Nests of Some Pemphredonine Wasps in the Pith of Miscanthus (Hym., Sphecidae)

By K. TSUNEKI

1. Pemphredon lethifer (*Shuckard*)

As to the structure of the nest of *Pemphredon* (*Cemonus*) *lethifer* (Shuckard) made in the stem of miscanthus two forms have been reported in Japan, in one of which the cells are separated by the partitions of pith particles and in each cell an egg is laid with the prey (Tsuneki, 1952), while in the other no partition is made except a few outermost imperfect ones and some eggs are scattered with some intervals on the prey that are collectively stuffed in the cavity (Ohgushi, 1950 and discussed by Tsuneki, 1952). The present instance belongs to the first form.

A dead stem of miscanthus collected was 6 mm thick and still stood in nature and in which a wasp of this species was provisioning from the entrance opening on top (23. V. 1972). It was brought to my laboratory, laid on the table and examined after a week. Twelve larval cells were linearly arranged and the 13th was in the course of provisioning, including 7 half dried aphides and no egg. In the greater part of the cells the wax white pupae or prepupae and in a few outer cells full-grown larvae, all one in each, were present. The length of the cavity was 270 mm, with the width 3.5-4 mm and nearly uniform. The cells were constructed in the range of inner 240 mm, the 7th and 10th-12th being 9 mm in length and the remaining ones 10-10.5 mm. In each cell containing a pupa or prepupa a thick partly pale brown cocoon-cap was flatly stretched across slightly behind the outer wall (with about 1 mm interspace) and from the periphery of which the thin cocoon tissue was extended along the cell wall posteriorly. But it soon disappeared after lining for about 2 mm and the greater part of the pupal body was not covered with the cocoon. The partitions of pith particles were about 2 mm thick in the cells in which a full grown larva was present, but in those including a pupa or prepupa they were more or less moved and pressed towards the lateral cell wall and the broad central area was closed with a block of the black feces. As a result apparently there was no partition between the cells. Of course the state was quite different from that reported by Ohgushi.

It seems a note-worthy fact that all the pupae later examined were found to have directed their heads inwards (downwards in the natural condition) without exception. The reason was unknown, but it might have some relation that the miscanthus stem was kept horizontal during the growth period of the larva, though there must have been some more important reason that brought about such a reverse orientation of the larvae.

2. Passaloecus monilicornis *Dahlbom*

In my previous paper I described a complicated nest made in the dead tree trunk (Tsuneki, 1955). The following are the records of those made in the pith of miscanthus used for the roof of the cottages in the montanic region of Fukui

Prefecture, about 600-800 m a. s. l. (unless otherwise stated the nests were collected on June 13, 1970)

Nest 1. Diameter of the stem 5.5-6.0 mm, the tunnel dug by the wasp 2.7-3.0 mm at the narrow entrance and gallery part and 3.5-3.7 mm at the inner cell part. The resin wall at the entrance, about 0.8 mm in thickness, was perforated and the wasps had already escaped. The first resin wall was constructed at 4 mm from the inner end and the traces of the attached resion showed that the cells were 9 in number, with the length from the interior 7, 8, 8, 6.5, 6.5, 6.5, 7, 8, 9 mm respectively and the empty space left at the outer end was 120 mm.

Nest 2. Outer diameter of the thach about 6.5 mm. The tunnel, 2.5-2.7 mm in width, was smooth and uniform and went in till 190 mm from the entrance. The cell length from the interior 14, 6, 6, 6, 7, 16 (empty cell) and the space left was 138 mm. The resin walls were transversely set, less than 1 mm in thickness and all were perforated. In cell 2 a dead female of *Psenulus maculipes* Tsuneki, covered with mould, in cell 5 52 dried aphides and before the entrance a dead female of *Omalus aeneus japonicus* (Bischoff) were discovered. In the first 14 mm chamber a pale yellowish white cocoon, about 7 mm long, cylindric, narrowed inwards and cut open at the outer end was left. Possibly in this chamber there were two cells of *Psenulus maculipes* and they were superseded by the resin plasterer. It was uncertain, however, whether the cocoon left was that of *Psenulus* or that of *Omalus*, and whether the cuckoo wasp parasitised on the former or on the latter.

Nest 3. With the stem similar in thickness and with the tunnel dug similar in width, including 7 brood cells, 8.5, 8.5, 11, 8.5, 6.5, 19, 6.5 mm in length respectively from the interior. In cell 1 the same empty cocoon as found in nest 2 and the bottom was tightly stuffed with kneaded mud for about 2 mm. In cell 2 a pupa of *P. monilicornis* with feces, in cell 3 a dead imago of *Omalus aeneus japonicus*, in cell 4 a dead pupa of *Passaloecus*, in cell 5 a dead prepupa, in cell 6 two dead pigmy wasps of Cynipidae and the last cell was empty, leaving a vacant space of 23 mm till the entrance stopper which was 2-4 mm in thickness, as the end of the miscanthus was obliquely cut off. The resin walls were all less than 1 mm in thickness and transversely constructed. The cocoon of *P. monilicornis* was thickly spun into a disc at the outer end of the cell, against the bottom wall of the next cell, but over the remaining part of the cell wall apparently no silk thread was stretched. It was unknown by what wasp the innermost mud stuff was made. But the cocoon left in cell 1 was doubtless that of *Psenulus* or *Omalus* and because of the fact that the resin walls till cell 3 were perforated it seemed certain that the *Omalus* was parasitic on the inner *Psenulus* and the cocoon was that of this cuckoo wasp.

Nest 4 (collected on June 13 and examined the next day). The wasp of this nest superseded the nest of *Psenulus maculipes*. She constructed a resin wall at 103 mm from the entrance and a thick resin tampon (2-3 mm) at the entrance. Strange to say, however, she did not make any of her own cell. The wasps emerged from the inner nest and imprisoned there were found dead behind the inner resin wall.

Nest 5 (do.). This was a nest made in the previous year. The tunnel was

3.5 mm in diameter, almost uniform, the resin septa were all broken, but from the traces on the wall it was clarified that the cells were from inside 7, 9, 10, 10, 9, 11, 10 mm in length respectively and an empty space of 55 mm was left till the entrance stopper. Inside the cell part some caps of the cocoons, ramains of food and a dead pupa of *monilicornis* were scattered.

Nest 6 (do.). Similar to nest 4 in general condition. The entrance was closed with a thick resin wall of about 4 mm and from there at 30 and 50 mm respectively a thin resin partition was constructed. Inside the 2nd partition a perforated cocoon cap was found, possibly an old one left. Separated by a 50 mm empty space from there a series of 10 cells of *Psenulus maculipes* was constructed inside, including either the prepupa or the growing larva. In this case the resin partitions were not broken and the space formed between them was left empty. Why did the wasp make such a meaningless work?

Nest 7 (do.). An old nest. The entrance was closed with a thick resin wall. From the entrance two empty cells, 17 and 38 mm in length and one long empty space, 170 mm and finally two larval cells, 27 and 17 mm long respectively were separated by the thin resin walls. The larval cells included dried aphides, 44 and 42 in number respectively.

Nest 8 (do.). superseded the nest of *Stigmus filippovi* which was occupied just after completing the first larval chamber (12 mm long, a female emerged afterwards). The *Passaloecus* first made an empty cell, 7 mm long, then a larval cell, 15 mm long, including, when examined, an already blackened pupa, then again an empty cell, 23 mm long and finally left an empty space, 55 mm long, till the entrance stopper of resin, which was 3-4 mm in thickness.

3. Passaloecus dubius *Tsuneki*

Nest 1 (collected on August 10, 1970, from the roof of the barn of one of the summer working houses in the montanic region of Fukui Prefecture). The nest was made in the pith of the miscanthus, the entrance gallery 1.5-2.0 mm in diameter, more or less irregular in width, at the cell part the tunnel slightly enlarged to 2.0-2.3 mm. The tunnel was 103 mm in total length and ended at the first node.

Cell 1: 10 mm in length, with inner wall, made of resin, was thickly covered with feces; inside was a prepupa, head out; the cell wall thinly lined with silk threads and close to the outer wall a thick cocoon cap was spun, like that of *Psenulus*; outer resin partition 0.1-0.2 mm thick. Cell 2: 9.5 mm, outer resin wall similar, both walls were covered with silk threads and at the outer wall the covering was thickened into a cocoon cap, but on the circumferential wall nothing was attached; there were a prepupa in the cell. Cell 3: 7 mm, outer resion wall slightly thicker, including 41 medium-sized nymphs of *Lachnus tropicalis* van der Good (the large black aphides of the chestnut tree), all covered with mould. Cell 4: 35 mm long, empty, with outer resin wall somewhat thicker. Cell 5: 37 mm till the entrance, empty, at the entrance the stem was obliquely cut and a large quantity of resin was stuffed to close there. On April 22 and on May 18 two female adult wasps emerged.

Nest 2 (do.). The stem about 7 mm in thickness and the tunnel dug by the

wasp 1.0-1.5 mm in diameter and 185 mm in length. Cell 1: 27 mm, empty, outer partition made of resin. Cell 2: 13 mm, an elongate oviform brownish cocoon, possibly of some cuckoo wasp, attached to the inner wall, outer wall made of pith particles compactly pressed, 3 mm in thickness. Cell 3: 34 mm, the inner 7 mm was packed with a lump of dead brown aphides covered with mould, remaining part was empty, its outer wall was a collection of pith particles compactly stuffed. Cell 4: 27 mm, at the bottom a mass of remains of food and the feces of the wasp's larva, just in front of the residue there was a prepupa, head out, with a thin layer of silk transversely spun at its anterior end, the remaining part of the cell empty, outer wall made of resin, delicately thin. Cell 5: 11 mm, at the bottom feces of the waspling, in the stage of prepupa, head out, near each end of the prepupa there was spun a thin layer of silk threads, outer wall was made of resin; from here till the entrance resin plug an empty space of 68 mm was left. Two female adult wasps were found dead on May 20, the next year, but the parasite did not come out of the cocoon.

This nest was first started by a *Passaloecus*, but after placing the first partition it was occupied by a *Psenulus* by some reason or other, however, when she made two cells her nest was superseded in turn by a *Passaloecus* and this wasp completed her nest in the stem.

Nest 3. Taken on July 5, 1971 and examined the next dey; the ower wasp was imprisoned by me with a cotton plug when she entered the nest and was found dead.

The stem used was 3 mm in thickness and in this the wasp dug her tunnel, 1.5-2.2 mm in diameter for the first 50 mm, but 1.0-1.2 mm for the next 48 mm, including somewhat enlarged places here and there. Cell 1: 14 mm long, 2.0 mm wide, slightly narrowed at both ends and partitioned with a thin film of resin of the Japanese ceder, including 41 prey, possibly the young of *Lachnus tropicalis*, on a 35th aphis from the interior a wax white egg of the wasp was attached, with its anterior end, to the side of the abdomen. It was 1.47 and 0.44 mm in length and width, slightly curved as usual. The partioning film of resion was 0.5 mm in thickness and a small quantity of pith particles was attached on to its outer surface. Cell 2: The prey aphides collected were only 13 and on a third one from the outermost the egg of the wasp was laid, glued to the ventral side of the abdomen and directed with its posterior end towards the head of the prey; it was an interesting finding that in this cell the resin partition was in the course of building, being attached in the form of a ring to the inner wall of the tunnel, 15 mm from the bottom wall; the prey of the cell were comparativoly large and it was presumed that the quantity was ample enough to rear a larva; outside the ring of resin particles of pith were attached also in this cell.

Nest 4 (do.). The stem 3 mm thick and the tunnel about 2 mm wide and 85 mm long, a resin film at 7 mm from the bottom, in front of it were found two perforated cocoon caps of possible *Psenulus* and an old cocoon of some cuckoo wasp in which the imprisoned owner of the nest was dead; from here till the entrance were irregularly scattered 18 prey of the black wingless aphides of small to medium-size, possibly the result of a confusion into which the wasp was plunged by the imprisonment.

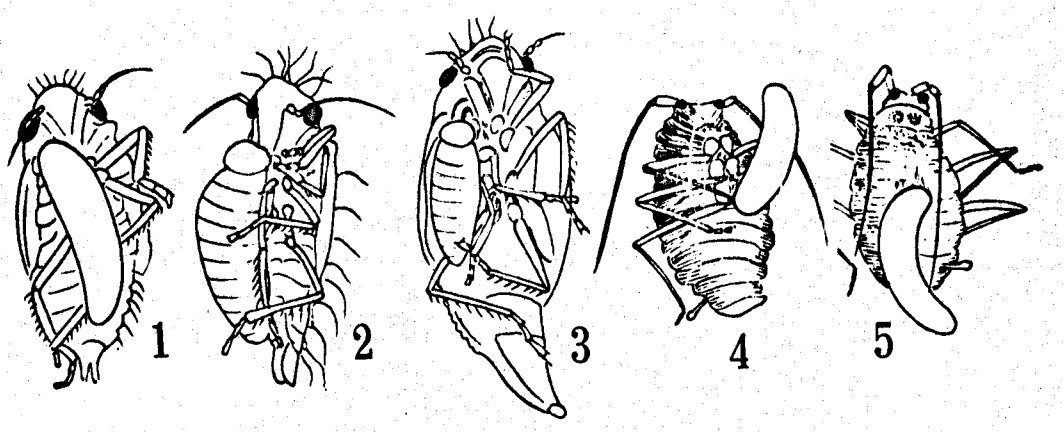
4. Psenulus maculipes *Tsuneki*

Summary. The nests of this species observed were made in the stems of miscanthus used for thaching of the roof. The tunnel is dug by the wasp herself which is 2-3 mm in width and varied in length, from about 10 to more than 300 mm, according to the condition of the stem and herself. It is sometimes more or less turned or curved and with scattered small hollows on the inner wall, possibly as a result of taking the pithy substance to close the cells. The larval cells are 2.5-3.5 mm wide and 6-11 mm long and closed with a wall of compactly pressed pith particles, convex inside and concave outside, 2-4 mm in thickness. In one nest 5-10 cells are arranged without the empty cell between. The prey collected by the wasp are mostly the nymphs of *Anomoneura mori* which are sometimes mixed with a few of other species of Psyllidae, the number per cell being 15-90. They are carried by the wasp on the wing, venter up, head to head, grasped by the middle pair of legs and in the cell placed crosswise. The prey in the cell are loosely bound together with silk thread. The egg of the wasp is usually found on one of the prey located towards the middle of the prey mass, but judging from the fact that in the cells in which provisioning is still going on the egg is never discovered on any of the prey, even though a great number of them have already been accumulated, it seems highly probable that it is laid after the completion of the prey collection by rearranging them in the cell, just as is known in the subfamily of Crabroninae. The egg of the wasp is attached to the anterior part of the side of the prey and laid lengthwise along the bodily axis. The full-grown larva spins its cocoon, consisting of only the anterior part, in the form of a disc which is called here the cocoon cap. The cocoon cap is comparatively thick and stretched crosswise slightly behind the outer cell partition. In Central Japan this species appears twice a year.

Nest 1 (taken on July 5, 1970 and examined the next day). The stem was about 4.5 mm in thickness and the tunnel in the pith 2.5-3.0 mm in width. It was closed with a compactly pressed plug of pith particles, about 4 mm in thickness, at 75 mm from the entrance and the wasp was working to provision her second cell. Cell 1: 11 mm long with the outer wall of pith chips 2.5 mm thick and included 34 nymphs of Psyllidae, *Anomoneura mori* Schwarz, each about 3 mm in length, transversely placed against the cell length; the egg of the wasp found on one of the prey located at 19th from the outermost (Fig. 1), the partition was convex inside and concave outside. Cell 2: Only 3.5 mm in length and loosely closed with a collection of pith particles, about 4 mm in thickness, including 10 prey of the same species as above, not as yet laid the egg by the wasp. All the prey found in the nest were tangled with each other with the silk threads and not easily separated.

Nest 2 (collected on July 20 and examined the next day). The imprisoned wasp was dead near the entrance. The tunnel pierced 2 nodes, reaching 320 mm from the entrance, inner diameter about 2 mm at the entrance gallery and 2.5 mm at the cell part. the bottom of the tunnel was packed tightly with pith particles for 7 mm. Cell 1: 18 mm long, outer partition 3 mm of pith chips, including 104 prey, 99 nymphs of *Anomoneura mori* and 5 leaf hoppers of undetermined species,

all nymphs; they were placed transverse, but with the back and venter uncertain; the young of the wasp, at the first instar, was on the prey located towards the middle of the mass (Fig. 2). Cell 2: Containing 54 nymphs of *Anomoneura mori*, with the same body orientation as above, without the egg of the wasp laid, but with a loose tampon of pith particles outside the mass, possibly a temporal closure. The prey were tangled with silk threads as above.



Figs. 1-5. 1-3: The egg or the young larva attached to the prey of *Psenulus maculipes* Tsuneki. 4: The egg of a parasitic wasp (possibly some Chrysididae) attached to the prey of *Psenulus nikkoensis* Tsuneki. 5: The egg of *Psenulus nikkoensis* attached to the prey.

Nest 3 (do.). The tunnel 180 mm, at 8 mm from the bottom a plug of pith particles, then the first cell, 8 mm long, including 15 prey, all but one greenish nymphs of *Anomoneura mori*, the exceptional one a nymph of other species of Psyllidae, very hairy and blackish brown in colour, no egg of the wasp. The wasp was confirmed by imprisonment.

Nest 4 (August 10, 1970). The wasp was confirmed. The stem was 4 mm thick and the tunnel 2.0-2.3 mm wide and 175 mm long, including 8 completed and 1 incompleted cell. Cell 1: 12 mm, outer partition 5 mm of pith, inside a prepupa, a cocoon cap made 4 mm behind the outer wall, at the bottom black lumps of fesces. Cell 2: 12 mm, 50 prey of Psyllid nymphs, a number of acari, the wasp's egg lacking, outer partition similar, 2.5 mm. Cell 3: 9 mm, prepupa, a cocoon cap about 1 mm behind the outer wall, black feces at the bottom. Cell 4: 9 mm, a mass of prey covered with mould, no egg nor the larva of the wasp, outer wall 2 mm thick. Cell 5: 9 mm, outer wall 2.5 mm, a cocoon cap 1 mm behind, a full grown larva, not as yet defecated. Cell 6: 8 mm, outer wall 2.0 mm, the larva possibly at the final instar feeding the prey. Cell 7: 8 mm, outer wall 2.5 mm, the larva smaller than that of cell 6, about 5 mm, a considerable number of prey remained. Cell 8: 7.5 mm, outer wall 1.5 mm, 58 prey of *Anomoneura mori*, a small larva on one of the prey towards the middle. Cell 9: In the course of provisioning, already 45 prey accumulated, but still no egg, suggesting that the wasp lays her egg after the provioning is completed, on one of the prey locating towards the middle, possibly by rearranging the prey, just as in Crabronine wasps.

The prey were all nymphs of *Anomomeura mori*, including various instars,

all loosely bound together with silk threads. On April 13, the next year, 1 pupa and 3 prepupae just before pupation were confirmed, but all others were dead. On the 25th of the same month 2 ♀ 2 ♂ imagoes had emerged and partly dead.

Nest 5 (do.). The imprisoned wasp was dead behind the cotton plug. The stem of the miscanthus about 4 mm in diameter and the tunnel 260 mm long, 2 mm wide, partly enlarged to 2.5 mm and at 240 mm from the entrance the outermost partition was constructed. Outside the partition 72 prey of *Anomoneura mori*, all nymphs, simply spun together with silk threads, were accumulated, but without the egg or the larva of the wasp. Inside the partition a cell of 16 mm long was found, including 67 prey consisting of the stumpy and the slender nymphs of Psyllidae, possibly belonging to two different species; a young larva of the wasp on one of them towards the middle part of the mass; the inner wall 4.5 mm thick. The next cell, also 16 mm long, with the inner wall 4.0 mm, including 68 prey, the same species as above, and a young larva on one of them, at the medial part of the prey mass. The series of the cells was presumed to have been made continuously inwards, but the miscanthus stem was broken at this place when collected.

Nest 6 (taken on July 30, 1971 and examined the next day in my laboratory). The stem 9 mm thick, the tunnel 2.5 mm wide, partly 3 mm, at 180 mm from the entrance a small lump of the dried remains of old prey, heavily attacked by a host of acari, from here about 12 mm inwards a partition of pith, 2.5 mm thick, was constructed, outside which 24 nymphs of *Anomoneura* were collected, without the egg of the wasp. The tunnel was more or less irregularly curved and from place to place with a small hollow on the wall, as if knawed by the wasp. This seems to show that when the wasp nests in the decayed wood she must make the branched tunnels in the substratum.

Nest 7 (do.). The stem 5 mm, the tunnel 2 mm wide and 160 mm long, went through the first node up to the second. Cell 1: 18 mm, bottom rounded, a full-grown larva spinning cocoon cap, made at 13 mm from the bottom, as yet paper-like, outer pith wall 2 mm thick. Cell 2: 9 mm, outer wall 2.5 mm, 89 prey of *Anomoneura mori* tightly stuffed, when separated it was well-defined that they were loosly bound together with whitish silk threads, almost all of them deposited crosswise as against the length axis of the cell, no egg, possibly eaten by the acari, 7 of which among the prey. Cell 3: Still provisioning, close to the inner wall 22 prey accumulated, tangled with silk threads and outside the accumulation about 20 small balls of pith particles, about 1.5-2.0 mm in diameter were pressed together as if to be a temporal closure, at 45 mm from here outwards 2 prey and further 30 mm towards entrance 1 prey was scattered in the tunnel. The imprisoned mother wasp was dead near the entrance. It was naturally presumed that the wasp imprisoned must have behaved unnaturally in the tunnel, so that the meaning of the small balls could not be evaluated too high.

Nest 8 (do.). The stem 5 mm, the tunnel 2 mm wide and entered for 67 mm till the first node. there 16 prey of the *Anomoneura* were placed in two groups, among the inner group several pith balls as observed in the preceding nest and outside the 2nd group many similar balls were piled and pressed. The wasp imprisoned was dead near the entrance plug.

Nest 9 (do.). Stem 5 mm, tunnel 3 × 120 mm, the bottom was stuffed with compact pith particles for 8 mm, then the lst cell. Cell 1: 7 mm, outer pith wall 2.5 mm, about 50 dried up *Anomoneuras*, with a number of the eggs of the acari. Cell 2: 9 mm, with outer wall 3.5 mm, 40 *Anomoneuras*, all nymphs, on one of which a just hatched larva of the wasp (Fig. 3), the location of the prey unknown, since they were splashed by the crack of the node when cut open. Cell 3: In the course of provisioning, 4 prey were scattered. The imprisoned wasp was dead behind the entrance plug of cotten made by the observer.

Nest 10 (do.) Miscanthus 5.5 mm thick, cavity made in the pith 2.5-3 × 263 mm, the bottom was packed with pithy substance for 4 mm. Cell 1: 8 mm, outer wall 2 mm, a prepupa in it, with a black lump of feces at the bottom and a cocoon cap 2 mm before the outer wall. Cell 2: 9 mm, a full-grown larva eating the last prey, the body blackish, with scattered white dots. Cell 3: 6.5 mm, a number of prey of the *Anomoneura* (82 !) placed crosswise and tightly pressed, the egg could not be discovered, outer wall 4 mm thick and a further loose packing of pith particles for about 10 mm, possibly a result of the disturbed behaviour of the imprisoned mother wasp who was dead behind the entrance plug.

Nest 11 (do.). Stem 5.5 mm thick, cavity dug 2-2.5 × 106 mm, at the part of the cell enlarged into 3 mm wide. Cell 1: 9 mm, 90 prey of *Anomoneura*, placed crosswise and tightly packed. I examined them carefully one by one, but could not find the wasp's egg, the prey were bound together as usual, outer wall 5 mm, as yet loose, not hardly pressed as in the completed cell, the imprisoned wasp was dead in the entrance gallery.

Nest 12 (do.). Stem, 6 mm, the tunnel 2-3 × 300 mm, more or less irregularly turned and twisted, with the gnawn pits hither and thither and the old cocoon caps were scattered for about 200 mm of the entrance gallery. The inner part alone of the tunnel was presumed to have been dug by the wasp, the interior space of 60 mm was occupied by 3 completed cells and 1 provisioning cell. Cell 1: 10 mm, 8 mm of packing at the bottom, a mass of prey dried up, 68 in number. Cell 2: 10 mm, including a prepupa, a cocoon cap at about 2 mm behind the outer wall which is 2.5 mm thick. Cell 3: 13 mm, 62 prey, on one of which a small larva of the wasp was attached, the exact location of the prey uncertain, but it was not the outermost one. The prey were loosely bound together with silk thread as usual and several of them were picked up at a pinch of the pincette. Cell 4: During the course of provisioning, including 18 prey, no egg, no temporal closure.

5. Psenulus fuscipes *Tsuneki*

Nest 1. July 5, 1970, from the roof of a cottage in the montanic region of Fukui Prefecture. The stem about 10 mm, the tunnel 2 mm wide and 150 mm long up to the first node where packing of pith particles of about 5 mm is stuffed. Cell 1: 64 aphides of unknown species tightly packed, but as yet no egg, outside the mass of the prey a loose plug of pith particles, not as yet accomplished, was formed. The prey were loosely bound together with silk threads, apparently including more than one species (but may be due to the different instars and condition ?).

Nest 2 (August 18, 1971). The tunnel made in the pith of miscanthus was 4-4.2 mm in diameter and 132 mm in length, apparently utilizing the old tunnel. The bottom was packed with pith particles and the surface was made concave. There 29 dark green aphides of about 1 mm or so in length were packed, without the egg of the wasp on any of them. Three of the prey were winged, having the comparatively long, characteristically dark maculated wings. All the prey were bound together loosely with silk threads.

6. Psenulus nikkoensis *Tsuneki*

Nest 1 (on July 5, 1970 leg.). The tunnel dug in the pith of miscanthus, 7 mm thick, was 3-3.6 mm wide and 205 mm long, at the cell part the tunnel becomes wider. Cell 1: 9 mm, 18 prey, wingless aphides, mostly placed nearly crosswise, on the one at a 14th from the exterior was attached the egg of the wasp. It was laid between middle pair of legs with its anterior end, laid along the median line of the prey and reached beyond the middle of the abdomen; it was wax white, slightly curved and slightly tapered posteriorly. Outer wall was a compressed packing of pith particles, 1.3 mm thick, concave out and convex in. Cell 2: Prey 13, the same species of wingless aphides, loosely packed, mostly laid transverse, no egg.

At 70 mm from the entrance a loose tampon of pith chips. The mother wasp that was imprisoned by a packing of a grass halm escaped and was dead in the venyl sack in which the collected material was kept.

Nest 2 (do.). The tunnel 170 mm long and 3-4 mm wide, in the course of provisioning to the first cell at the bottom, including 12 prey, the same species of aphides as in the preceding nest (having the red eyes and the tips of the cornicles swollen into a small blackish ball). In this nest the prey were not bound together with silk thread.

Nest 3 (do.). The tunnel 3 mm in diameter, at the entrance gallery 2.5 mm. The bottom was stuffed with remains of cocoons and then a bit of resin at a second node 165 mm from the entrance and the wasp was working to collect food for the 2nd cell. Cell 1: 17 mm, 26 wingless green aphides of unknown species (the same as in the preceding nests), all stuffed obliquely, with the head inwards, on the outermost prey an egg of a possible parasite (Fig. 4), on a 8th from the outside a larva of about 3 instar and on a 13th from the outside also a similar larva was attached. The reason of the excessive larvae or whether one of them was a parasite or not was unknown. Cell 2: 12 mm, 26 aphides of the same species as above, including 3 winged, no egg, no outer wall. Rearing of the larvae failed.

Nest 4 (do.). The tunnel 124 × 2.8-3.0 mm, at the bottom it was stuffed with pith chips for 2 mm. Cell 1: 7 mm, wingless aphides of the same species as above, 14 in number, on a 3rd one from the interiormost an egg of the wasp was laid. It was attached as given in Fig. 5, outer partition of pith particles 2.5 mm thick. Cell 2: During the course of provisioning, 9 prey of the same species of aphides, no egg, the imprisoned wasp was dead behind the entrance plug of cotton. The prey were not bound together with silk threads.

7. Psenulus pallipes yamatonis *Tsuneki*

The miscanthus stem used 6 mm thick, the tunnel 2.5 mm wide and 155 mm long, including 5 cells, the length of the cells and their outer walls (within parentheses) were from cell 1: 10 (1.0), 8 (3.0), 12 (7.0), 10 (6.0), 11 (8-9) mm respectively, then an empty space of 77 mm down to the entrance plug of pith particles, 10 mm thick, compactly pressed. In each cell a black lump of feces on the inner wall, covered thinly with silk threads and the prepupa imprisoned itself within a narrow space partitioned with a thin layer of silk spun crosswise at each end of its body, while, tubular part of the cell was not covered with the silk layer, that is to say, the cocoon was represented by two end layers of silk. But, further, slightly apart from the outer layer of silk, with a 1-4 mm space between, a thick, partly brownish cocoon cap was stretched across the cell cavity. This cap must also be included in the constitution of the cocoon of this species. Outer wall of the cell was made of tightly packed pith particles, with the outer surface always covered thinly with silk threads. This was the work of the mother wasp. The length of the cocoon, that is to say, the space between the thin layers of silk, was from inside 6.3, 6.2, 6.5, 5.5 and 5.8 mm respectively, the prepupae were all head out. On July 2, 1972 two females were emerged from cells 2 and 3 and already dried up, all others did not emerge.

8. Psenulus rubricus *Pérez*

The stem of miscanthus 6 mm, the tunnel dug in the pith 3 mm in width and 320 mm in length, the innermost part of which was filled with the remains of old nest for 38 mm and the place was covered with a thick layer of pith chips which formed the bottom of the tunnel. Cell 1: 8 mm, a prepupa, very slender and long, head out, a cocoon cap present close to the outer wall (with a 0.5 mm space), otherwise no trace of silk smearing over the inner surface of the cell, outer wall made of pith particles, very thick, 15 mm. Cell 2: 8 mm, 48 dead aphides already dried up, with about 10 acari, no remains of the egg or the larva, outer wall 4 mm. Cell 3: 8 mm, a full grown larva, already finished the spinning of the cocoon cap, but not as yet defecating, no other part of the cell lined with silk, outer wall 5 mm. Cell 4: 9 mm, stuffed with prey, the larva about 5 mm in length in its natural posture, dull, possibly before the final moult and was at the innermost part of the prey mass, the remained prey 34, including 9 winged aphides, presumably the prey devoured were only several, so that the total prey might be 37-38, thus the greater part of the prey might be eaten during the final instar of the larva, as was usually the case in non-social wasps. Outer wall 2.5 mm. Cell 5: 9 mm, filled with prey, a dead but not rotten young larva attached to the largest aphis of a lump of prey, consisted of about 10 and located at the innermost part of the cell. The total prey were 35 of which 17 were the dark coloured winged imagoes and the rest were the dirty yellow wingless nymphs. Outer wall 5 mm. Cell 6: 9 mm, 32 prey including 11 winged, the prey were fairly compactly stuffed, but as yet no egg.

The prepupa in cell 1 was 7-8 mm, very slender and stretched straight, with the head not bent ventrally. The nest was still in the course of provisioning,

remaining the empty space of 225 mm till the entrance where the imprisoned mother wasp was dead.

A strange nest of an unknown species of the aphis hunter

Collected on August 6, 1970, from a bundle of tubes of miscanthus horizontally settled on July 31 to the railing of the wooden wall of a barn of a summer house at Arashi, Fukui Prefecture, about 600 m a.s.l. Stem diameter 4.5 mm, tunnel length 223 mm and its width 3 mm, the bottom was closed with a node. The inner 23 mm remained empty, there the 1st partition. The partitions were all made of silk, spun into a layer like a cocoon cap, about 0.3 mm thick at the attaching ring on the cylindric cell wall and apparently thinner towards the centre of the layer; 18 cells were linearly arranged. Cell 1: 11 mm, a prepupa, head out, at 3 mm from the silk partition a thin silk membrane was stretched across the tube, thence a very thin pale brown cocoon was spun along the cell wall which was ended, before the block of black feces, in a transverse silk layer similar to that found at the outer part of the cell, limiting the space (cocoon length) 7.3 mm, just the size of prepupa. Cell 2: 11 mm, just the same as in cell 1, except that the posterior layer of silk, i.e. the cocoon end, was stretched obliquely. Exclement out of the cocoon. Cell 3: 10 mm, a dead blackened full-grown larva, no prey remained, no exclement. Cell 4: 8.5 mm, the prepupa much slenderer than those in cells 1 and 2, outer partition like a cocoon cap. Cells 5 and 6, both 8.5 mm, Cell 7: 8.0 mm, all similar to the preceding cell. Cell 8: 8.5 mm, a prepupa, reconfirmed that the cocoon was separately made from the outer partion, pale brown, very thin, especially at the lateral wall of the cell where it is rather inconspicuous. Cell 9: 9.0 mm. Cell 10: 8.5 mm. Cell 11: 8.5 mm. The three cells each included a dead blackened prepupa. Cell 12: 7.5 mm, the prepupa shrank, much thicker than the dead ones in the preceding cells, the pale brown thin cocoon invisible. Cell 13: 8.5 mm, a prepupa, 7-8 aphides remained were pressed within 3 mm space between the outer partition and the cocoon cap of itself; in this cell the cocoon cap, namely, the truncated anterior end of the cocoon, was distinct and the rest of the cocoon was not remarkable, but defined under careful observation. Cell 14: 9.0 mm, the egg was not hatched, 28 dark brown aphides were packed in the cell, already partly attacked by the mould, a shrunk egg on the prey at a 8th from the interior. Cell 15: 11 mm, 47 prey, a shrunk egg-shell was found attached on to the prey located at about a fourth from the outside of the prey mass. Cell 16: 10 mm, prey heavily covered with mould, not counted, the dead egg could not be found out. Cell 17: 12.5 mm, about 10 aphides remained intact, a full-grown larva was spinning the cocoon, the cocoon cap had already completed, 2 mm apart from the outer partition, it was working at other parts of the cocoon. Cell 18: 14.0 mm, 6 intact prey remained, a full-grown larva spinning the cocoon, the cocoon cap had already completed, 2 mm apart from the outer partition. The nest was closed again as naturally as possible and kept in a glass tube plugged with cotton, lest they were attacked by the pygmy parasites of Cynipidae. Unfortunately, however, not a singls adult wasp did emerge from the nest.