, Mellinini and Alyssonini

By K. TSUNEKI
(Biological Laboratory, Fukui University)

OCTOBER 25, 1969

GLEANINGS ON THE BIONOMICS OF THE EAST-ASIATIC NON-SOCIAL WASPS (HYMENOPTERA)

IV. Some species of Bembicini, Stizini, Gorytini, Mellinini and Alyssonini*

By K. TSUNEKI
(Biological Laboratory, Fukui University)

BEMBIX NIPONICA PICTICOLLIS HANDLIRSCH

Bembix niponica picticollis is one of the common species of the genus in Central and East Asia, ranging widely from Mongolia as far eastward as Korea. Phylogenetically, however, the species occurring in the Japan Islands (*Bembix niponica* F. Smith) must be a subspecies of this continental representative, but according to the nomenclatorial rule it must be treated as a subspecies of the latter.

In Apaka, Inner Mongolia, this species is not abundant as compared with the smaller species that will be dealt with succeedingly, namely, *Bembix weberi* Handlirsch.

On September 18, rather late in the wasps' season I visited the village of the wasps mentioned in connection with *Oxybelus latro*, about 8 km apart from my lodging. The wasps were still actively working for burrowing and provisioning, and I examined a number of the nests of various species of wasps and bees. Among them were included 3 nests of this species. However, except for a single instance that was in the course of digging the two others that I observed that day were discovered by chance.

Nest 1. In the course of excavation of other nest I dug to a tunnel of the burrow of some wasp. It was about 10 mm wide and obliquely went in the earth. I followed the tunnel and soon found a larval cell (cell 1) at the end. After examining the cell I followed the tunnel in the opposite direction and found two branch tunnels (Fig. 1), one of which (cell A) soon ended without being enlarged and without containing anything, while the other (cell 2) contained a completed cocoon. It was presumed that the nest belonged to a wasp of *Bembix niponica picticollis*.

Cell 1. Depth to cell ceiling 12 cm, length 5.5 cm, width 1.2-1.5 cm, slightly less in height; a considerably grown larva, 21 mm in length, was at the centre of the cell, with the remains of prey in the rear portion and with the intact prey in the front portion.

The intact prey: 3 large flies (two flower flies, *Eristalomyia tenax* and a blue bottle fly, *Calliphora* sp.) and 3 small flies (of various species, about 6 mm in length).

The remains of the prey: 14 large flies (including 2 *Eristalomyia* and 2 *Lucilia* sp.) and 8 small flies.

The tunnel in front of the cell was closed with soil for about 10 mm.

Cell 2. About 70 mm in length, the cocoon was hung at the front porion of the cell, directing its rounded part toward the entrance, elongated oviform, 21 mm long and 9 mm wide and made of a layer of earth grains. The remains of food showed that the prey included at least 17 large-sized flies.

Cell A. This must be an accessory branch (Evans' spur) and was apparently used as her resting chamber.

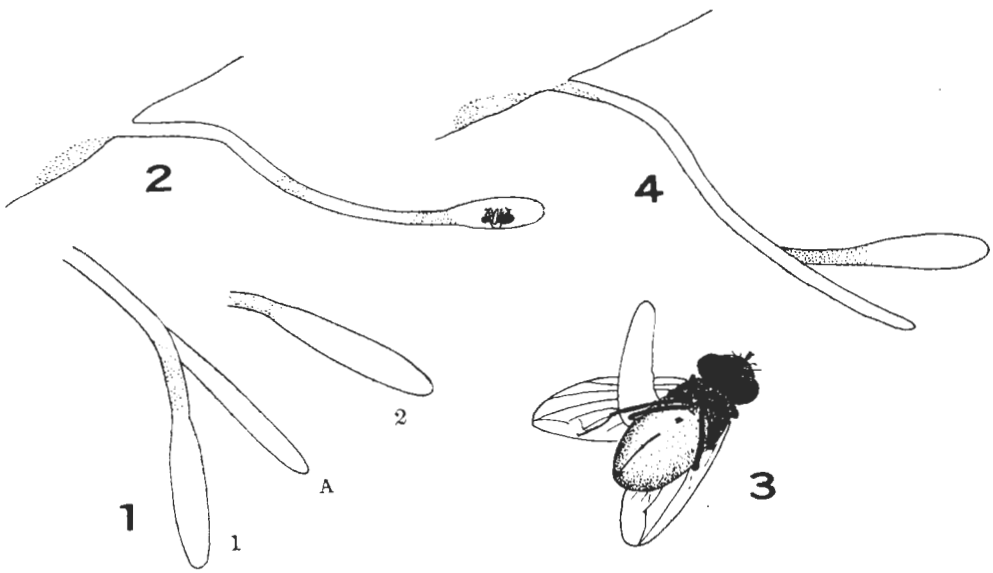
Probably in this nest the tunnel to the accessory branch must have been open throughout,

* *Contribution No. 130 from the Biological Laboratory, Fukui University, Japan.*

except for the entrance stopper, but the branch point to cell 1 from the accessory branch must be closed and the mother wasp was still in the course of provisioning to cell 1, despite that the larva in the cell was fairly grown in the final instar.

In this nest some doubt remained as to whether cell 2 belonged truly to this nest or to some other nest that was closely made, since the continuation of the tunnel was already destroyed by my preceding excavation and remained unknown.

Nest 2. This nest was also examined from the middle of the tunnel to both ends. But the general structure was made clear as given in Figure 2. In the cell was found the egg of the wasp attached to the pedestal fly (Fig. 3) without the additional prey. It was 5.0 mm in length, 1.5 mm in width near the lowest end and 0.8 mm at the upper portion, and somewhat shrunk.



Figs. 1–4. 1, 2, 4 ... Nests of *Bembix niponica picticollis* Handlirsch (1 ... Dorsal view. 2, 4 ... Lateral view). 3 ... The prey that carrys the egg of the wasp.

Nest 3. I found this nest 3 days before when the wasp was digging. The manner was very similar to that of the Japanese representaive. Especially the alerting manner shown by the wasp at the entrance of her nest before penetrating into the tunnel was the exact copy of that of the typical race. I left a mark by the side of the burrow.

When I dug the nest the entrance was closed. But the tunnel was, after proceeding for 15 cm in the earth ended without being enlarged. According to my later study on *B. n. niponica* it seems that the present race also has the habits of hunting the prey first before preparing the larval cell at the end of the tunnel.

On September 21, I again visited the village of the wasps to observe behaviour of them and to examine their nests. This day I dug 5 nests of this species. The structure of the nest and the nesting condition of the wasps were similar to those of the Japanese representatives. The debris dug out of the burrow by the wasp were left in front of the nest entrance as they were piled up (as in *niponica niponica*) and this gave me the easy clue to find their nests.

The low temperature of the morning deprived the wasps of their active movement. When I arrived at the village at 9:00 a number of the wasps and bees were found inmovable on the flowers of the digick and naby-blue-chrysanthemum and among such insects I saw 4 females of this species. They could easily be collected without using the insect net. The nests of this species

were concentrated on the upper portion of the oblique slope of the side of the dried rain-ditch, about 5 meters in depth, with an inclination of about 45° where the ground was not covered with grass. The nests were all dug in against the inclination and the larval cells were made 8–15 cm, mostly 13–15 cm below the surface.

Nest 4. The gallery was at first gentle in inclination, then, however, became fairly steep and finally turned again somewhat gentle and ended without a marked enlargement. It was about 16–17 cm in total length and only the entrance was closed with soil. At the end the mother wasp was sat, with her head toward the entrance. She could not move actively, only very slowly walked when taken out of the hiding place. About 1.5 cm above her hiding place a branch tunnel which was loosely packed with soil was discovered and it was connected with the larval cell (Fig. 4). The cell was about 5 cm long, 1.5 cm wide and 1.3 cm high, and somewhat lowered toward the interior. Near the centre of the cell a flower fly of *Eristalis cerealis* Fabr. was laid up-side-down with its right wing half opened and having the egg of the wasp vertically stood at its base, as was the rule in this genus. Beside the pedestal fly a smaller fly belonging to Stomoxyidae was placed, both directing their heads inwards. The tunnel was 9.5 mm high and 11.5 mm wide at its inner portion.

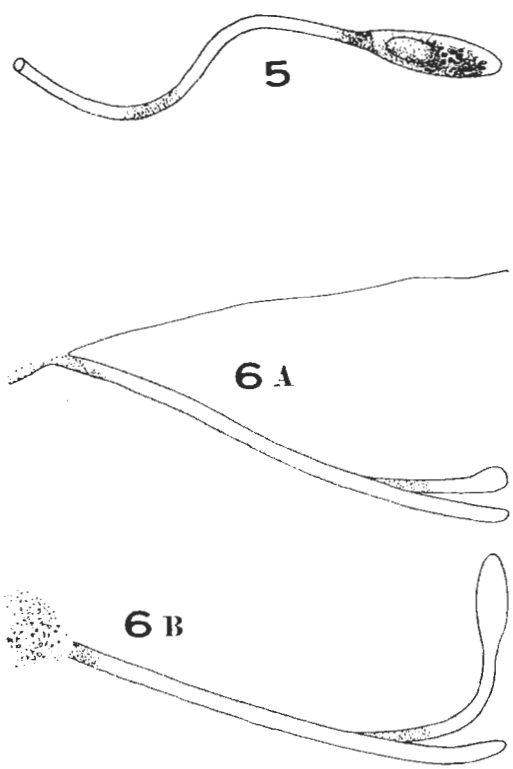
Nest 5 The structure of the nest was similar, but the accessory tunnel was empty. In the cell was placed a large-sized hover fly, *Syrphus* sp. and at the base of the half-opened left wing an egg of the wasp was vertically laid. Strange to say, however, the egg was thick at the upper portion and thin at the lower portion, as if it were up-side-down. The prey had already been covered with mould.

In this nest the mother wasp must have already been dead.

Nest 6. In this nest I could not find out the accessory tunnel, and the tunnel was left open at the entrance, closed in the middle portion and in front of the larval cell. In the cell a fly of Stomoxyidae was laid up-side-down and on the base of its left wing half opened the egg of the wasp was stood as usual.

Nest 7. The tunnel was usual in inclination, but it twice turned on the way to the cell (Fig. 5, dorsal view). It was closed only at the first turning point and in front of the cell, in spite of the fact that the cell contained the cocoon, that is to say, the nest was completed. The depth to the cell ceiling was 16 cm and the prey, calculated from the remains of food, were at least 14 in number, including 6 *Lucilia* and 1 *Eristalis*. The cocoon was made at the outer portion of the cell which was about 70 mm in length, directing its rounded end toward the tunnel.

In this nest possibly the mother wasp



Figs. 5–6. Other nests of *Bembix niponica picticollis* Handlirsch (5, 6B ... Dorsal view. 6A ... Lateral view).

must have been killed by the low temperature of the night while she was out on the flower, before completely provisioning the cell (but after finishing the greater part of provisioning).

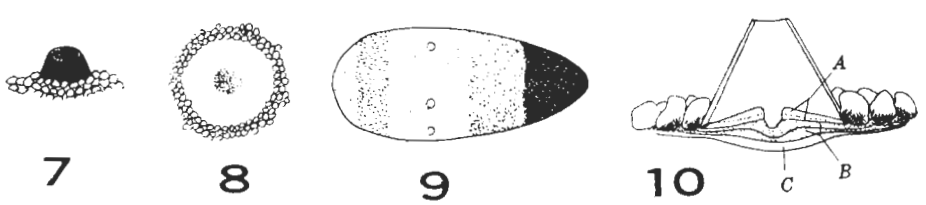
Nest 8. The nest was as given in Figure 6, A and B. In this nest the accessory tunnel was made straight in a line with the tunnel and the main tunnel leading to the larval cell was turned to the left, as often met with in the nest of *B. niponica*. In this nest also the mother wasp must have been died. The fly, a species of Stomoxyidae, carrying the egg of the wasp at the base of the left wing had already covered with mould.

Nest 9. This nest was examined on September 24. It went in obliquely nearly straight for 15 cm in the earth and connected with the larval cell, without the accessory tunnel. In the cell a hover fly of *Syrphus* sp. was laid. It was already rotten and the egg of the wasp was not found on the left wing which was half opened. Possibly the egg must have been decomposed.

Encasement. An almost full-grown larva obtained from cell 1 of nest 1 on September 18 was put in tube bottle, 15 mm in diameter, with both ends stuffed with a cotton plug. I gave it 11 small paralysed flies obtained from the nests of other wasps. Although there were 6 intact flies in the cell of the larva it did not eat further. It at once began to build the cocoon. It first stretched the silk threads between the given flies and the glass wall and formed a silk hammock. Then it gradually raised the attaching points of the thread and finally completed a silk pouch which was oblipuely hung, with the anterior end high and broadly opened. When I examined it on the 23rd the larva was dead in the silk pouch, without further proceeding with the work, probably of the low temperature at that time.

Structure of the cocoon. I brought back 2 cocoons obtained from the nests to Japan one of which was intact and the other was broken at the anterior end by the emergence of the adult wasp. They were examined in Sapporo when I was at the Hokkaido University.

The general structure and form is similar to that of *B. n. niponica*. At the rounded (= anterior) end the trace of the attachment of the silk funnel remains as a ring. The area within the ring is the lid of the cocoon finally made by the larval wasp where the sand grains attached are distinctly larger than those in other place, consisting of about 30 grains. The lid is not flattened as in *Stizus pulcherrimus* F. Smith, but roundly convex as in *B. n. niponica*. The respiratory pores are also scattered over the equatorial zone, 7 in number in both cocoons. Their outside appearance is also similar to those of the compared race (Figs. 7 and 8), but the dark brown wall is somewhat lower. The inner surface of the cocoon is lined with silk threads, more



Figs. 7–10. The respiratory pore of the cocoon of *Bembix niponica picticollis* Handlirsch. 7 ... Outside appearance. 8 ... Bottom of the organ seen through the opening. 9 ... Inner surface of the cocoon; circlets show the swellings of the respiratory pores. 10 ... Schema showing the structure of the respiratory pore; A ... Outer layer; B ... Middle layer; C ... Inner layer (A and B consist of two layers).

densely so on the broad (7 mm in width) equatorial zone and beneath the outer lid and the inner fourth is smeared with the excreted blackish substance, thus showing a sort of zonation in colour (Fig. 9). In the broken cocoon the intermediate zone and the broad posterior portion are very sparsely lined with silk thread, apparently almost without the silk lining. In this cocoon the

posterior third is smeared with the excreted blackish substance without the silk threads over the area, showing that the excretion was made finally. While in the other a few silk threads are stretched over the substance, showing that the excretion was made before the completion of the lining work.

The inner appearance of the respiratory pore is the same as in *B. n. niponica*. The area is minutely roundly swollen in the intact cocoon and pale yellow as on the other area of the equatorial zone, but in the broken cocoon yellowish brown at the centre. The structure was completely identical with that of *B. n. niponica* as schematized in Figure 10 (see Tsuneki, 1956, p. 117).

* * *

From the morphological point of view I combined *Bemdix picticollis* Handlirsch with *Bembix niponica* F. Smith. Judging from the data above given *picticollis* is almost completely identical with *niponica* in the biological point of view. This seems to give an important support to the above combination. In connection with this it must particularly be mentioned that the activity of the wasps late in the season in Inner Mongolia was very similar to that of *B. niponica* in Hokkaido (Tsuneki, 1956).

BEMBIX WEBERI HANDLIRSCH

Near the base of the wall of our lodging facing the south several wasps of this species had their nests. This species is distinctly smaller than the species treated in the preceding section and more brightly pale yellow maculated, with 2 longitudinal stripes on the dorsum of the thorax. It was to me one of the acquaintances whom I first met with in Tiendang, Peking. There the wasps of this species appeared rather late in summer and in Inner Mongolia also I saw them late in August for the first time. But this might be due to the fact that they worked for their nesting on the flat land during the hot season and when the temperature fell they gather together at the warmer area to attract our attention.

Nest 1. On September 5, I dug one of the nests in front of my lodging which I saw on August 29 a wasp was digging. Since that day the weather was continuously fine and the condition was favourable to see whether the progressive provisioning in this species, if any, was due to the external condition that compelled the delayed provisioning, or to the internal hereditary inclination of the wasp.

The entrance was closed simply with sand and the tunnel went in the earth in a rather steep inclination as a nest of species of *Bembix*. After proceeding a short distance it was closed again and in front of the closure where the tunnel was distinctly enlarged the mother wasp was sitting. This second closure was about 10 mm in thickness and thereafter the tunnel was left open for about 2 cm up to the larval cell (Fig. 11).

In the cell there was a mass of flies which was already covered in part with mould and on the mass a larva of probably a third instar, 5-6 mm in length, was eating. The prey consisted of 5 small flies, including 1 house fly and 4 hover flies. The house fly was considered the pedestal of the egg.

Whole the length of the tunnel was about 12 cm and the larval cell was 25 mm long and 12 mm wide and high.

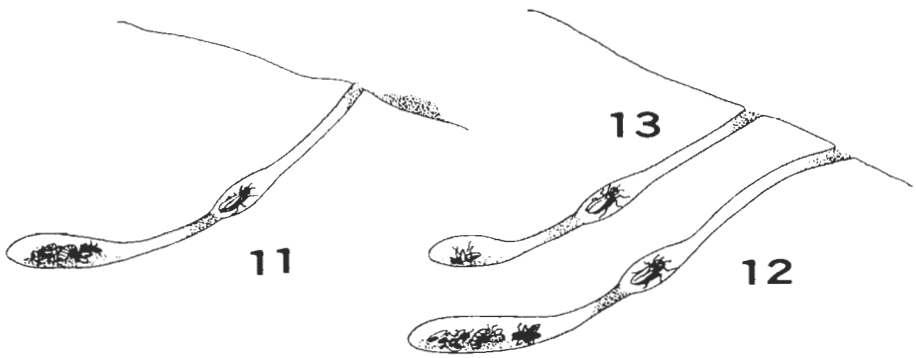
According to the result the wasp of this species made distinctly the progressive provisioning and it was clear that it was not the delayed provisioning compelled by the weather condition.

I reared the larva. It lasted eating for 3 days further, but died after all, obviously because

of the cold climate.

Nest 2. On September 15, in the wasps' village. The day was exceptionally warm and the temperature stood up at 19.7° (usually 14–15° toward the time) and I could find various species of bees and wasps flying about. Among them several individuals of this species were mixed. I saw one of them enter a burrow. When she came out she closed the entrance and flew away. I at once dug out the nest.

The tunnel was comparatively steep in inclination and went in for 15 cm straight. There it was gradually enlarged as if to be a larval cell, with the posterior wall roundly concave. But the tunnel was continued further behind the posterior wall where it was fairly compactly filled with soil for about 12 mm and then open to the larval cell (Fig. 12). In the cell a fairy well developed larva, about 15 mm in length in its head-bent posture, was near the entrance, with 2 fresh prey provided in front of it, one being *Eristalis* and the other a species of Anthomyiidae. Behind the larva a mass of remains of food was discovered, but their constitution became unknown, because a gust blew away them from my palm.



Figs. 11–13. Nests of *Bembix weberi* Handlirsch.

I dug further the extention of the tunnel to examine if there was another cell linearly arranged. But it could not be found out.

Nest 3. During the course of the excavation I found another nest that was made close to the above mentioned nest. It was very similar in structure (Fig. 13), only slightly shorter in the first part of the tunnel (12 cm). In the enlarged part of the tunnel at the end of the first section the mother wasp was sitting, showing that the chamber was for herself. In the larval cell was placed a fly, about 6 mm in length, up-side-down, and the egg of the wasp was laid on the base of the half-opened left wing of the prey as usual. But it was interesting that the base of the egg was slightly deviated and about half of it was outside the wing.

Nests observed late in the season. September 18. Nine nests were dug out. To dig open the nest of this species was not my first intention that day. But, whenever I tried to dig the nest of other species, almost always I dug to the tunnel of the nest of this species. So much was crowded the favourable place of the wasps' village by the various species of solitary bees and wasps — the sparsely vegetated zone of land where the grassland inclined to a dried rain-ditch, especially the area facing the south and on upper portion of the slope. Probably the inhabitants selected such a place from the instinctive precaution against the winter as well as the rainy season.

At any rate I was rather compelled to examine the nest of this species by an accidental finding, when it had always partly been destroyed. The structure was always similar. The tunnel went in 15–20 cm with a gentle inclinntion, forming an angle of about 30°–40° with the surface

of the slope, usually with a weak vertical sinuation on the way and reached the closure in front of the cell which ranged from 2 to 4 cm. In most of the nests examined the mother wasp was sitting at the end of the tunnel where it was somewhat enlarged into a waiting cell for herself. The tunnel was comparatively broad, as compared with a rather small size of the wasp, 8–10 mm in diameter, and the larval cell 2.5–4.0 cm in length. The entrance of the burrow was completely closed when the wasp was not in the tunnel, but when she was in the waiting cell it was at times narrowly opened. Among the wasps found in the waiting cell some were already dead, some were quite vigourless, almost immovable, but some could walk and when they were warmed by the sun they recovered their vigour and flew away. But, only few of them could fly away directly from the tunnel. The offsprings of the wasps in the cells: Egg ... 3; larva ... 4 (Empty ... 2.). Among the larvae one had already been dead; of the living 3 one was 10 mm and 2 were 5 mm in length.

Structure of the cocoon. Except for the smaller size, the outside appearance of the cocoon is similar to that of *Stizus pulcherrimus* F. Smith, obtained from the field nest, that is to say, made of mud. Under the microscope, however, it is distinctly made of sand grains, but the grains are so fine that the granulate structure can not be distinguished with the naked eyes. At the outer rounded end there is a trace of the silk funnel as usual in this genus. The lid that is finally made at the encasement at the outer end is roundly convex. But the particularly large sand grains are not used to make the lid.

Because of such a mud-like appearance of the cocoon case the respiratory pores are very marked on the equatorial zone. In the 2 cocoons at hand they are 5 and 6 in number respectively. The external structure of the respiratory pore is quite identical with that of *B. n. niponica*. But the lining on the inner surface is very scanty as compared with other species, only somewhat thick at the outer lid and equatorial zone (about 3 mm in width). The inner narrowed portion is smeared with the excreted substance and over it a little amount of silk is stretched. The rounded swelling at the site of the respiratory pore is stronger and more marked than in other species. But the structure is utterly the same as in other members of *Bembix* examined.

* * *

In the biology of this species it is characteristic that the mother wasp makes a particular chamber in front of the closure of the larval cell and uses it as a sitting room for herself.

BEMBECINUS HUNGARICUS JAPONICUS (SONAN)

The nesting biology of the Japanese race of the Hungarian species is generally similar to that of *Bembecinus tridens* which is well-known among the biological entomologists through the classic but excellent investigations of C. Ferton (1901, 02, 08, 10 and 11). It was first recorded by Iwata in 1936. As to the Formosan race of the same species he also recorded on its biology in 1939. I also touched on this subspecies in my recent paper (1969), together with the near relative, *B. posterus*.

The biology of our race has little particularity worthy of special mention except the process of the provisioning. But, as there is no record written in the language other than Japanese I will describe in the following from my note books the nesting and other biology of this race in a rather general form. Only the process of provisioning that is partially similar to the mass provisioning and the process of the cocoon building seem to be of some interest.

Nesting area. The sandy area is always selected by the wasps as their nesting site, usually consisting of the homogeneous fine grains of sand, sometimes, however, of rough sand mixed

with grains of their head size. The clear area is preferred, but sometimes the burrow is made among the scattered herbaceous plants. Usually the burrow is dug against a gentle inclination, having the wet layer of sand 2-5 cm below the surface.

Burrrowing. The selection of the nesting site is simply made and the wasp begins at once to dig with her front pair of legs. When the dried sand of the surface layer crumbles down so heavily that she can not deepen the hole, she changes her position little by little to the right and left until she meets with the place where the sand is more or less fixed. Sometimes the wasp flys off to some neighbouring place to try newly the digging work.

In digging the dried layer only the front pair of legs are used. The wasp throws the sand grains backward through under her abdomen, lifting her abdomen high. When the tunnel reaches the wet layer the mandibles also begins to cooperate. This is realized through the abraded state of the organ in the worn-out females and from the fact that when the nest is made in the pebbly ground the wasp carries out pebbles one by one with the mandibles. When the burrow is deepened the wasp from time to time comes out of the tunnel with the burden of sand and throws it backward to a distance of 4-5 cm through under her abdomen. The sand is thrown as a mass and one burden is usually divided into 2 or 3 masses, thus at her appearance 1-3 throws are usually observed. The thrown mass is wet and black and makes a marked contrast when dropped on the dried sand layer. Before she enters the opening the wasp used to try to level the surface 2-3 times mechanically and while she proceeds in the tunnel she again quite reflexively throws the sand backward at her every step, just as done by the members of *Bembix*. The sand thrown from the entrance sooner or later makes a heap, and then the wasp comes out of the burrow and levels it quite elaborately. She proceeds forward and backward, always keeping her head toward the entrance and levels the neighbourhood all over.

From toward the beginning of burrowing till it is about to end the wasp very frequently shows particular behaviour which is considered to have bearing upon the dreadful heat on the one hand and upon the site learning on the other, as pointed out by Iwata (1947). That is that the wasp suddenly flys up 5-10 cm above the sand surface, flying still in front of the opening like a helicopter, keeping her head toward the entrance and after several seconds flys down to resume the work. The movement is more frequently observed when the wasp digs or level the surface layer of the dried and heated sand and less frequently so when she digs the inside layer of the wet and less heated sand, or when she digs under the overcasted weather or toward evening. The fact shows that it is the adaptive behaviour against the baking heat of the sand. But this is not always all of the reason, because even when the burrow has considerably been deepened the wasp from time to time flys out of the tunnel and performs the same movement. Further, when the sand surface is not so awfully heated the wasp shows the behaviour as usual, though not so frequent as in the hottest time.

I am consistent with Iwata in opinion that the behaviour is externally a movement compelled by the environmental condition and at the same time internally a movement connected with the instinctive site-learning of the wasp. The fact that the manner of her flight is similar to that of the orientation flight later carried out seems to give evidence to the opinion.

During the work of burrowing it is frequently observed that the wasp abandons the partly dug tunnel, mostly without any apparent reason and resumes the work at another place. On the nesting site of this species, therefore, a considerable number of the holes of various depths are always scattered. It seems that some of these holes are aimlessly dug from the beginning, in other word, it is a sort of the so-called appetitive behaviour, basing upon the inadequate driving power of intention to make the burrow, because in such a case the wasp does not perform

that characteristic flying up movement.

The time spent to dig a burrow is 10 minutes or so when the condition of the ground is favourable and the wasp does not make the useless trying. However, when the ground is pebbly it takes more than an hour to make a nest, though she never takes a rest during the work.

Temporal closure of the burrow and the orientation flight. The wasp appears at the entrance of the burrow, head foremost (during the work of digging the wasp always comes out backing), and without leaving there, collects the sand grains from around the entrance into the opening, supporting them with her body and then slightly crawls out without leaving the opening. Again she collects the sand to fill the aperture given rise to by her progress. Thus, she fills the opening little by little with sand, preventing it with her body from dropping deep into the burrow. After several times of sand filling work the wasp completely appears out of the opening and begins to level the ground in front of her nest. She keeps her head toward the just closed entrance of the nest, goes backward, sweeping the sand with her front pair of legs. Then she walks to the entrance, sometime sweeping the sand, sometimes without sweeping and resumes the same series of work, changing the direction to the right and left. During the time if the surface of the area is heated the wasp repeats very frequently that characteristic heat avoiding flying up. The sand once thrown is again thrown farther and the bound of her leveling is gradually increased. This work of leveling is usually 3–4 minutes lasted and it becomes that no trace of the nest remains there.

The wasp then flys up and begins to fly about around the site of her nest. The flight is not circular nor spiral with the nest at the centre, but is to come hither and to go thither, always passing above the nest at each flight. From time to time she stops above and in front of the nest entrance like a helicopter, directng her head toward the entrance as if to gaze at it, and after several moments flies off. During the course the wasp often sits on sand near the entrance as if to try to return to the nest. After 2–3 minutes of such a flight the wasp goes out of sight. After a moment, however, she turns back, alight on sand in front of the nest entrance, but at once flies far away. At an interval of 30–100 seconds the wasp used to return twice or thrice further to the site of her nest before she finally goes away.

This is no doubt the orientation flight.

In the course of the provisioning work the wasp always makes the temporary closure at the entrance every time at her departure and the method is always the same as above described, but usually somewhat simpler. This is probably due to the instinctive presupposition that there is a considerable interval between the oviposition and the first provisioning, while during the work of provisioning interval between the provisionings is very short.

Leveling is performed only during burrowing and just after burrowing is completed. The wasp does not show the same sort of behaviour in the course of her provisioning activity.

Structure of the nest. The nest of this species is simple in structure (Fig. 14). Usually it is dug against a gentle slope. The tunnel is about 4 mm in diameter, goes obliquely in sand in a gentle inclination and after running for 7–12 cm it is enlarged into a brood-cell which is horizontally made and 12–14 mm in length and 5–7 mm in width and high. The depth of the cell from the sand surface to its floor is usually 3–10 cm, mostly 5 cm or so. As a rule, the tunnel goes nearly straight, only

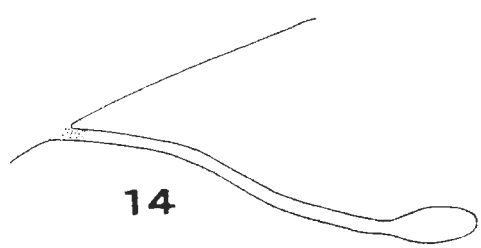


Fig. 14. The typical nest of *Bembecinus hungaripus japonicus* (Sonan).

rarely it is somewhat more steeply inclined in the middle portion (in the Formosan race of this species the latter case is the rule). It is closed simply for 5–10 mm only at the entrance during the course of the provisioning activity. No instance of the compound nest has been found in the Japanese race (in the Formosan race one instance was recorded by Iwata).

Oviposition. Following the general rule in this genus our race also lays the egg just after the preparation of the larval cell. The peculiar mode of egg-laying is also similar to the case in other congeners. A block of sand-grains, about half the size of the wasp's head is placed at the centre or somewhat interior of the larval cell and on top of this block the egg is laid vertically. It is about 2.5–2.7 mm long and 0.7–0.8 mm wide, milky white in colour, somewhat curved and its top end represents the cephalic pole. According to my note books:

(1). Four sand grains of comparatively large size; the egg is inserted with its caudal end among them and stood up-right (10. VIII. 1930, Saitama Pref.).

(2). A ball of fine sand-grains, about 1.2 mm in diameter and to one side of which the egg is attached with its caudal portion and stood up-right (10. VIII. 1930, Saitama Pref.)

(3)(4)(5). A block of fine sand, about half the size of the wasp's head is placed near the centre of the cell and on top of the block the egg was stood up-right (3. VIII. 1932, Chiba).

(6)(7)(8). The pedestal was slightly less than as large as the head of the wasp and the egg was laid up-right on it (6. IX. 1936, Utsunomiya).

(9). Similar, but the egg was attached to the side of the block (ditto).

(10). Pedestal of the sand mass is distinctly less than half as large as the head of the wasp, and the egg was laid up-right on top of it. (5. IX. 1947, Sapporo).

(11)(12). The sand mass was as large as about half the size of the head of the wasp and the egg was laid on top of it vertically (15. VIII. 1957, Fukui).

Provisioning and final closure. In my previous paper (Etizenia, 37) I dealt with the biology of the Formosan race of this species and said that the process of the provisioning in this subspecies is close to the case of the so-called mass provisioning and in one case the wasp finished her provisioning before the egg has not as yet hatched out.

In the Japanese race the provisioning process is generally similar to the case of the Formosan race, although the instance of the mass provisioning above mentioned has not as yet been observed.

The wasp does not return to her nest for some time after the oviposition. The duration of this time has not fully been investigated. It seems that she does not carry the prey in the brood-cell during the rest of the day of oviposition. But it is uncertain whether or not the wasp inspects the state of the egg before she brings the prey to the nest, as was confirmed by Baerends and others in some species of the genus *Ammophila*. However, so far as observed by Iwata and myself there is no instance in *japonicus* in which the prey is laid by the side of the egg. If

Table 1. Growth degree of the larva for which the mother wasp is in the couse of provisioing.

Prey L	Prey M	Nest	Larva (mm)	Lacality
3	7	Provisioning	2.5	Saitama
"	17	Provisioning	2.5	Saitama
1	8	Provisioning	3.0	Saitama
–	18	Provisioning	2.5	Chiba
–	20	Just completed	2.7	Utunomiya
9	–	Just completed	5.0	Sapporo
5	–	provisioning	3.0	Sapporo
–	11	provisioning	2.7	Fukui

Remarks. L...Large-sized prey, more than 7 mm in length. M...Medium-sized prey, less than 7 mm, mostly 3-5 mm in length.

she does not inspect the state of the egg, therefore, she must perceive the hatching of the egg through the time sense possibly possessed by her. In the sense that the wasp waits for hatching of the egg to bring food by the side of it this species can be included within the scope of the progressive provisioning. However, in the method of collecting food this species can not be said to belong to the group that has the habits of the progressive provisioning. Becausc once the provisiong is started it is, as a rule, very rapidly and continuously, that is to say, massively, carried out and in a day or two it is completely finished, unless the work is delayed by the unfavourable weather condition, with little connection with the progress of the larval growth. The fact is presumed by the contents of the nests dug open that are in the course of provisioning (Table 1).

According to the records by Iwata (1936) the number of the prey in the nests that were in the course of provisioning and that contained the larva less than 5 mm in length was 11, 2, 25, 24, 4, 19, and 32. In one instance he recorded tbe larva of 1 cm in length with 29 prey, but it was the nest dug out two days after the final closure.

According to our results in the nest of this species which is in the course of provisioning the larva found in it is always less than half of its final growth, mostly within 1-2 days after hatiching out and nevertheless the prey found in the larval cell is very frequently markedly large in number, sometimes it is considered to be full provisioning. The fact is given evidence by the 2 instances of the just completed cells (Table 1).

The process of provisioning of our race, together with the Formosan race of the same species, is, therefore, not of the true progressive provisioning. Apart from the fact that the wasp does not make provisioning before the egg hatches out, the method of collecting food in this species, at least in the East-Asiatic races, must be said to follow the rule of the so-called mass provisioning.

In the Japanese species of *Bembix*, according to my investigation, the food is collected daily in accordance with the growth of the larva, until it attains the final instar. Even in this species, however, the process is not always complete in the development of the progressive feeding. Certainly the wasp of this species brings food day by day to the larva, but not hour to hour, in other words, not according to the request of the larva. The mode of collecting food in a day is massive. The mother wasp collects the prey within a limited time of the day and piles them up in the larval cell. Furthermore, most of the wasps finish their provisioning as soon as the larva grows into the final instar — half the size in growth —, collecting a large amount of food massively in the larval cell. However, in this species the process is certainly progressive, because the wasp brings food day by day to the larva, and some individuals continue provisioning until the larva reaches the full-grown state.

In comparison with the species of *Bembix*, the species dealt with here of *Bembecinus*, at least in the races of East Asia, the method is less developed along the line of the progressive feeding, although the species — or it can be said, the genus — is considered more evolved as to the time of oviposition.

It must be mentioned, however, that the above described mode of food collection in *Bembecinus hungaricus* is not always the rule in this genus. At least in *B. posterus* of Formosa it has been known that the mother wasp usually brings food to the larva that is much more advanced in development than in the case of *B. hungaricus*.

In the final closure the tunnel is closed completely with sand. The wasp carries in the sand from the entrance backing and packs and pounds the collected materail with the tip of her abdomen, just as done by the members of *Bembix*.

Prey and the mode of carriage. The prey belong all to the comparatively small species of Homopterous insects, imago and nymph, male and female being indifferently mixed. The species so far observed:

1. *Nephotettix bipunctatus cincticeps* Uhler
2. *Eutettix disciguttus* Walker
3. *Anomoneura mori* Schwarz
4. *Deltocephalus dorsalis* Motschulsky
5. *Drebescus ogumae* Matsumura
6. *Parabolocratus prasinus* Matsumura
7. *Penthimia* spp.
8. *Jassus praesul* Horváth
9. *Platymetopius cinctus* Matsumura

In carrying the prey the wasp keeps it venter to venter, head to head, capturing it with the middle pair of legs and always goes on the wing. When arrived at the entrance to the nest the wasp opens the closure with her front pair of legs, without letting off the prey. The entrance is easily opened and the wasp goes in the tunnel with the prey, pushing it backward to make it in a line with herself. Sometimes, however, the wasp drops the prey in the tunnel near the entrance and after a while catches it from within and drags it backing into the cell. Probably this is usually done in the tunnel after the wasp goes out of the observer's sight.

Larval growth. On the 14th, August, 1947, in the suburbs of Sapporo, in one of the *Bembix* colonies I found a wasp of *Bembecinus* enter her nest with a prey. I marked the nest and dug it out on the 17th and obtained a full-grown larva from the brood-cell. I brought it back to my laboratory and reared. The next morning it had spun the cocoon of a thin layer of silk and in the evening the cocoon is almost completely inlaid with sand grains. In the morning of the 19th, the cocoon was dried up and at least the outer case of the cocoon was completed. Possibly the egg must have been laid on the 13th, or at the earliest the 12th. Therefore, according to this instance, under the natural condition it took 4 or 5 days to finish the growth of the larva and the larva required further 1.5 days to spin the outer case of the cocoon. When reared in the room without being warmed by the sun the larva needs much more time to grow:

On September 4, 1947, I obtained 2 larvae from 2 nests, in one of which the mother wasp just made the final closure and the larva (*A*) was 5 mm in length and in the other the mother wasp was in the course of provisioning and the larva (*B*) was soon after hatching, still standing on top of the egg-pedestal. In the first instance the mother wasp was seen to carry in the prey the previous day, and the egg must have been laid on the 2nd, and in the second instance, judging from the larval state, the egg was laid on the 3rd.

On the 4th at 18:00 I placed both larvae in each rearing cell, each with 4 prey out of those found in each cell (Table 1).

On the 5th at 10:00, *A* reached 7 mm in the posture of bending the head, lost greenish tone from its body and was eating a second prey*. *B* was still greenish in colour, almost 5 mm in length and was sucking the first prey.

On the 6th at 8:00 *A* had eaten up whole the contents of the prey and was inserted its head into the chitin case of the final leaf-hopper. *B* was sucking a second prey.

On the 7th at 8:00. *A* was eating the remains of prey. I gave it as a trial a small cabbage caterpillar, about 10 mm in length and was made immovable. *B* sucked up the second prey. It made a small hole in the skin of the prey and sucked the body fruid. At 19:00, *A* ate up the given caterpillar, so I gave it a new caterpillar of somewhat larger size. *B* was sucking a third prey.

On the 8th at 9:00. *A* was eating the remains of the caterpillar. It became considerably

* As the sand grains that were attached to its body when it was taken out of the cell remained as they had been it was certain that the larva did not make moulting since it was collected.

plump, more than 10 mm in length. *B* was eating the last prey, grew to about 7 mm and fatty. Two of the remains of the prey was apparently intact, since it was not gnawed. At 17:00, *A* was eating the newly given caterpillar. *B* was still sucking the prey.

On the 9th, at 8:00, I gave *A* a new caterpillar, 12 mm in length. *B* was eating (gnawing) the remains of the prey. At 18:00, *A* ate up the caterpillar and to *B* a caterpillar was newly given, 10 mm in length.

On the 10th, at 8:00. *A* again completely ate up the caterpillar. *B* had eaten more than half of the caterpillar. At 18:00, *A* was resting still. *B* was eating.

On the 11th, *A* was resting, apparently without vigour. Overeating ? *B* was still eating the caterpillar.

On the 12th, 8:00. *A* was dead and had turned blackish. *B* stopped eating and was stuck to the upper lid of the coverglass. I replaced it on the floor of the cell.

On the 13th, at 10:00, *B* was resting. At 17:00 it began to spin the silk thread.

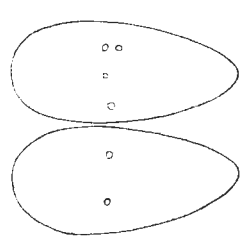
The next day at 9:00, the form of the cocoon was completed. It was open at one end.

According to the result *A* spent about 6 days to eat up all the prey that were given by the mother wasp. But it took the additional food of unnatural prey for 3 further days. *B* also spent 6 days to eat the natural prey and 3 days to eat the additional unnatural prey. Therefore, under the natural condition at Sapporo the eating period is considered 6 days or so usually. As to the additional unnatural prey *A* accepted and ate up 3 caterpillars, while *B* only 1 caterpillar. The difference may explain the cause of the death on the part of *A*.

Cocoon. In the first attempt of rearing, the larva was weaving the silk cloth between the opposite sides of the artificial cell in the morning of the 18th of August. It was apparently completed at least regarding the external pouch of the cocoon. I took it out of the cell on the 30th of the same month. The cocoon was loosely covered with a thin layer of silk to which some sand grains were attached. In reality this might be the silk layer which the larva stretched over the inner wall of the cell and not the silk pouch which was to be inlaid with sand grains. In nature, to this uppermost layer an innumerable number of remains of the prey are attached and the cocoon appears to be a rag ball.

This layer is not tightly attached to the sand cocoon and easily removed. The cocoon itself is made of sand grains, elongated egg-shaped and in the instance above given it was 13.5 mm in length and 5 mm in width (this is exceptionally large). At the outer rounded end the outer layer is also rounded and it makes me suppose that this end was left open until th end of the cocoon spinning work and through here the sand grains must have been taken in.

Seen from the outside the cocoon is not provided with the so-called respiratory pore, as is always observed on the cocoons of *Bembix*. When cut open and observed from inside, however, it is made clear that some respiratory pores are always present on the equatorial zone of the cocoon. In the instance above mentioned they were 5 in number and 2 of which were made side by side, but others were equidistantly scattered (Fig. 15). The inner wall of the cocoon is lined with whitish silk thread and was glossy. The portion of the respiratory pore is somewhat roundly swollen out and more or less blackish brown in colour. At the corresponding spot of the outside of the cocoon the respira-



15

Fig. 15. Inner surface of the cocoon of *Bembecinus hungaricus japonicus*. Circlets show the swellings of the respiratory pores.

tory pore shows no particular structure. The place is apparently without the pore. But the close examination under the binocular microscope shows that at the place the sand grains are somewhat sparse and the silk threads are more densely crossed over the aperture. The inside swelling of the respiratory pore can easily be removed with a needle and shows an impression at the place. But it does not perforate the sand layer.

The process of the cocoon building. As to the technique of cocoon building of the allied genera, *Bembix and Stizus*, Fabre (1886), Evans (1966) and I (1943, 56, 65) dealt with the subject in considerable detail. Regarding the genus *Bembecinus*, however, to my knowledge no observation has been made until now.

I have tried several times to observe the procedure of cocoon building in this species, but mostly I failed because of attachment of the remains of food or the sand grains to the silk pouch first spun by the larva which prevented me from direct observation. It was at Sapporo that I could succeed in observing the general process of the larval work.

Larva *B* reared finally with a cabbage caterpillar (p. 13) began to stretch the silk thread between the walls of the artificial cell that was made on the wet sand in a dish by impressing with my finger. It was in the evening, about 17:00, of September 13, 1947.

The next day at 9:00 the form of the cocoon was completed. It was an acorn-shaped pouch of silk thread, about twice as long as wide, still semitransparent and by a careful observation it was confirmed that one of the ends was left open and at the end there was a funnel-like stretch of silk membrane, as in the case of *Bembix* and *Stizus* (Tsuneki, 1956, 65).

At 10:30, the equatorial zone of the pouch was narrowly covered with the layer of sand grains. At 11:00 the larva protruded its anterior body up to the 5th segment from the opening and was collecting the sand grains from the floor. At 14:20 the sand-inlaying work was markedly progressed. The sand had covered alreaby the broad central zone and the outer zone, leaving a narrow portion at the outer opening area and about one fourth of the cocoon length at the inner portion free from the sand covering. At 18:00 the larva was lining the inner portion of the silk pouch with sand grains. The result showed that the order of the sand inlaying work was first commenced at the central zone, then shifted to the outer zone (leaving the entrance opened) and to the inner zone and finally closed the entrance with the sand lid.

On the 15th (a third day), at 8:00, the silk pouch was completely lined with sand grains and the portion of the entrance funnel was also completely closed with the sand layer. But at the upper side of the cocoon where it was attached to the coverglass the sand grains dropped off and the inside of the cocoon was dimly visible through the pale brownish yellow layer of the secretion of the silk gland. The larva was observed still working. At 18:00, the upper side was further added the silk gland secretion. The outermost layer to which the sand grains were roughly attached was distinctly separated from the cocoon proper as a sort of the cocoon cover which was usually covered, under nature, with the remains of the prey.

According to the result the general process of the building of the sand cocoon is similar to that of *Bembix*. It remains unobserved, however, whether the inner end of the silk pouch first spun is fixed by a bundle of the silk strings to the floor of the cell or not.

ARGOGORYTES MYSTACEUS GRANDIS GUSSAKOVSKIJ

See: Tsuneki, K. 1965. The Life Study, 11 (3 4): 41 42.

In the paper above given I recorded one of the nests observed as a compound bicellular nest. But it is uncertain whether they represent the cells belonging to a single nest, or they are the

cells of the separate nests closely made.

GORYTES (S. STR.) *KOREANUS* HANDLIRSCH

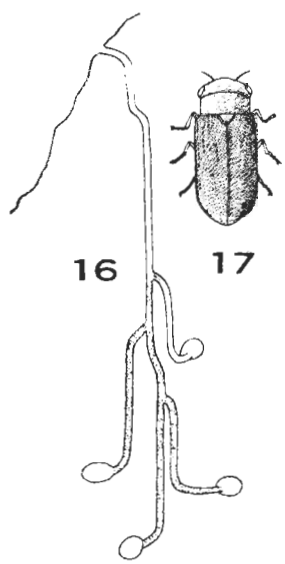
In the valley of Hôheikyô, Jôzankei, near Sapporo, on the heap of earth at the road side, under the dense foliage of the tall trees, I found a wasp of this species walking with a prey under her body. It was at 14:00 of the 24th, July, 1946. The wasp soon went in a hollow between 2 stones of the fist size for 3 cm and there began to open the entrance to her nest. The prey was held venter to venter, with the middle pair of legs alone. It was not let off even while the wasp opened the entrance and enterred the tunnel. Soon the wasp showed her anterior body at the entrance, raked together the soil, then came out of the tunnel, turned round and pressed the closing material with her head. She came out of the hollow between the stones and flew abont slowly around the stones. After a minute's flight she alighted in front of the hollow, entered there, but at once turned back to resume the apparent orientation flight. After 3 times of such a flight she was caught and the nest was examined.

The tunnel went in the earth horizontally for 3 cm along one of the stones, then freely proceeded further 2 cm and enlarged into a pocket, the larval cell, which was 14 mm long and 7 mm wide and high and located 2 cm below the surface of the earth. The tunnel in front of the cell was not closed. In the cell was laid the prey that had been observed by me to be carried in. It was a beautiful species of Cercopidae, about 10 mm in length, with the vivid green body, pale brown dorsum of the thorax and the brilliant scarlet eyes. On no place, however, was the wasp's egg laid. But I took notice of something whitish moving under the wing. I examined it and, to my surprise, I knew that it was a maggot of the parasitic fly. Since I found the wasp, I did not see the parasitic fly follow after the wasp. Probably the parasite might have laid the maggots in the hollow while the wasp was absent from the nest.

DIENOPLUS LAEVIS (LATREILLE)

In the village of the wasps and bees found by me near Beizumiao, Apaka, Inner Mongolia, I found a nest of this species while I was digging a nest of *Agnosicrabro mongolicus*. The structure of the nest was as given in Figure 16, the main tunnel being 18 cm in length. The arrangement of the larval cells belonged to the limited type (from apex to base). The cells were 10 × 5.0–5.5 mm in size. The branch tunnels, when the cell at the end is fully provisioned and oviposited, are packed with soil. In this nest the difference in the colour of the packing soil made it easy to clarify the feature of their running. The prey (Fig. 17) were Homopterous insects (Cercopidae), about 4.5–5.0 mm in length, 5–6 insects to each cell, all laid head in and on the outermost (uppermost) one the egg of the wasp was laid. In cells 1 and 2 a young larva was present instead of the egg.

The egg was flatly attached to the underside of the



Figs. 16–17. 16 ... A nest of *Dienoplus laevis*. 17 ... A prey of the species. The cells are made from lower to upper; they are called from the lowest No. 1, No. 2 and so on respectively.

prey at the outside of the legs along the coxae, from the neck region to the hind coxa. Judging from the body orientation of the young larva the anterior end is the cephalic pole. But, with which end it is glued was uncertain.

Cell 1 ... 7 prey with a larva. Cell 2 ... 6 prey with a just hatched larva.
Cell 3 ... 6 prey with an egg. Cell 4 ... 3 prey without the egg.

Cell 4 was in the course of provisioning and the tunnel leading to it was left open, though the entrance of the main tunnel was simply closed.

Remarks. In 1937 Iwata published his observation on a speces of *Dienoplus* under the name of *Harpactus laevis*. According to his explanation of the wasp, however, it is considered not *D. laevis*, but *D. tumidus japonensis* m. *D. laevis* has not ever been known from Japan.

ALYSSON (ALYSSON) CAMERONI YASUMATSU ET MASUDA

As to the nesting biology of this species Masuda (1931) published his observations. According to him the entrance of the nest is always left open. The larval cell at the end of the tunnel is stuffed with several prey and on one of them the egg of the wasp is laid. The prey are species of Homoptera including *Cicadella viridis* (L.), *Mileewa margheritae* Dist., *Euscelis limbifer* (Mats.). The head of the larva has 5 very conspicuous processes.

It was on July 22, 1937 that I found a crowded colony of this species on the path from Mt. Myôhô to Mt. Dzizô, about 1300 m high, in the mountain range of Chichibu, Saitama Prefecture. On the path, less than 0.5 meter in width, within the range of about 3 meters about 25 nests were crowded, all with a small mound of soil around the entrance hole. The inhabitants of the colony were seen to carry in the prey to each nest. They came flying with the prey, landed near the nest and then walked to the entrance. The prey was held by the wasp venter to venter, being captured by the rostril with the mandibles of the wasp. Apparently none of the legs cooperated with the mandibles in keeping the prey. As soon as the wasp reached the entrance she entered the burrow directly without letting the prey off.

As it was rather late in the afternoon and I had to go far within the day I dug several nests in a hurry that were made scatteringly at the end of the colony. On such account it is very regret that the records of my note book was not detailed.

Nest 1 (Fig. 18, A and B). The tunnel, about 2.5 mm in diameter, went perpendicularly for 7.5 cm, then bent to the right at an angle of about 70° against the ground surface and further went for 7.5 cm. There it was stopped without any trace of continuation of the tunnel. I enlarged the excavation around and below the end of the tunnel and found 4 larval cells:

Cell 1. Depth from the surface 15 cm, including 1 leaf-hopper, without the wasp's egg.
Cell 2. Depth 17 cm, 4 prey, with the egg of the wasp on the uppermost one.
Cell 3. Depth 20 cm, 4 prey, with a young larval wasp on the outermost prey.
Cell 4. Depth 18 cm, 4 prey, with a young larva on top of the prey mass.

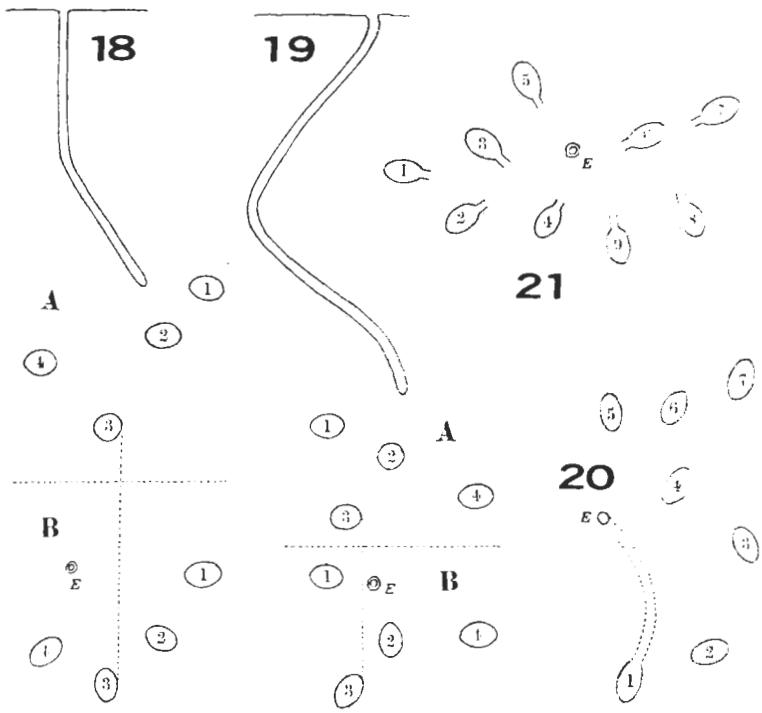
The prey were the large-sized leaf-hoppers, wholly green in colour, belonging to a single species, *Cicadella viridis* (Linné).

Nest 2 (Fig. 19, A and B).

Cell 1. Depth 20 cm, 4 prey, with the egg of the wasp.
Cell 2. Depth 21 cm, 6 prey, with the egg of the wasp.
Cell 3. Depth 24 cm, 4 prey, with a large larva of the wasp.
Cell 4. Depth 23 cm, 4 prey, with a larva of the wasp.

Nest 3 (Fig. 20, dorsal view).

Cell 1. Depth 6 cm, with 7 prey, offspring of the wasp unknown.
Cell 2. Depth 14 cm, with 4 prey, offsprimg unknown.
Cell 3. Depth 10 cm, with 5 prey, larva of the wasp, 5 mm.
Cell 4. Depth 18 cm, with 2 prey, larva 4 mm.
Cell 5. Depth 18 cm, with 4 prey, with an egg.
Cell 6. Depth 18 cm, with 2 prey, with a larva.
Cell 7. Depth 17 cm, with 2 prey, with a larva of 4 mm.



Figs. 18-21. Four nests of *Alysson* (*Alysson*) *cameroni* Yasumatsu et Masuda (18A ... Lateral view, all others dorsal view).

Nest 4 (Fig. 21, dorsal view).
Cell 1. Depth 18 cm, with 4 prey, with an egg.
Cell 2. Depth 15 cm, with 4 prey, with a larva of the wasp.
Cell 3. Depth 14 cm, with 3 prey, with an egg.
Cell 4. Depth 13 cm, with 5 prey, with ?
Cell 5. Depth 10 cm, with a cocoon.
Cell 6. Depth 10 cm, with a cocoon.
Cell 7. Depth 14 cm, with 8 prey, with an egg.
Cell 8. Depth 14 cm, with 9 prey, with a larva of about 3 mm.
Cell 8. Depth 13 cm, with 4 prey, with ?

At the right hand of the figure I found 7 further cells, but it seemed that they belonged to another nest closely made, the number of the prey in the cells being 2, 4, 4, 6, 3, 4 and 4. No record regarding the depth and the offspring of these cells were given in my note book.

The egg was about 2.3 mm in length, 0.7 mm in width, milky white in colour and glossy. It was always laid on the ventral side of the thorax of the prey along the outside of the coxae, attaching with its anterior end to the outside between the neck and the front coxa and reaching

the outside of the hind coxa of the same side.

According to the observations the wasp of this species (1) makes the branched compound nest having a single cell at the end of each branch, (2) leaves the debris piled up as a mound and leaves the entrance always open, (3) hunts the Homopterous insects belonging to Cicadellidae, (Jassidae), (4) collects 2–9, mostly 4, prey in one cell, (5) lays her egg on the prey that is last taken in. Method of oviposition is similar to that of the allied genera, such as *Gorytes, Argogorytes, Dienoplus* and *Mellinus*.

MELLINUS OBSCURUS HANDLLRSCH
(= *M. tristis* Pérez)

(1) On September 4, 1945, in the Sapporo Botanical Garden, I found a female of this spesies alighted on a leaf of a shrub carrying a prey. The prey was a fly, *Sarcophaga* sp.

(2) On September 15, 1945, in the valley of Hôheikyô, Jôsankei, near Sapporo, I captured a wasp of this species carrying a fly. The prey was a female of *Fannia canicularis* L.

(3) On September 22, the same year, at the same place as above I found a wasp of this species walking with a fly. The fly was held, venter to venter, by the wasp apparently with the middle pair of legs. After a while, she came to a hollow that opened at the base of a small perpendicular elevation of the ground and tried to enter with the prey. But she failed. She dropped the prey at the entrance and entered it empty-handed. At once she protruded her head from the entrance, caught the fly by the rostril with her mandibles and tried to drag it in. But again she failed. Again she dropped the fly and went herself deep into the burrow. Soon, she came out, picked up the prey and walked round and round in front of the hollow. Finally she left the prey 6 cm from the entrance of the hollow and walked about in a manner which seemed to me quite indiffernt to the prey.

I took up the fly which was later identified with *Mesembrina latreillei* Besvuidy. I at once dug the burrow. It went in, with a more of less sinuation, for about 13 cm and at the end a deälated young female ant of *Formica fusca* was sitting. Possibly the ant selected the nest of the *Mellinus* as a favourable hiding place to found her new colony. I dug broadly around the tunnel in search of the larval cell of the wasp. But the attempt ended in vain.

(4) The same day and at the same place I saw another wasp walking with a prey. The prey was a small fly and carried about with the mandibles only. Judging from the manner of her catching of the prey when she drags it backing into the burrow it seemed possible that she caught it by the proboscis of the fly only.

Maruyama's observation. A colony consisting of over 10 wasps was found on a patch of bare ground along the mountain path, about 1700 m high, in Tottori Prefecture. The wasp transports her prey, venter to venter, holding it with her fore (?) and middle pairs of legs and grasping it by the proboscis with her mandibles. She sometimes let go her prey from her legs but always tightly holds it by its proboscis with her mandibles. At the entrance to the nest she changes her direction and enters the burrow backing, carrying the prey which is held by the proboscis only. The nest belongs to the branched compound type, having 2–4 cells within, which are laid 5–20 cm below the surface. The cell is 15–18 mm long and 7–10 mm wide. The prey belong to various families of Diptera, such as Syrphidae, Empidae, Muscidae, Anthomyiidae, Tachinidae, Ortalidae, but includes exceptionally the soitary bees of Andrenidae. The number of the prey in one cell ranges from 4 to 9. The egg is laid on the bottommost prey, but is not laid as soon as the first prey is brought in. It is 3.3 mm long, 0.6 mm wide and is fixed to the lateral or ventral surface of the thorax between the first and second legs, directing its cephalic pole toward the mesal line of venter. The cocoon is orange in colour, covered with remains of prey. The wasp sometimes reuses the old nest.

REFEEENCES

Evans, H. E. 1957. Studies on the Comparative Ethology of Digger Wasps of the Genus *Bembix*. Comstock Publishing Associates.

——— 1966. The Comparative Ethology and Evolution of the Sand Wasps. Harvard Univ. Press.

Ferton, C. 1901, 02, 08, 10, 11. Notes détachées sur l'instinct des Hyménoptères mellifères et ravisseurs. Ann. Soc. ent. France, T. 70, 71, 77, 79 et 80.

Grandi, G. 1961. Studi di un Entomologe sugli Imenotteri Superiori. Boll. Ist. Ent. Univ. Bologna, 25: 1–659.

Iwata, K. 1936. On the habits of *Stizus* and *Bembix* which occur in Japan. Kontyu, 10 (5): 233–250 (in Japanese).

——— 1937. On the habits of *Harpactus laevis* Latreille. Ibid, 11: 404–409 (in Japanese). (Possibly the species is not *Dienoplus laevis*, but *D. tumidus japonensis*).

——— 1939. Habits of some solitary wasps in Formosa (IV). Trans. Nat. Hist. Soc. Formosa, 29 (189): 161–178 (in Japanese).

——— 1964. Bionomics of non-social wasps in Thailand. Nature and Life in S. E. Asia, 3: 323–383.

Maruyama, K. 1948, Habits of a Diptera-hunter, *Mellinus obscurus tristis* Pérez (Hymenoptera). Mushi, 19 (2): 7–11.

Tsuneki, K. 1942. A Naturalist at the Front. Osaka (in Japanese).

——— 1946. The prey of *Mellinus tristis* Pérez. Matsumushi, 1 (2): 85 (in Japanese).

——— 1943. On the habits of *Stizus pulcherrimus* Smith. Mushi, 15: 37-47 (in Japanese).

——— 1956. Ethological studies on *Bembix niponica* Smith, with emphasis on the psychobiological analysis of behaviour inside the nest. I. Biological part. Mem. Fac. Lib. Arts, Fukui Univ., Ser. 2, 6 (4): 77–172.

——— 1964. Nyssoninae of Japan and Korea. Life Study, 9 (1-2): 24-33; (3-4): 44-48 (in Japanese with English key).

——— 1965. The nesting biology of *Stizus pulcherrimus* F. Smith (Hym., Sphecidae), with special reference to the geographical variation. Etizenia, 10: 1–21.

——— 1965. Nesting biology of *Argogorytes mystaceus grandis* Gussakovskij (Hymenoptera, Sphecidae). Life Study (Fukui), 9 (3-4): 41-42.

——— et T. Iida. 1969. The biology of some species of the Formosan Sphecidae, with description of their larvae. Etizenia, 37: 1–21.

Yasumatsu, K. et H. Masuda. 1932. On a new species of the hunting wasps in Japan. Trans. Fukuoka Nat. Hist. Soc., 1: 53–65.