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SUCCESSIVE OBSERVATIONS ON THE LIFE OF  
GORYTES TRICINCTUS PEREZ  
With Special Reference to the Cocoon Building Behaviour  
of the Larval Wasps

By K. TSUNEKI

M I S H I M A

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On the nesting biology of this species I recorded briefly on p. 35 of the Hymenopterists Communication No. 8, 1978. As I have been occupied by the study of the southern species of Trypoxylon the detailed report of my observations ranging over several generations of this species has been delayed. In 1980 I was compelled by some reasons to write the records of my observations in Japanese (Ibid., No. 10) and as I became free from Trypoxylon now it was determined to try to translate the paper in English for my foreign friends, with some additions of my later observations.

The wasps that I have observed live generation after generation in my little garden, forming a little colony. Late in spring the males appear first, fly about between the plants and wait for the appearance of the females, frequently visiting the places where the nests of this species are present. When the females appear they love each other and the females began soon to make their nests.

The place they nest is invariably the earth of the plant pots. The same habits of this species was previously reported in some detail by Mr. S. Kubota in Hym. Comm., No. 2, 1975, which was observed in Nara Prefecture. The similar flower pot nesting habits of this genus were reported with G. laticinctus Lep. by F. Maillard as early as 1847 in France.

However, the nesting site of the present species is not confined to the earth of plant pot. I formerly observed several wasps of this species nesting on the sandy shore of lake Suganuma, Oku-Nikko, Japan, which was erroneously reported as done by Argogorytes mystaceus grandis Guss.\* But in my garden, except a single try-digging I have found no nest in other place than the plant pot.

\* Tsuneki, K. 1965. Life Study (Fukui), 9 (3-4): 41-42.

As the species of the genus Argogorytes are not provided with the tarsal combs on the fore legs they are considered to be xylocolous and I have had a doubt about the identification of the specimens of the report. But the specimens got astray and I could not have examined them. Recently, however, I happened to discover them and could confirm that they are not the Argogorytes, but Gorytes tricinctus Pérez. The cause of the error lies in that at the moment of identification they were placed with the Argogorytes collected at the same place and time and as they are similar in dorsal appearance the specimens of the former alone examined under the microscope.

Recently Mr. T. Nambu, Saitama Prefecture, sent some interesting communications to our Journal, Hymenopterists' Communication, No. 14, 1982, about the nests of Argogorytes nipponis Tsuneki which he observed. As I have obtained his consent and as he has no intention to publish it in foreign language his observations will be presented at the end of this paper as an Appendix.

Nesting Activities

Early in summer of 1977 I frequently met with the flying wasps of this species in my little garden (about 130 m<sup>2</sup>), some of them were carrying their prey under the body and I thought that they might be nesting somewhere within this area.

In 1978 a chance came to me. I saw two males of this species come to a large Camellia pot and fly about from leaf to leaf of the plant. The next day, on May 30, again I saw the two males, sometimes one male only, repeat similar behaviour. To me it seemed that they were waiting for the appearance of the females who were possibly still in dormant state in the earth of the pot.

June 1 (fine), at 14:30 I saw a small hole on the surface of the earth in a pot of the Camellia tree, but I did not pay special care about it sprinkled water as usual over the pot earth. To my surprise, a wasp of this species hurried out of the hole and fled away. I waited, but she did not return after all. Possibly she was digging her burrow, not as yet with a brood chamber inside.

June 3 (fine). I again repeated a similar failure. When I sprinkled water over

the earth of around the foot of a Ternstroenia japonica a wasp of this species flew up and got away. On the earth was a shallow hollow that was just after beginning to dig. It was also finally abandoned by the wasp. But as I could confirm that some wasps of the Gorytes were surely nesting in my garden I became careful when I sprinkled water over the pots.

July 6 (fine). In the morning I saw a comparatively little wasp of this species fly about in front of a cypress tree at the east side of my garden as if she was searching for something. She soon flew slowly southwards and I followed her. She went to a group of the pots of the garden Rhododendron placed under the polyethylene roof and flew about from one pot to another and finally landed on the earth of one of them. She walked about and soon began the trial digging hither and thither. The earth for the garden Rhododendron is a rough soil consisting of the broken pieces of the well efflorescent claystone and to our knowledge it appears quite improper for the nesting ground of the digger wasps. Moreover, the plants potted in such soil have abundant fine frizzled rootlets that are entangled to form a complicate network, filling every space between the soil grains and let the digging very difficult. Certainly the wasp soon ceased digging at one place, but she tried again at another place. She then flew to the next pot and repeated the similar try-digging. Finally she went to pot A and again tried. The earth of this pot was mixed with a considerable proportion of the farm soil and she could dig in fairly smoothly. I thought that she would succeed in making her nest in this pot, letting her alone and came back to my room. In the evening, however, when I went to the pot, to my disappointment, it was abandoned half way.

June 8 (fine). I found a female wasp digging in the rough earth of one of the Rhododendron pots. She was slightly larger than that observed on the 6th. Another much larger female was also seen on a leaf of a nearby Camellia tree. It seemed that she had also her nest at some place in my garden. The wasp in the plant pot soon disappeared and thereafter I could not see any one at the place.

June 10 (fine). At 4:30 when I returned from my morning running I saw a little female fly towards the pot group of Rhododendron, but I did not follow her. At 7:20, I saw again a wasp, possibly the same one as I had seen earlier, fly towards the pots. By following her I could confirm that she went to the pot that was previously called by me pot A. On the earth there were some holes that were dug in trial digging on the 6th and in one of which the wasp entered. It was already so deep that the wasp entered at once disappeared. Certainly it was her burrow. Soon the wasp began to push out the earth very actively from her burrow. She came out backing to the entrance and there with her hind pair of legs threw out the earth that was pushed up with the tip of her abdomen. After observing a while I left there. At 13:00 I went to her nest. The wasp was closing the entrance and when finished she at once flew away. At 16:00 I saw the wasp make apparently the final closure, judging by the behaviour of Bembix at the same situation. So I observed her behaviour carefully.

The wasp comes out of the hole, collects the grains of earth with her fore legs in front of the entrance, she then scrapes them backwards also with her fore legs into the hole. Then she enters the hole backing and pounds the earth and the grains thrown in with the tip of her abdomen. The manner is much the same as that which is exhibited by the wasps of Bembix spp. at the time of the final closure of their nests. When the hole becomes shallow frequently the wasp highly lifts up the tip of her abdomen before pounding. When the entrance becomes level with the surrounding areas she walks about near the nest and throws the heaps of earth dug out or the scattered grains backwards to the entrance through the underside of her body with her fore legs. It appears to be a simple levelling behaviour, but viewed from the fact that various objects are indifferently thrown towards the entrance it seems to be a camouflaging behaviour also.

The wasp suddenly ceased her activity, flew up and flew away.

June 11 (fine). The next day, at 4:30, just at the time of sunrise I saw the possible same wasp as I observed the previous day already digging her nest on the earth of the same pot as that of the previous day, namely pot A. It seemed that the wasp made several simple nests during her life time. When she entered her burrow she was completely disappeared. The fact told me that she must have begun to work considerably before sunrise. She was also as diligent as the Eumenes dealt with in No. 21 of SPJHA.

At 9:30 when I went to the nest the wasp was opening the entrance to her nest, holding a prey under her body. It was slightly brownish ashy grey in colour, apparently a homopterous insect. It was held by the wasp with her middle pair of legs, venter to venter. The wasp did not let it off, dug out the packed soil and grains with her fore legs. Soon the entrance was opened and the wasp crept in it with the prey, but she let it off in the tunnel within my sight and disappeared empty-handed. At once she

came back, head foremost, caught the prey with her mandibles and disappeared backing in the depth. It was a rather surprise that the manner of taking the prey into her burrow was quite the same as that of the wasps of the Japanese Bembix. After a while she appeared at the entrance and began to close there. She produced her anterior body out of the entrance, collected the earth and grains that had been dug out and heaped in front of the burrow and swept them into the entrance and then pounded them with the tip of her abdomen. This was three times repeated and the entrance was completely closed. She flew away at once without making any levelling activity. The manner of pounding was, however, at this time very rough. Notwithstanding it is very curious that in the case of the temporary closure this method is employed. In this respect this species differs distinctly in habits from Bembix.

At 15:00 I went to pot A. The heap of the earth placed in front of nest 2 had been disappeared and the surface was broadly levelled. Apparently the wasp had completed this nest, having collected ample amount of prey and finished the final closure to the nest. I placed a bit of a leaf on the place where the entrance had been. It was not moved when I examined it at 17:00 and a new burrow was already opened by the side of nest 2. I stayed there for a while, but the wasp did not come out of the burrow. It was unknown whether it was an abandoned hole or a temporarily stopped one, but as it seemed that she was not inside I stopped the observation. At 18:00 I again visited the pot. The hole remained as it had been.

June 12 (cloudy, often rainy). At 5:00 the rain that began to fall last night was still falling. To my surprise, however, the burrow that I saw was closed. At 6:30, to my further surprise, the wasp was closing the burrow with the method of the final closure. It must have been that the wasp was digging her burrow while I saw it at 18:00 previous evening, she dug it up after I left there, finished most of the provisionment to the nest during the rest of the day and made the temporary closure to it. This was the state that I saw at 5:00 this morning. Judging by the permanent closure made at 6:30 this morning the final prey must have been provisioned in the light rain just before this time. Such an early activity of the wasp except the Eumenid wasp mentioned in No. 21 of the SPJHA I have not been aware of. Even the Eumenid did only the nest building work and not the hunting activity.

The wasp repeatedly scraped the earth and the grains that were piled up in front of her nest into the entrance hollow and elaborately pounded them with the end segment of her abdomen. Finally she carefully levelled the surface and then flew out of the pot, went to other near-by pots, flew about among them, sometimes landed on the earth of some of them, but soon after returned again to pot A and began to dig a new burrow at the west side of the pot. The relative position of the four nests she made in this pot was as given in Fig. 1.

At 7:30 I went again to the side of pot A. The burrow was already fairly deep and the working wasp could not be seen when she was inside. But from time to time she came out backing, carrying the debris at the end of her abdomen and pushed out it from the entrance. In digging the mandibles and the fore legs are used as usual. At the entrance the earth and the grains of the debris are thrown out through the under space of her body. But the manner is not so nimble as in the case of most species of Bembecinus. The debris is not so far thrown away, but rather pushed away. This seems to be not only due to that the debris is larger in grain and much heavier, but also due to the difference in nimbleness of their nature. Notwithstanding, she lifts her abdomen when she scrapes the earth backwards as done by Bembecinus and Bembix and shows somewhat an attitude of throw. But her movement is slow and less in number as compared with even the Bembix. In digging the wasp of this species gathers the debris first under her abdomen. When it becomes to hinder her movement she scrapes and pushes it further backward, namely toward the entrance with the front pair of her legs. The behaviour is repeated and when a large amount of debris becomes to close the tunnel she comes backing to the entrance through the debris and carries it out of the burrow by repeating the movement above mentioned. When the burrow becomes deep the wasp only rarely appears at the entrance, possibly she works within the narrow empty space at the apex of her tunnel, advancing the space by forward digging and backward packing.

At 8:30 I visited the nest and knew that the wasp was still digging. At 9:00 she was cleaning the burrow by carrying the debris out of the tunnel, but she soon entered it and resumed her digging activity. Until 9:10 I continued to observe, but she did not come out. This burrow seemed to be particularly long.

At 10:30 the entrance was closed. At 11:30 without change. I placed a leaflet on the entrance to know whether the wasp entered the nest or not. At 12:30 the matter was unchanged. At 14:30 same. The place was under the translucent polyethylene roof, but the outside of the roof was frequently beaten with rain and possibly the wasp would

not try hunting. Air temperature was 19-22°C. At 17:00 and 18:00 weather condition and the state of the nest were unchanged.

June 13 (heavy rain since last night, but ceased in the morning and from about 9:00 the sky began to clear). I observed the state of the nest once an hour, but it remained unchanged at 5, 6, 7 and 8. At 9:30 when the sky began to clear the leaflet on the entrance of nest 4 was moved for the first time and partly covered with soil. It was certain that the wasp entered the nest (possibly with a prey). I rearranged the leaflet as before. At 9:50 it was again moved. At 10:30 again moved, but since then, though I frequently visited there it was not moved till noon. But at 12:30 it was moved, at 14:00 unmoved, at 15:00 moved and at 16:00 moved.

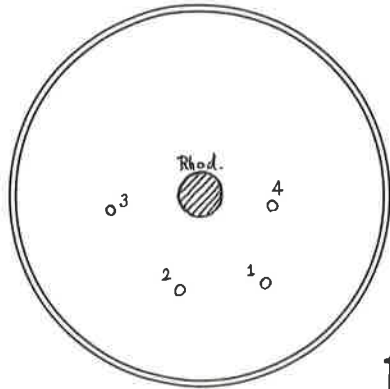


Fig. 1. Pot A, with four burrow entrances, 1, 2, 3 and 4.

At 17:00 when I went to the pot I saw a wasp fly about over the potted plants. Intuitively I thought that the wasp was doing something but she stopped it and flew up by my sudden intrusion. So I stood still. The wasp soon went to the pot of Rhododendron at the western end of the row and landed on the pot earth where was opened a burrow in which the wasp entered at once. It was already fairly deep and she resumed her digging work. I called it pot B and her wasp B.

At this time nest 4 of pot A was left as it had been. At 17:10 wasp B appeared out of the burrow and flew about low over the concreted ground, appearing somewhat like the orientation flight, but somewhat also like the searching flight for a new nesting site. After a while the wasp flew away.

At 19:10 I went there and found that burrow B remained as before, apparently it was abandoned. While in pot A wasp A was closing her fourth nest with the method of the temporary closure. When finished she at once flew off. I rearranged the leaflet.

If the wasp carried in the prey every time of her entering the nest it becomes that she collected at least 6 prey in her nest since 9:30 this morning and yet the provisioning to this nest was not finished.

Wasp B was very similar in appearance to wasp A. But they were surely different individuals.

June 14 (cloudy, later fine). At 4:40 when returned from my daily running of 5 km I went to the Rhododendron pots and observed. In pot A the wasp was already digging the burrow. It was certainly nest 4. I wondered whether she was doing repair work of nest 4, or digging a new cell inside the nest. If the latter was the case it became that this Gorytes made a compound nest occasionally. If the former it was considered that the wasp enlarged the brood chamber of nest 4 to enable it to receive further prey in it. It was unknown whether she had provisioned further prey last evening or not and it was also unknown whether she had brought in a prey this morning or not. At any rate the state of the inside of this nest became very interesting to examine. At 6:00 the wasp was still carrying out the debris from the inside and continued the digging work. At 7:30 the entrance of nest 4 was closed. Two white stamens of the Rhododendron were fallen on to the entrance of this nest. I left them as they were. At 8:30 the stamens were moved, telling the entering of wasp A. I rearranged them as before.

At 10:00 the matter was unchanged. At 11:50 the surface was levelled, the stamens were separated and scattered at different places, the heap of the soil in front of the entrance disappeared. Apparently the nest was permanently closed.

At this time I saw the burrow in pot B and was surprised to find a wasp in it. When I had seen this pot at 10:00 the burrow was left as before, with the entrance half closed with a pebble of the size of a rice grain. But now, it was widely open and soon appeared in it that characteristic yellow pattern of the clypeus of this species and from its movements it was obvious that the burrow was in the course of closing. I continued the observation. At 12:30 the burrow was closed till mouth and thereafter the

surface centering around the nest entrance was broadly levelled. The earth of this pot was the so-called Kanuma-soil, consisting of broken pieces of the weathered claystone and many grains of her head-size or breast-size or much larger-size were included and these were eagerly scattered about by the wasp. She grasped the grains with her mandibles and pulled or pushed about, or scraped them with her front pair of legs. She continued the work for a long time till 12:50 and flew to a leaf of the near-by Camellia tree, took a short rest and flew away towards the western sky.

In the behaviour of wasp B are included some curious elements. While she was absent from her nest and possibly during the course of her provisioning activities she left the nest entrance opened or half opened, so that I thought it abandoned. She was digging this nest at 17:00, last evening. It was left opened at 19:00. This morning at 10:00 it was half opened and during 12:00-13:00 it was permanently closed. This morning I stayed by the side of the pots-row frequently and for a fairly long while, but I did not see wasp B enter her nest even a single time. So I determined to examine the nest for a start before those of wasp A. The results are given on p. 13.

At 14:00 while I replanted the Rhododendron of pot B as before a wasp (apparently wasp B) came and flew about around me. It landed on one of other pots, but soon flew away. In replanting I added a small amount of farm soil at the periphery of the pot so as to consolidate and fix the root-mass to the pot. As a result the appearance of the surface of pot B became considerably changed. But I placed this pot just at the position where it had been.

At 14:15 a wasp came flying and flew about between and around pots in a row. She landed from time to time on some of the pots and walked about on it, examining the soil with her antennae. She went to pot B and examined the surface. From the manner it appeared that she was wasp B, but as it was uncertain she was called wasp C hereafter. I followed her with my eyes for a while, but she did not begin to dig and I returned to my room, letting her alone.

At 16:00 I went again to the pots row. In the soil of pot C the wasp was digging her nest which was already considerably deep. At 17:00 this nest was closed, but at 18:00 it was half-opened just as done by wasp B. Judging from the size, feature, behaviour that first flew about around replaced pot B and dug indifferently into the rough Kanuma-soil and the manner of leaving the nest entrance half opened while she was absent, it seemed certain that wasp C was the same individual as wasp B.

June 15 (fine, cloudy in the evening and rainy at night). At 5:00 I saw wasp C digging her burrow, but it was uncertain whether she was making a second cell or enlarging the first cell. While I was there she carried out the grains of soil backing and threw them backwards and at once entered the nest. At 6:45, however, the entrance was completely closed and on it were placed 3 small pebbles of different colour. As they were convenient to assure the activities of the wasp I left them as they were.

At this time on the earth of pot A, apparent wasp A was walking about, but soon she flew away. Colour marking to each wasp seemed to be necessary. But I hesitated, because the wasps of this species appeared to be sensitive and the manipulation might let them abandon their nests and also my garden.

At 7:45 the pebbles were as before, but I saw a wasp come flying and alight on a leaf of the nearby Camellia tree. She held a prey under her body. After a short rest of about one minute she flew to pot C, landed in front of the pebbles and began to open the entrance, lowering her head and lifting her abdomen, without letting the prey off. The entrance was apparently tightly closed and she needed about 1 min. to remove the packed grains and soil from there. A hole was thus opened, but it was too small for her to penetrate with the prey under her body. So she let it off at the entrance hole and the posterior half of the prey was seen produced from there. Soon it was dragged into the nest. After about 20 sec. the wasp appeared at the entrance, but without coming out of there, scraped the earth and grains into the burrow in the usual manner of the sand wasps, and then pounded them with her abdomen as done by other individuals of this species. When finished the closure she flew away at once without levelling activity. A glance of the prey left at the entrance hole suggested that it was the same species as those provisioned by wasp B.

At 8:20, when I went to pot C the wasp had just come back there with the prey. She let the prey off at the entrance hole in the same manner as in the preceding provisioning and dragged it in also in the same manner, but this time, the time spent during the course was only 10 sec. She then similarly pounded the grains that were swept in from around the entrance and at once flew off. I placed a leaflet on the entrance.

At 10:00 the leaflet remained unaltered in position.

At 11:00 Strange to say, the wasp was opening the entrance without having a prey.

She grasped a grain of the Kanuma-soil and pulled it out from the entrance one by one, from time to time mixing the dust sweeping-out behaviour. What is this? Has she begun to dig a second larval cell in this nest?

At 11:08 when I came back to pot C after observing another wasp the nest was closed and the wasp was absent. The surface condition told me that it was the temporary closure. I placed a leaflet on the entrance.

At 13:50, at 14:15 the surface of pot C was unchanged. But at 14:30 when I went there the wasp was closing the tunnel by means of the permanent closure — closing the burrow from the deep part of the tunnel and at first we can see the head of the wasp only which is trembling violently in her pounding behaviour in the burrow —. I could not understand the meaning of her opening the nest at 11:00. When the hole is closed to the level of the surface of the pot earth the wasp began the levelling activity. This was elaborately continued till 14:47 and she flew away.

From 14:10 I investigated the A's nests in pot A for about 2 hours, and at 16:00 I went to pot C and found 2 shallow hollows dug on the surface of the soil, one near western wall of the pot and the other near the first nest just completed and close to the foot of the trunk of the Rhododendron.

At 16:20 a wasp was deepening the second hollow of pot C, but after 10 min. it was closed and the wasp was absent, while 5 min. later the wasp was again digging the place. It seemed to me, therefore, that this species, or this wasp, or this wasp in this pot with very coarse soil, tried to dig and close the hole several times before completing it as her nest. I continued the observation. The wasp also continued her digging work. The part that was closed by her in her previous trial was apparently firmly closed and the wasp must have costed much labour. From about the depth of her body length the digging became formal and she stayed long inside the tunnel before her next coming out backing. At 17:00 the burrow became fairly deep. At 18:00 the wasp was continuously digging and I left the place. But when I examined the pot at 19:00 the entrance was closed and the wasp was not there.

June 16 (cloudy, often fine, often rain fall). At 6:00 I saw wasp C eagerly digging her burrow that was closed at 19:00 of the previous evening. It was fairly deep and the wasp came out to the entrance only occasionally. After waiting for about 5 min. the wasp appeared at the entrance when I tried to capture her with a vial, but failed and the wasp fled away. I went again to the nest after 20 min. and saw that the nest was closed. It was certain that she came back here and continued to work. I placed a stamen of Rhododendron on her nest.

At 8:00 no change. At 10:00 the stamen was stirred, showing the entry of the wasp. At 11:55 she was closing it with the method of final closure. I caught her when she finished the work to confirm her correct name, because some closely resembling species occur in Japan. But I failed in temporary paralysis and the wasp died. As I had fully examined the nests of this species with wasp A, the nests of this wasp were left untouched, partly because of the expiation of my failure to let her die and mostly because of the precaution for keeping the species continuously in my little garden. However, by the sacrifice of her death it was surely confirmed that the species belonged without doubt to Gorytes tricinctus Pérez.

June 17 (cloudy, once rainy, later fine). At about 16:30 I saw a wasp of this species resting on a leaf of a Magnolia tree. She was eagerly making her toilet; extending and scraping together her hind pair of legs, rubbing her antennae alternately with her front leg, brushing her wings with her hind pair of legs, etc. Certainly she was just after the finish of a series of her work and was resting. She stayed there for about 5 min. and finally flew away eastwards. I examined the plant pots one by one if I could find out her nest. During the course I found a wasp (D) digging her nest in a large pot of an Ericaceous, 30 cm in inner diameter at the top. The plant was still young and the ample empty space was around it. Moreover, the earth of the pot was good forest soil and seemed to be proper for nesting of this species. The pot was placed under the sky and at fairly sunny place. The burrow was already fairly deep. I left her free and revisited at 17:00. It was closed and the wasp was absent. But I found another wasp (E) in the same pot who was actively digging her nest at the place only 8 cm apart from nest D. It was also fairly deep and she came backing to the entrance only with long interval. I had certainly seen a hollow at this place when I found wasp D. But I thought that it was an abandoned trial hole, and paid no special notice. After observing her work for about 10 min. I left the place. At 19:00 this nest (E) was closed, as well as nest D.

June 19 (heavy rainfall at 2:00-5:00, later frequently fine). At 4:30 when I returned from my morning running I went to the pot. It was as yet before sunrise, but

a wasp was already flying about around the top of the Erica, possibly either wasp D or E. Soon she flew away. The entrance condition of nests D and E was almost unchanged. At 6:40 wasp E was about to provision a prey (at this time weak rain began to fall). As done by other wasps of this species in the pots of Rhododendron, she also opened the entrance to her nest without letting her prey off, holding it under her body with her middle pair of legs. She spent some time to clear the entrance, possibly because of the thicker and fairly firmly pounded temporary closure. She also let off the prey in the entrance hole, visible from outside, and then dragged it from inside backwards in the tunnel. She soon appeared and made the temporary closure with the pounding behaviour, spending one min. for the work. Finally she flew away NEwards.

At 7:30, a bit of the flower petal of the Rhododendron that was placed on each of the two nests was unaltered on nest D, but moved on nest E. At 8:13 wasp D returned with a prey from the west. She spent also one min. to open the entrance of her nest and carried the prey into the nest with the same method as mentioned repeatedly in regard to the wasps of this species. When D flew off E came back from the east with a prey, provisioned it and at once flew away. The time spent by her was about one min. to open the entrance and one and a half min. to carry in the prey and to close the entrance temporarily. Between the two wasps E slightly larger than D.

At 8:25 the nest of wasp E was open. After about one min. the head of the wasp came in sight of the hole, soon she appeared completely outside the nest, but at once turned round and entered the nest head foremost. Since then she did not come out for a long time. At 8:38, after 12 min. she came out, produced her head out of the entrance and began to close the nest. The manner was distinctly that of the final closure. At 8:44 the head of the wasp was seen at the bottom of the tunnel, still fairly deep. At 8:50 the wasp to her thorax appeared outside the nest, yet the heap of the earth in front of her nest was fairly high. During the course of closure the wasp from time to time came completely out of the tunnel, but at once turned round in front of the entrance and entered the tunnel, head foremost. She turned round at the bottom and resumed the pounding activity. At 8:55 the entrance became level with the surroundings but she still continued the pounding activity. Finally levelling was commenced.

Levelling consists of two sorts of behaviour: Scattering the heaped earth in front of the nest entrance, and throwing the newly dug earth towards the entrance. The work is always made by throwing the earth through the underside of the wasp's abdomen with the front pair of legs.

Here the work was continued till 9:00 when she flew up and flew about over the pot earth a little, but soon landed at the entrance and resumed the levelling behaviour as before. At 9:05 she again flew up, alighted on a leaf of a nearby tree, made toilet and walked about over 3 leaves flew away towards the east.

After the observation I inspected other plant pots. In one of the Camellia pots, 30 cm in inner diameter at the top, there were 3 hollows on the earth surface, possibly the trial digging hollows by some one of this species. In other 27 cm pot there were also 2 hollows.

When I came back from visit at 11:20 I saw the casual meeting of both the wasps of the Erica pot. At that time D was closing the entrance and E has returned from the field empty-handed. The two wasps recognized each other and flew up, apparently in amazement, but no trouble occurred. E flew away at once and D returned to her nest and continued her work. Soon she finished the temporary closure and flew away (11:30).

Wasp E had made her new nest during 9:05-11:20, possibly soon after her finish of nest 1, while I was absent. It was in the same pot, at 12 cm apart northwards from nest D and at that time it was closed. The prompt construction of the new nest was considered to be due to the good texture of the pot earth.

Soon after D went out I found E closing her new nest. Ten min. later E was again closing the nest. But whether she carried the prey in her burrow or not was uncertain in both times, since at 11:20 she came back empty-handed.

At 12:29 D was closing the nest. At 12:41 E was closing her nest. At 12:53 D was making the provisional closure, but at 14:00 she was working to make the final closure. At that time it was near the end of the closing work and her closing behaviour was seen already from the outside. Her mode of closure was rather coarse. She came out of the nest, frequently picked up a large clod of earth, about 2-3 times as large as her head, carried it to the entrance and dropped it in the hollow. She swept the fine dust, grains or bits of dried leaves indifferently into the tunnel. In her final levelling work, however, she was very prudent and spent about 5 min.

At 14:16 E carried in a prey to her nest. After temporary closure she flew to one of the leaves of a nearby tree, took a rest for about 10 sec. in toilet and flew away westwards as usual in her.



At 15:30 the entrance of nest E was open, apparently the wasp was inside, but she did not come out for a long time. After waiting for about 10 min. she came out, made the temporary closure and flew away. What had she been doing? If she stayed for so long a time for oviposition it seemed interesting, because it became that she laid her egg during the course of provisionment.

At 16:00, (possible) wasp D was digging at about 5 cm south of her previous nest. It was as yet as deep as her body length. At this time the leaflet placed on the entrance of new nest E was not stirred.

At 16:55 wasp D was still continuing her digging activity. It became fairly deep and only from time to time she carried out the debris from the inside. At this time E was inside her nest, with the entrance closed with the earth pushed out from within. This time, too, she did not appear for a long time. At 17:03 both wasps did not appear. At 17:10 wasp D was still digging in the depth and wasp E was still stayed inside. A light rain began to fall. At 17:13 E appeared, but at once turned round and entered the nest again and began to dig. Both wasps pushed out the earth at considerably long intervals from within. It was considered that E was constructing a second larval cell in the present nest. The rain became fairly heavy, but as the pot was covered high above with dense forage of a maple tree standing nearby and covered again low above with leaves of its own Erica the surface of the pot earth was almost not beated with the rain. At 17:45 both the wasps continued the digging work, at 18:00 the matter was unchanged. At 18:13 nest D was closed at the entrance, but wasp E was still digging. The rain ceased a short time before 18:00 and the sky became lighter. At 18:20 nest E was also closed.

June 20 (cloudy, often rainy). At 4:35 at my return from the morning running I examined the pot. There was no change on the two nests. But at 5:45 a leaflet on nest E was moved and partly covered with soil, the entrance itself was closed. At this time wasp D came to her nest empty-handed and opened the entrance. At first she scraped a small amount of soil before her nest, then came to the entrance, moved the leaflet put on it with her mandibles and began to dig. At 5:47 the entrance to nest D was closed and the leaflet was stood in the packed soil.

At 6:31 while I was there wasp E came flying with a prey and provisioned it as usual, leaving the prey once in the entrance hole. She soon came out, swept the earth in the tunnel and pounded it as usual, but this time the closure was comparatively simple and the wasp flew up, came in front of the entrance, keeping her head towards the nest and flew right and left as if she tried the orientation flight and soon flew away. The behaviour was very strange and to me its significance was ununderstandable. The leaflet was replaced on the nest.

At 7:01 when I went to the pot E had already returned with a prey. She removed the leaflet, opened the entrance and provisioned it as usual. Only about one min. was spent by her till she came to the entrance, she closed there temporarily and at once flew away. At 7:10 and 7:15 I examined the nest condition. No trace was observed to show the return of either of the wasps. At 7:30, however, wasp E came out of the nest, closed it somewhat more elaborately than before and flew away. How long she was in the nest was unknown.

At 7:45 wasp D provisioned her nest and flew off towards the west (this wasp always flew westwards). At 8:27 D again carried a prey in her nest. I measured the accurate time. She spent 30 sec. till entering, 35 sec. till reappearing at the entrance and 45 sec. till finish of the temporary closure. I continued the observation, but both the wasps did not return till 9:20 and the observation was stopped.

At 9:53 when I went there wasp E was about to come out of her nest. As she did not return till 9:30, possibly this was the first return since 7:30. She made a temporary closure and flew off.

At 10:50 I saw E close the entrance of her nest and fly away. There was no trace of return at the nest of wasp D.

At 11:25 E provisioned a prey, requiring 30 sec. and came out. At the outside of the entrance she turned round and entered again head first, remained inside for 15 sec. and again came out. In front of the entrance she turned round again and at once penetrated head foremost. After 40 sec. her head was seen near the entrance, but at once she backed in. Apparently she was closing the tunnel inside. But she did not come in sight (at this time the rain began to fall), at 11:33 ditto and at 11:35 ditto. At that time another Gorytes came flying and alighted on a leaf of a nearby tree, but soon she flew away in the rain. At 11:40 wasp E came backing and produced her abdomen completely out of the entrance, but from there she again entered the burrow, scraping the earth. At 11:47 she showed the same behaviour. But after one min. she came out head foremost and began to close the entrance. It was done by means of the temporary clo-

sure and flew off in the rain. What was she doing in the nest? Oviposition and closure of the possible second larval cell? Wasp D did not return till this time. I put a stamen of the Rhododendron on the entrance of both the nests.

At 11:35 rain ceased, but the sky was dark. At 11:57 again rainfall. At 13:00 the rain became somewhat lighter, but did not cease and the stamens on the nests were not moved. The earth of the Erica pot was completely moistened after all. At about 15:00 the rain ceased and the sky became somewhat lighter, but the wasps did not return.

At 15:53 when I examined the nests the stamen on nest E was moved and at 16:30 E was closing the entrance. It was a temporary closure, it was somewhat more simply done and the wasp flew away. At 17:00 the rain again began to fall and the observation was stopped.

June 21 (strong wind by a typhoon, frequently rainfall, but from about 15:00 wind became weak and the scattered blue sky began to appear).

At 12:00 no trace of return of both the wasps.

At 15:00 a trace of return of wasp E on her nest, but uncertain whether it was once or twice or more. Nest D was unaltered.

17:00, the wind became much weaker and the sky began to clear. Apparently nest E had been permanently closed. The earth on nest D was also moved, but it was uncertain whether it was finally closed or not. At this time I saw a wasp digging her nest, only 1 cm apart from nest D. This wasp was continuously digging at 17:20, but at 17:43 she began to close the nest. After it was closed by means of the temporary closure she began to level the surface around the entrance of her nest. It was elaborately done by spending a considerable time for it. Finally she pounded the surface of the closed entrance with the tergites of her ventrally curved apical segments for a while and then flew up. She flew about slowly 10-20 cm above the ground, describing loops and letter 8 around and in front of her nest, from time to time she flew still in front of her nest, keeping her head toward the entrance as if gazing at it. Her flight became gradually higher and larger and finally she flew towards the west, but she was blown back by the wind again and again and at last she flew southeastward with the wind.

This wasp resembled wasp D in her behaviour to intend to fly westwards, but from the fact that she made such an elaborate orientation flight as mentioned it seemed to be proper to treat it as a new wasp, namely wasp F.

June 22. Hard wind, heavy rain, often thunder, not the weather to permit the activity of the wasps.

June 23 —. It completely entered the rainy season. Bad weather was almost continuous from day to day. When the rain ceased to fall I visited the nests of the Erica pot, but always without the least trace of the return of any of them. Possibly all of them must have died within 2 or 3 days after the 21st.

The activities of the 5 wasps (F excluded) are given summarily in Table 1.

### 1979

On May 25, the first escape hole appeared on the earth of the Erica pot. In 2-3 days thereafter further 4 holes were observed. The holes were sometimes completely open, sometimes half closed with earth. It was certain that at least 5 wasps emerged from this pot. In the case of the compound nests, however, the wasps born in the different cells of one nest may escape through the same tunnel that was made by the first emerged wasp, so that one hole does not always mean the birth of one wasp. As far as observed by me both the wasps D and E made 2 nests respectively in the pot, and E, moreover, made apparently 2 or 3 cells in her second nest. The appearance of 5 escape holes on the surface of the earth of the Erica pot fairly well agreed with my observations of the previous year. As to the nest(s) that might have been made before my observation I can not say anything.

The examination of the nests observed could have confirmed the facts about the problems given rise to during the course of the observations and it was possible to do so even under the rain, as the nest base was the pot earth. But I did not do so, because the knowledge of the nests and larvae of this species had fairly sufficiently been accumulated and, moreover, I wished to keep the population of this species flourishingly in my little garden.

In pot C also appeared one escape hole of the young of wasp C. As above mentioned this did not always show that only one wasp was born in this nest (see Table 1).

Early in June of this year I frequently met with the wasps of *Gorytes*. Possibly all or most of them must have been born in my garden. On June 3 one of them was seen digging her burrow in the pot of the Erica, possibly one of the offsprings born in

Table 1. Activities of wasp A, B, C, D and E in the Ericaceous pot observed in 1978

Wasp A. June	Wasp B. June	Wasp D. June	Wasp E. June
10. 4:30 dg	13. 17:00 dg	18. 16:30 dg	18. 16:30 dg
6:30 dg	17:15 hop	17:00 c	17:00 dg
13:00 prg	19:10 hop	19. 4:30 o	19:00 tc
16:00 fcg	14. 10:00 tc	7:30 o	19. 4:30 to
11. 4:30 dg	11:50 fog	8:13 prg	6:40 prg
9:30 prg	12:30 lg	11:20 tcg	7:30 tr
15:00 fc	12:50 lg	11:30 to	8:16 prg
17:00 op		12:29 tcg	8:25 dg
18:00 op	Wasp C. June	12:53 tcg	8:35 st
12. 5:00* c	14. 14:30 dg	14:00 fcg	8:38 fcg
6:30 fcg	16:00 dg	16:15 dg	8:44 fog
6:45 dg	17:00 tc	16:55 dg	8:55 lg
7:30 dg	18:00 hop	17:10 dg	9:05 lg
8:30 dg	15. 5:00 dg	17:45 dg	11:20 o
9:00 dg	6:45 tc	18:00 dg	11:30 tcg
9:10 dg	7:45 tc	18:13 to	11:40 tog
10:30 tc	7:47 prg	20. 4:30 to	12:41 tcg
11:00 tc	8:20 prg	5:40 e	14:16 prg
12:30* tc	10:00 tc	5:47 tc	15:30 op
14:30* tc	11:00 dg	7:45 prg	15:40 tog
17:00 tc	11:08 to	8:27 prg	16:55 st
18:00 tc	13:50 tc	10:50 tc	17:10 dg
13. 5:00* tc	14:15 tc	11:47* to	17:13 dg
8:00* tc	14:30 prg	13:00* to	18:13 dg
9:30 tr	14:46 lg	21. 17:00 tr	18:20 tc
9:50 tr	14:48 prg		20. 4:35 tc
12:00 tc	16:20 dg		5:40 tr
12:30 tr	17:00 dg		6:31 prg
14:00 tc	18:00 dg		7:01 prg
15:00 tr	19:00 to		7:30 tog
16:00 tr	16. 6:00 dg		9:53 tog
17:00 tc	6:20 tc		10:50 tog
19:00 tcg	8:20 tc		11:25* prg
14. 4:40 dg	10:00 tr		11:35* fog
6:00 dg	11:55 fog		15:00 tc
7:30 tc			15:50 tr
8:30 tr			16:30 tcg
10:00 tc			21. 15:00 tr
11:50 fc			17:00 fc

Abbreviations: o ... closed. cg ... closing. dg ... digging.  
 e ... enter without prey. fc ... finally closed. fog ... finally closing.  
 hop ... half opened. lg ... levelling. op ... opened. prg ... provision-  
 ing. st ... stay in the nest. tc ... temporarily closed. tog ... tempor-  
 arily closing. tr ... trace of entering. \* ... rainy.

this pot. She continued to work there. On the 6th of the same month one more female also began to dig her burrow in this pot. The first female dug a second nest on the day, 3 cm apart from the first. In the afternoon of the day she was observed to carry in a prey — pale brownish grey in colour and possibly the same species as those hunted by her mother — in quite a same manner as that of the mother. The second wasp, after 5 or 6 trial digging, made her nest near the southern wall of the pot, 17 cm apart from the second nest of the other wasp. In this year I could see several other nests made in the pots of various size planted with Camellia, Rhododendron and others. But I did not try special observation.

1980

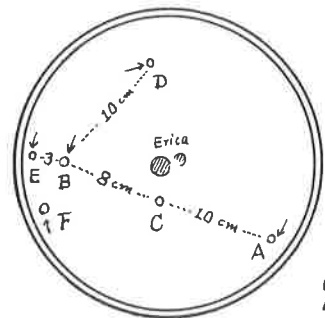
- June 1. At about noon a wasp was digging her nest in the Erica pot at A in Fig.  
 2. June 2. At 15:00 two wasps were digging their nests at B and C respectively shown

in Fig. 2 (Erica pot). At 16:00 two wasps were still digging. At this time nest A was closed.

June 3. At 12:30 in the Erica pot nest B and D were in the course of digging and nests A and C were closed.

June 4. At 17:30 nest B was open, but D was closed and wasp E was digging at E (Fig. 2). At 17:40 nest B was temporarily closed and wasp E was closing her nest. Her behaviour was abnormal and seemed worth description.

Wasp E was closing nest E shown in Fig. 2. Her mode of closure was fairly elaborate, but she did not make that pounding behaviour which was shown even in the temporary closure in this species. The apparent burrow was completely closed till its mouth. Then the wasp flew out of the pot, but soon returned on the pot earth. She repeated same manoeuvre once more and then went far away over fence to the south. She turned from there to the west and again returned to the pot. She walked about on the earth as if to search for the new nesting site. Again she flew to the west, came back from northwest and again walked about on the pot earth. At 17:50 the wasp began to dig at F in Fig. 2. Apparently nest E was closed for abandonment. At 18:10 she was still digging her new nest, F, but at 18:30 when I went there it was already closed, apparently by means of the temporary closure.



2

Fig. 2. Nests of the Erica pot (1980)

June 5. At 9:00 wasp E was digging nest F. B came back with an ashy grey prey — possibly the same species of Cercopidae as those hunted by her mother — and carried it in her burrow by the usual method (in this case when she let off the prey in the entrance hole the posterior third of the prey's body was left outside the opening). At 11:00 B was doing the final closure and at 11:15 she flew away. At 14:00 a wasp was walking on the pot earth, repeating frequently flying-away and coming-back behaviour as done by wasp E, but finally she did not return there while I stayed by the side of the pot till 15:00.

June 6 and 7. The weather was good. But I could not meet with any of the wasps as well as the trace of their activities, though I went to the pot from time to time.

### 1981

The 4th generation of the Erica pot family continued to nest in this pot. Mostly 2, sometimes 3, individuals were working at a time. But I did not make special observation.

### 1982

Three escape holes were observed in the Erica pot this year, but none of the wasps made the nest in this pot. This is considered to be due to the worsening of the environmental condition of the pot. The place became less sunny by the growth of the nearby trees, the roots of the Ericaceous were more broadly spread and the surface of the earth was invaded by herbage. However, at least several wasps of this *Gorytes* still live in my garden, one of which makes her nest in one of the *Rhododendron* pots and others are frequently seen on the leaves or fly about over the earth. But now I throw upon them only the intimate eyes.

### Summary of General Nesting Activities

The wasps of this species make their nests in my garden almost exclusively in the earth of the planted pots. But this species occurs in Japan also in the montane area without the human house and so it must usually make the nest in the natural ground. In my garden also one of the wasps appeared to make her nest in the exposed ground.

The wasps that nested in the pot earth were indifferent to the size of the earth particle, whether it was coarse like the Kanuma-soil, or fine like the good farm soil.

First the wasp makes some trial diggings and when the site is determined she sometimes digs it up continuously within 1, 2 or 3 hours according to the earth condition and to the length of the burrow, but sometimes she takes a rest on the way or repeats dig and fill before final digging. When a digging is stopped in the late evening it is resumed early in the next morning before sunrise. When a considerably deeply dug tun-

nel is abandoned by some reason the wasp usually closes it till its mouth, but in this case she does not pound the earth packed in.

When the nest is dug up the wasp closes the entrance temporary. In this species, however, the closure is comparatively thick and somewhat firmly pounded with the tip of her abdomen (in reality dorsal surface of the curved apical segments). In the case of the temporary closure levelling of the surface around the entrance is not done as a rule. After the nest is prepared the wasp makes the so-called orientation flight, but this is omitted when a second nest is made near the first one. When the conditions are favorable hunting is made successively and provisionment is finished within 2 or 3 hrs. Then the burrow is permanently closed. This final closure is technically the same as the temporary one, but it is longer, thicker and more elaborately pounded, filling whole the length of the tunnel. It is always followed by the levelling activity, raking, scraping and sweeping the surface around the entrance of the nest carefully, by spending usually from about 5 to 20 min.

The prey (Homoptera, Cercopidae) is carried in flight, held beneath the wasp's body with the middle pair of legs, venter to venter and head to head. The wasp lands in front of her nest and begins to open the entrance with her mandibles and fore legs without letting the prey off. As the temporary closure is somewhat elaborately made it takes 30-60 sec. to clear the entrance stopper. When carries in a prey the wasp always lets it off at the entrance part of the burrow, goes empty-handed to the depth, head foremost, then she turns round in the interior, comes to the prey left, catches it with her mandibles and drags it backing into the larval cell. She then makes a temporary closure and at once flies off.

When one nest is completed the wasp usually begins to dig a next one near the first within several min. to one hr. Sometimes it is presumed that she makes a second or even a third cell inside the same nest.

In the period of her highest activities the wasp begins to work from before sunrise and continued till near sunset. Even hunting is done soon after sunrise. When the conditions are favourable the wasp completes two simple nests in a day.

#### Summary of the Activities of Wasp E

As it seems to me that this wasp made three larval cells in one nest her activities under my observations will be summarized in the following:

Wasp E made at least 2 nests in the Erica pot during the same period with wasp D. She was digging her first nest (as far as I saw) on June 18 at 16:00-17:00 and the nest was temporarily closed at 19:00 (Table 1). On the 19th I saw her carry in a prey at 6:40, 7:30, 8:16 and 8:25. During the time while I was absent she might bring in some prey, so that the Cercopids collected by her for this nest were at least 4 in number. After the final provisionment she remained inside for 12 min. and then made the final closure (8:30-9:10). If she laid her egg during the time while she stayed inside, it becomes that this species (or in this case) lays the egg after the provisioning to the larval cell is completed. However, it seems to me that the stay of 12 min. in the nest is too long for the oviposition, viewed from the general knowledge of the hunting wasps.

At 11:20 of the day her second nest had already been dug up and temporarily closed and at 11:30 she brought in a first prey. Thereafter at least at 11:40, 12:41, 14:16, 15:30 she carried in a prey. Totally the prey became at least 5 in number. At 15:30 she remained for 10 min. inside, then at 15:40 she closed the entrance temporarily. At 16:55 she was inside the nest and it was presumed that some prey had already been brought in it. At this time she stayed inside the nest for 13 min. since I began to observe. Then she came out of the tunnel, but at once entered it and it was 17:10 when she began to dig. She carried out the debris backing from time to time and her work was continued till 18:13 when I left there. At 18:20 the entrance to her nest was closed temporarily.

The next day (June 20) she provisioned to this nest at least 5:40, 6:31, 7:01, 7:30 and further added at least at 9:53, 10:50, 11:25 and after the final provisionment showed a behaviour of the final closure. But she did not fill the burrow till the entrance, on the contrary she began to dig and carried out the earth from within. At 11:40 she closed the entrance by means of the temporary closure and flew away. At 15:50 (till then rainy) she carried in a prey and thence at least 16:30 of the day and at 15:00 of the next day (till then rainy) she added the prey and at 17:00 of the day the nest had been permanently closed.

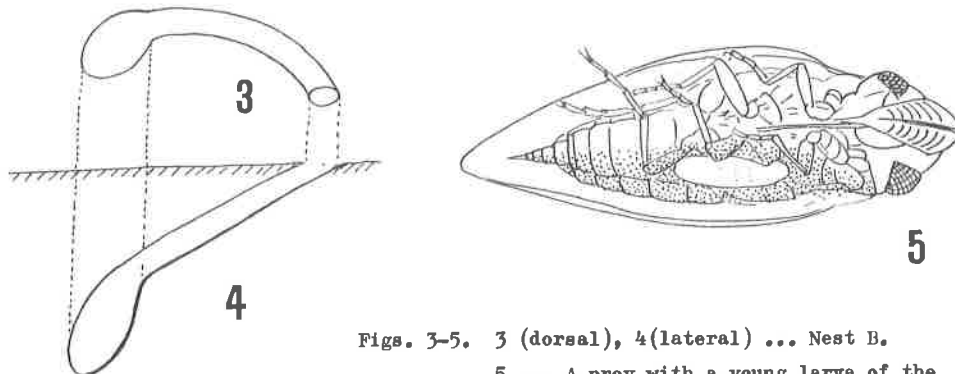
The fact that this wasp had a long stay inside the nest twice during the course of the long continued provisioning activities, each followed with the active digging, could not be explained otherwise than that she made three larval cells in the nest. The prey carried in during each of the three periods were proper in numbers for one

larva, even if the unobserved provisionments were not taken into account.

#### Examination of the Nests

##### (1) Nest B by wasp B in pot B.

Pot B was a small and shallow one, with the inner diameter at the top being 14 cm, and at the bottom 8 cm and 6 cm in height. I pulled out the *Rhododendron* from the pot. The earth entangled with the beard-roots was pulled out as a mass. The nest was nearer to the pot wall than to the base of the plant. I broke little by little the mass of the Kanuma-soil, but it was heavily broken on the way and the larval chamber was directly exposed, from which the greater part of the contents fell down. The cell was provisioned with 6 imagoes of *Cercopidae*, Homoptera, all belonged to a common species, *Aphrophora maritima* Matsumura, including 2 ♂ and 4 ♀, 2 of which were left in the cell without



Figs. 3-5. 3 (dorsal), 4(lateral) ... Nest B.

5 ... A prey with a young larva of the wasp.

falling down and both were placed with the head inwards and ventral side upwards. On one of the fallen prey (♂) was laid an egg of the wasp. But it was unknown where was it in the cell, namely the position of the egg-laid prey among others. By its position we can judge when does the wasp lay her egg during the course of her provisioning activities.

On *Gorytes canaliculatum* of North America H. E. Evans says that the egg is laid on one of the topmost leafhoppers after the cell is fully provisioned.

The form of the nest seen from above: Fig. 3, seen from the side: Fig. 4. The tunnel was about 3 cm in length and about 4 mm in diameter. The larval cell was ellipsoidal, about 15 × 9 mm in dimensions.

Under the microscope the egg was observed. It was laid longitudinally on the left side of the thorax-abdomen of the prey placed venter up (cf. Fig. 5, here the egg is already hatched), 3.0 mm in length and 0.7 mm in maximum width, slightly bent, milky white in colour and glossy. Apparently it was attached to the side of the first abdominal segment with its posterior end and with the anterior end reaching outer side of mid coxa and left free. An examination of other prey indicated that the side of first abdominal sternite was slightly depressed and favourable to attach the end of the egg. The egg was reared as mentioned afterwards.

##### (2) Nests by wasp A in pot A.

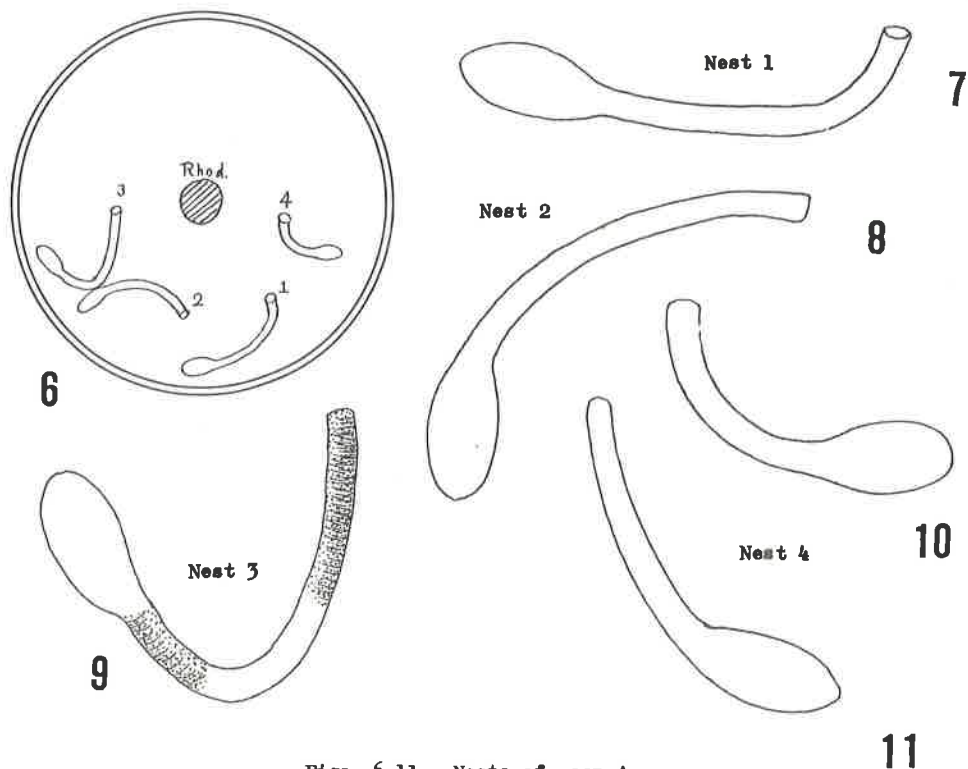
The pot was an unglazed earthen one, 28 cm in inner diameter at the top, 19 cm at the bottom and 12 cm in inner height. The earth that was firmly fixed with the entangled beard-rootlets of the *Rhododendron* was easily pulled out as a mass. It was placed on the up-turned pot and after confirmation of the relative position of the 4 nests observed the earth was crumbled from the periphery towards the nests one after the other. It was June 4, between 14:00-16:00. The earth of the pot consisted mainly of the coarse Kanuma-soil and partly mixed with a farm-soil. During the course the soil was sometimes irregularly crumbled and the state of the nest and the contents were disturbed, but I could obtain the main knowledge about the nest and the prey of this species.

Nest 1. Dug from outside of the pot-earth-mass. At a depth of 3 cm from the surface a *Cercopid* suddenly appeared and fell, subsequently one other prey. The second one

was already without the head. At the outer side of the cell, possibly at the next position of the second fallen prey a larval wasp was there, already about 12 mm in length when fully extended. It was taken out and inner part of the cell was examined. There were 4 further prey inside, 2 of which already lost their heads, namely eaten by the larva. The prey were all imagoes of *Aphrophora maritima* Matsumura as in nest B, sex unexamined. These were all taken out of the cell and the innermost area of the cell was examined with the pincette. The soil of the area was somewhat looser than the surroundings and I could follow the tunnel of the nest leading to the entrance. That is to say, this nest was examined from the cell bottom. The burrow was roughly as given with 1 in Fig. 6. The tunnel was, seen from above, gently curved near the entrance, about 5 cm in total length and about 4 mm in diameter; if measured till bottom of the larval cell the burrow was 6.5 cm. The larval chamber was ellipsoidal, about 15 x 10 mm in dimensions. the deepest place of the larval cell was 3.5 cm from the surface of the soil.

**Nest 2.** The brood cell of this nest was very close to the tunnel of nest 3, almost contiguous with this. In the course of my digging my pincette suddenly broke and thrust into the larval cell and the larva was unfortunately crushed with the tool. It was about 10 mm in length, but it was uncertain where was it in the chamber. The prey were 5 in number, all belonged to the same species as in nest B and all were imagoes. The prey that was at a second position from the bottom of the cell had the thorax completely devoured and so possibly it was the one that was attached with the wasp's egg. The tunnel was about 5 cm in total length, with the brood cell at its end which was somewhat inclined, forming a gentle angle with the tunnel, with the dimensions of about 15 x 10 mm and its bottom lay at 5 cm from the surface of the ground.

**Nest 3.** This nest was searched for by shaving the earth from the upper surface of the earth mass. This was done to observe the state of the fill of the tunnel. During the course a small hole was opened near the pot wall and the wing of a Cercopid was seen. The hole was deliberately enlarged and the contents of the cell could be observed in a complete condition. The cell was very large, 23 x 10 mm in dimensions, including 10 Cercopid of the same species as above, all being imagoes, consisting of 5 ♀ and



Figs. 6-11. Nests of wasp A

5 ♂. The larva was about 8 mm in length and a prey at its side was decapitated and with the thorax considerably eaten. Two further prey were placed below them. The Cercopids were placed all head in, but the direction of the ventral side was uncertain, some venter up, some venter down and some on the side, although during the transportation by the mother wasp the prey was always held venter up. This is possibly due to the fact that the prey was once let off at the entrance hole and then dragged in backing by the wasp. Furthermore, the cell was broad and the prey were not placed in one row, but packed and piled in part and, therefore, it was uncertain to know the exact order of the provisionment of the prey. But it was certain that the prey placed at the inner part of the larval cell were the earlier provisioned ones than those found at the basal part. As the larva was not present at the bottom of the cell it seemed sure that it was not laid on to the prey that was first hunted, but it was uncertain whether the egg was laid on the way of the provisionment or at last after the provisionment was finished, because as the cell was broad it enabled the wasp to lay her egg on any of the ones that were at the surface of the prey mass. However, as the larva was present rather near the bottom, the possibility of oviposition on the way of the provisionment seemed to be considerably high.

The tunnel was carefully dug out and it was confirmed that it was not completely packed with the soil, but with an empty space in the middle part of it, namely it was about 5 cm in total length, with 2 cm at the entrance part and 1 cm before the larval chamber compactly filled with the soil, but with 2 cm in middle part empty. It was curved as given in Fig. 9 seen from above. It was about 4 mm in width and the deepest place was 6 cm from the surface.

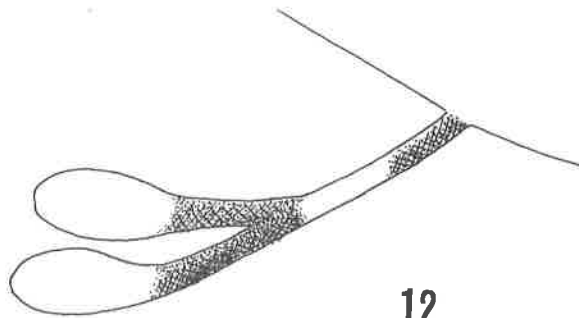
Nest 4. It was examined by the same method as used with nest 3. At 3 cm from the entrance and 2 cm from the surface a wing of the Cercopid came to appear. The fine pebbles and the earth around it were carefully removed and it was taken out with the pincette. It was the same species of the Cercopid as above examined, ♀, and one other, ♂, was by the side of it. The next one, ♂, was attached with an egg of the wasp at the right side of its thorax. Viewed under the magnifying glass the body segments were obscurely observed, showing that hatching was approached. The prey was placed head in as in others, but not completely venter up, but laid somewhat obliquely on its right side and the egg was attached to the undersided right flank. When it was taken out, 2 further prey, ♂♂ were below this. The tunnel was only 3 cm in total length and slightly bent as a whole and nearly completely filled with earth and grains of the Kamuma-soil. The larval cell was 15 × 8-9 mm, inclined in about 70° with the surface. The general form seen from above: Fig. 10 and seen from the side: Fig. 11.

### (3) Other instance.

Of the 2 nests that I observed in 1964 at the sandy shore of Lake Saganuma, Oku-Nikko, and was erroneously reported as done by Argogorytes mystaceus grandis, one was the simple nest as in those of the present wasp, A, but the other was compound one, including two larval cells within (Fig. 12). It seems possible, therefore, that wasp E made a multicelled nest in the Erica pot. In the nests at Saganuma the tunnel was 4.0-4.5 in diameter and 8-12 cm in length, the larval cells were mostly 17 × 10 mm in dimensions, much larger than in the cases of my garden and located at 2.5 and 3.7 cm in the bicellular nest and 7.0 cm in unicellular one. The prey collected by the wasps were much larger species of Cercopidae, Aphrophora spp. (notice the same in genus) and the number provisioned in a completed nest was only 4. The position of the wasp's egg on the prey was the same as in the above instances.

### S. Kubota's Observation.

The wasps of this species that were investigated in Nara prefecture by S. Kubota also nested in the planted pots. But their prey were Aphrophora flavomaculata Matsumura largely and partly mixed with A. maritima Mats. and the number of the prey provisioned per cell was 4, 9, 8, 5 and 10. The structure of the nest was much the same as that of my cases, but as to





its contents there is one question; According to his report (in Japanese) he found in one of the nests, which was provisioned with 9 prey, two eggs of the wasp that were separately laid on one prey respectively. If surely so it may be due to the mistake of the wasp, but to me it seems possible that it was in reality two brood cells that were made contiguously to each other, as in the case of nests 2 and 3 of wasp A above mentioned. Because, this species has a gregarious habits and moreover, each wasp has habits of making several nests within a restricted area of the pot-soil, and it is not always rare that the larval cells of the different nests come in contact with each other and the soil of the pot observed by him is considered rough and apt to be crumbled, making the observer misunderstand the contiguous two cells as one.

#### Summary on the Nests and the Contents

The nests directly observed in my garden are all unicellular, but from the activities of the wasps it is presumed that they make sometimes the multicellular nests. The tunnel of the nest is 4 mm wide and 3-5 cm long and connected with the larval cell at the end which is ellipsoidal, usually 15x10 mm in dimensions, but sometimes somewhat longer (over 17 mm) or less wide (8-9 mm). The tunnel is usually gently curved, but sometimes strongly so, its inclination is generally weak, but sometimes reaching an angle of about 30° at the inside. The depth of the burrow is largest at the bottom of the larval cell which lies at 3.0-6.0 cm from the surface of the ground. In the completed nest the tunnel is filled with earth comparatively thickly in front of the larval cell and at the entrance, leaving the median part empty, but when the tunnel is short it is completely filled with earth.

The prey found in the 5 nests examined are all the imagoes of *Aphrophora maritima* Matsumura, Cercopidae, Homoptera, the male and the female being indifferently mixed. The number of the prey found in one cell is 5, 5, 6, 6 and 10. All are placed head in, but the direction of the venter is inconstant. The egg or the young larva is always found on the prey located at the median part of the surface of the prey mass, but the time when it is laid on the prey is undetermined, because the prey is not placed in a linear order and the prey mass is not firmly packed in the cell. The egg is glued on to the side of the venter of the first abdominal segment of the prey with its posterior end and laid along the side of its thorax, with its free anterior end reaching the side of the mid coxa.

#### Rearing of the Larvae and the Observations on Their Cocoon Spinning

##### (1) The Larva from pot B

June 14. The egg that was laid on one of the prey was reared in a Petri dish, with the earth in it. A hollow, as large as the larval chamber and similar in form to this, was made on the earth and in it were put the prey with the wasp's egg, together with 5 other prey found in the larval cell.

It was certain that the egg was laid during the forenoon of the 14th, but the exact time was unknown, although the final closure to the nest was done at 11:50 of the day.

On the next day, at 8:00 the egg was not as yet hatched out, but at 19:00 it had been hatched out and was sucking the body juice of the prey (Fig. 5). Certainly it was attached to the side of the venter of the first abdominal segment with its caudal end and the head part was laid free, as in *Bembix* and *Bembecinus*, although the egg was not erected.

On the 16th, at 3:30 the larva had been attacked by several mites and was about to die. Its body was shrunk and without lustre. When observed under the microscope a weak sucking movement of the larva remained still. While I drew the prey and the larva under the microscope the mites began to leave the larva. Possibly they could not endure the strong illumination. The cause of the failure was the use of the infected garden earth.

##### (2) The larvae from pot A.

The two larvae and the one egg taken out of the nests made by wasp A were separately reared in each Petri-dish, with fresh river sand, disinfected with heat, in it. Each was placed in the hollow made on the wet sand, with the prey found in each cell. It was June 15, at a little after 16:00.

At 3:30 of the next day (June 16) the egg from nest 4 was already hatched out and was sucking the prey. Two other larvae were also healthy and eating each prey. At 8:30 the larva from nest 1 had already eaten up all the prey given, so I added two Cercopidae

from nest B (sterilized with light). The larva from nest 3 that was given 10 prey by her mother was grown well and somewhat larger than larva 1. At noon larva 1 lay still after eating a half of one of the prey added. Larva 3 was still eating actively in the midst of the mass of the prey. Larva from nest 4 was at its original position as yet and was still sucking the pedestal prey.

Larva 1. June 16. At 15:00 the larva finished eating and would not eat the further prey added, but it raised its head and moved it about as if to search for something. I thought that it reached the condition to spin the cocoon and so I shifted it into an observation vial, 12 mm in inner diameter and 90 mm in length, with the bottom firmly stuffed with properly wet sand for 40 mm. The matured larva and the remains of the prey (to see how they utilized or treated) were put in the vial, giving them an empty space of 17 mm in length and closed the entrance part firmly with a cotton plug.

At 17:30, the larva had already spun a thin whitish cocoon of silk, apparently just as large as its size and was spinning a hammock at its anterior end facing the sand mass which had been considerably crumbled down. The hammock was a silk lace, triangle in form, enlarged towards apex, a rather half-funnel shaped, connecting the open mouth of the cocoon with the interior sand mass, similar in texture to the cocoon. The cocoon was obliquely inclined, with the anterior mouth part high and the posterior closed caudal part, facing the cotton plug, low and was supported with numberless silk threads from the surrounding glass wall. It was just the same as those of the larval Bembix and Stizus, except that the caudal end was not suddenly bent to stick to the floor. The remains of the food were not specially weaved in the surface layer of the cocoon, but were either pressed to floor near the caudal end or hung on the supporting silk threads.

At 17:40 the larva protruded its anterior part out of the mouth of the cocoon on to the hammock, scraped off the grains from the sand mass pressed at the bottom and raked them with its mandibles into the cocoon, with the up-and-down movements of its head. The behaviour was much the same as in the larval wasps of the compared species. At 17:50 the larva continued the sand collecting behaviour. The cocoon was very thin and the movements of the larva in it was well visible.

At 18:00 the larva retreated into the cocoon and was attaching the sand grains to the inner side of the cocoon near the mouth. At 18:05 it protruded its body from the cocoon mouth on to the hammock and raked down the sand grains from the inner sand mass. I made a V-shaped stand (in cross section) by folding the card board and put the vial on it, brought it under the binocular microscope and observed the movements of the larval wasp under low intensity of illumination, lest the wall of the vial covered with the vapour evaporated from the contents. The larva under the light did not cease its movements and behaved as before. At 18:07 the larva almost completely came out of the cocoon on to the hammock, only holding itself at the edge of the cocoon mouth by its caudal segment bent and collected the sand grains from the inner mass. Then it half entered the cocoon backing and raked the grains collected on the hammock backwards into the cocoon by the up-and-down movements of its head. In this case the mandibles were actively opened and closed, but they did not hold the sand grain between them. This behaviour was repeated over and over again, together with the gradual retreat of the larval body into the cocoon. Thus the sand grains were first collected on the hammock and then moved to anterior part of the cocoon. The larva, then, stuck several grains of sand to its mandibles, possibly with the secretion of the silk gland and spread them over the inner surface of the cocoon near its opening. The behaviour was repeated. At 18:10 the upper area of the opening part of the cocoon was plastered with a layer of sand grains for about 10 mm in width. At the lateral areas the sand ring appeared narrower and at the lower area broader than above.

At 18:15 the larva again thrust the anterior half of its body on to the hammock and was collecting the sand grains in the cocoon. At 18:16 it moved back into the cocoon and plastered from right side to underside. At this time point it was confirmed that the edge of the mouth of the cocoon was left unplastered and appeared whitish. This was considered convenient for spinning the mouth lid afterwards. During 18:17-19 the larva plastered from left side to underside. In plastering the larva fixed the posterior half of its body in the cocoon and moved its anterior half only, like our arm and the mouth parts — mainly the mandibles — played the part of our hand. The elaborate and very skillful movements of its anterior body and mandibles were worth astonishing.

At 18:21 again it collected material from the sand mass and then plastered the inner surface of the cocoon. From 18:23 the larva was let alone in the dark till 18:42 when I resumed the observation. Under the microscope I saw that the cocoon had completely been plastered with sand grains over its inner surface and the larva was arranging the edge of the cocoon opening with its mandibles, protruding a part of its

head. At 18:43 the larva drew its head inside the cocoon, bent its neck and picked at the plastered sand-layer with its mandibles, possibly to rearrange the sand position of the layer. The movements of its mouth parts were well imaginable from outside through the poking-outs of the sand layer which was still wet and very flexible. According to these movements of the sand layer the larva was able to reach about the mid point of the cocoon with its mouth without turning round in the cocoon.

At 18:47 the larva stretched its anterior body out of the cocoon over the hammock till its 7th segment and at :48 till its 8th segment and collected the sand grains. At 18:50 it came out of the cocoon almost completely on to the hammock which was already thickly covered with the fallen sands to collect the material from the sand mass. This was due to that the distance between the cocoon opening and the sand mass was as much lengthened as the sand grains were scratched off from the mass. The larva lay on its side, reflected its head and a part of the thorax backwards and raked off the sand grains. Then it pushed back the material inside the cocoon with its backing movement. At 18:55 the same behaviour of sand collection was repeated. At :56 the larva retreated inside the cocoon, thrust its head alone out of the opening, caught the sand grains with hhe mandibles and moved them beneath its breast. At :58 it completely backed into the cocoon. At 19:00 the larva possibly turned round in the cocoon. The still soft and elastic wall of the cocoon enabled it to do so. It was observed that the plastered cocoon wall was successively poked out from inside at its posterior part. At 19:05 it turned round again and stretched its anterior body out of the cocoon pening and began to collect the sand grains. The larva continued this work comparatively long and from 19:12 scraped the material into the cocoon till :14 when it completely drew back inside the cocoon and apparently addign sand grains to the already plastered layer. At this time the opening of the cocoon was well observed. It was a round hole of about 3 mm in diameter. The larva continued the same supplemental plastering work till 19:20 when it again came out to collect the material from the sand fill. Under the natural condition it seemed that the larva might no so far come out of the cocoon, because the material to plaster the inner surface of the silk cocoon was around and nearer to the cocoon mouth. Here, as the material was restricted to the vial bottom, the part of the body of the larva that came out of the cocoon mouth was amply 10 mm in length. As the sand fill was dug and scraped down the space between this and the cocoon mouth became as much longer and the larva must have come out of the cocoon as much farther to collect the sand grains. Thenceforth the sand collecting activities of the larva were further repeated at 19:25, 35, 37, 43, 50, 20:03, 10, 22 and 35. During the rest of the time the larva continued the supplemental plastering work in the cocoon. At 20:40 the larva was in the cocoon and the cocoon opening remained unchanged, a round hole of about 3 mm in diameter. At 20:43, however, the larva produced its head to the opening and picked the rim of the cocoon opening with its mandibles. During 20:45-53 the larva performed the final sand collection and then added the silk threads to the opening rim. At 21:20 the opening became smaller, only 1 mm in diameter and the larval mandibles were seen picking at the rim of it. The completed part of the opening lid was covered with sand layer from inside as on other areas. I stopped the observation to go to bed. (I used to go to bed at 20:00 and get up between 1:00 - 2:00, taking a short sleep after breakfast).

June 17. At 0:50, as I woke I went to the larva. The opening had completely been closed, but the cocoon was still wet and it was successively poked out from inside by the mandibles of the larva. Possibly it was making the supplementary silk adding work. Apparently the anterior part of the cocoon was somewhat lengthened (because the lid was convex) and two grains of sand, about half the size of the rice grain were attached to the centre of the lid (final plug ?). At the caudal end of the cocoon the silk cocoon was pointed and glued on to the vial floor, but the inner sand cocoon was rounded at the end, and there was a little empty space between them

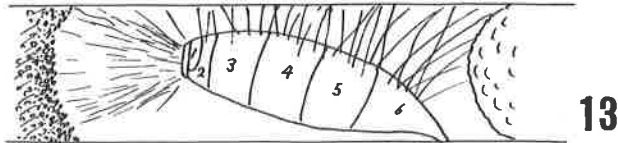
At 3:20, the cocoon had completely been dried up and the movement of the larva inside could not be observed, even if it was still continuing the supplementary work.

Larva 3. June 16, at 18:10 the larva was still voraciously eating the prey. At 18:55 it ceased eating and lay still. At 20:07 the larva was apparently began to weave the cocoon, so it was examined under the binocular microscope and it was confirmed that some silk threads were spun between the remains of the prey. Hereupon (20:10) it was transferred in the similarly equipped and same-sized glass vial as that of larva 1, but in this vial no remains of the prey was placed in order to make the inside clearer and more easy to observe, and the space given to the larva was made narrower (15 mm) in order to let the larva more easily collect the sand grains from the inner sand fill.

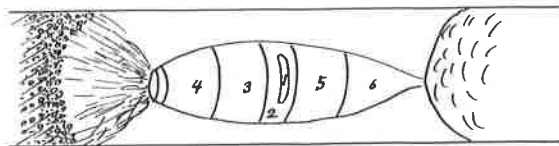
June 17, at 0:50 the larva was spinning the silk threads between different parts

of the glass vial wall and between the glass wall and the cotton plug. As yet the silk threads were not dense and the form of the cocoon was only dimly observed. The larva extended slenderly its anterior body, turning it in various directions and glued the threads on to the vial wall and the cotton plug. To the sand fill at the bottom of the vial also some threads were stretched and on the surface of sand fill a trace of digging was seen. At 1:20 the form of the cocoon became slightly clear. At 3:20 the silk cocoon had been completed in a general way, with the half-funnel-shaped hammock was also spread from its mouth toward the sand fill. The differences of this cocoon from that of larva 1 were that the cocoon was not obliquely inclined posteriorly, but spun almost horizontally, and that the posterior end of the cocoon was not glued to the floor of the vial, but to the central part of the cotton plug. Furthermore, as

the space given to the larva was narrower than in the case of larva 1 and larva 3 was larger than larva 1 (its cocoon was larger than that of larva 1 accordingly), the distance between the cocoon mouth and the inner sand-fill was much smaller than in the case of larva 1. The cocoon was 15 mm in length and 6 mm in maximum width and more pointed at both ends than in that of larva 1. The space between the sand fill and the cocoon plug became somewhat wider than the original condition given at first to the larva, about 18 mm in length. This was considered to be due to that the larva dug and crumbled down the sand fill and that the cotton plug shrunk by being covered with the silk threads.



13



14

At 3:30 the larva began to collect the sand grains from the inner sand packing by the same behaviour as observed with larva 1. At 3:35 a short band of sand grains was attached to the dorsal side of the cocoon across middle (Fig. 14, 1). The position of the cocoon where the sand grains were first plastered was different from the case in larva 1 (cf. Fig. 13, numerals show the order of plastering).

At 13:50 the band became broader and longer to form a sand ring. At 14:45 when I came back from daily running the band was expanded towards the opening. It was almost twice as wide as that observed at 3:50. At 5:30 the layer of the sand grains reached near the cocoon opening. Seen from the side and beneath by taking up the vial from the stand the anterior half of the cocoon including the underside had completely been covered with the grains of sand on its inner surface, and in the posterior half the posterior part of the larval body was observed. At 5:40 the sand layer had occupied the anterior  $\frac{3}{5}$  of the total length of the cocoon. Owing to the shorter distance to the sand fill (with shorter hammock accordingly) this larva could collect the sand grains much more easily than larva 1, as a result the sand plastering work was as much more promptly progressed. At 6:00 the area of the silk cocoon that was free from the sand layer was confined to the posterior quarter only where the caudal end of the larva was seen, possibly it was plastering the anterior part of the cocoon. At 6:50 the posterior end of the cocoon was completely plastered with the sand grains, possibly the larva turned round to do the work. At 8:15 the sand cocoon was apparently accomplished, but as yet it was wet and at its central zone the intervalic poking-outs by the mandibles of the larva were observed. But the state of the anterior opening could not be seen, because the inner sand fill was too close to it. This is partly due to that the cocoon was horizontally hung along the central axis of the vial. At 10:00 the cocoon was as yet moistened and changed its form according to the movement of the larva inside. It must have been working for the supplementary plastering.

At 17:00 the cocoon had completely been dried up.

**Larva 4.** When I saw the nest of this larva on June 14 at 15:00 it was as yet an egg just before hatching and the body segments were obscurely seen. The next day at 3:30 it was already hatched out and was sucking the pedestal prey. At noon of the day the larva was still sucking the prey. On the 17th at 3:20 it had already left its

mouth from the prey and eating it with the mandibles. As the prey other than the egg pedestal were not touched by the larva it seemed that it had ceased its sucking soon before my observation. Nevertheless, it already reached about 7 mm in length. At 4:45 the larva left the pedestal prey and was at its caudal portion. At 10:00 it was eating the pedestal prey from the other side. It became slightly larger, but much fatty and far whitish in colour. At 17:00 it was eating a second prey. On June 18 at 3:00 the larva was still eating, it became larger, about 10 mm in length when shrunk and about 15 mm when stretched. Of the 5 prey in the cell none was intact. At 8:00 it was still eating the remains of the prey.

At 11:00 of June 18, the larva and the remains of the prey were put in an observation vial, similar in size to those used for larvae 1 and 3, but with inner sand fill 35 mm in thickness and with the space given to the larva 20 mm. The entrance of the vial was similarly closed with cotton plug.

At 16:00 the larva was still eating the remains, but at 18:00 it ceased to eat and began to raise its head, moved it right and left. At this time point no thread was stretched even under the microscope. At 20:35 the threads were stretched and the inside of the vial became considerably whitish, but the form of the cocoon was as yet indistinct.

June 19, at 3:00 the silk cocoon had been completed and already its inner surface was plastered with sand grains, except the posterior third. It was made low, close to the floor and parallel to it. The remains of the prey were pressed to and weaved in the dorsal and lateral sides of the cocoon and became unfavourable for the observation. Under the microscope the anterior sand plastered area of the cocoon was frequently poked out from inside with the mandibles of the larva and the posterior unplastered part was empty, but from time to time the caudal end of the larva appeared. Sometimes the mandibles of the larva were seen at the anterior opening of the mouth which was, however, not well visible in this cocoon.

At 3:50 the larva turned round and began to plaster the posterior silken part of the cocoon. At 55 the posteriormost part was covered with sand and the area in front of it remained without sand, appearing whitish ring. At 56 - 4:00 the waspling was observed plastering this area with sand grains. Apparently the larva expanded the thick layer of sand placed at the posteriormost area to this part. At 6:00 the sand cocoon was completed, but as yet wet and the movement of the mandibles of the larva was discernible. At 12:00 the cocoon had completely been dried up.

#### Summary of the Cocoon Spinning Behaviour

As in Bembix niponica and Stizus pulcherrimus the larva of Gorytes tricinctus spins at first an ellipsoidal silk cocoon, 13-15 mm in length and 4-5 mm in maximum width which is opened at the anterior end and provided with a half-funnel-shaped hammock. The larva comes out of the cocoon from time to time on to the hammock (but not leaving the cocoon) to collect the material to cover the inner surface of the cocoon. The material is crumbled down from the cell wall on to the surface of the hammock with the mandibles of the larva and then raked into the cocoon by the up and down movement of its head. The larva plasters the material thus collected over the inner surface of the silk cocoon with the secretion of its silk gland. Sometimes plastering is begun from the mouth part posteriorly, but sometimes it is begun from the central area forwards and then backwards. Then it collects the final material and closes the opening with it. The method of this final closure is, however, different from that of Bembix and Stizus cited. In these the larva first spins a convex silk lid and then plasters it with particles of the material, but here in Gorytes the opening is gradually narrowed from the periphery by weaving accompanied with plastering. Thenceforth the larva continues the work of finish at least as long as the cocoon remains wet.

The time spent for building the sand cocoon is in the 3 instances observed more or less different from each other, especially for the spinning of the first silk cocoon: in larva 1 it is about 2.5 hr, in larva 3 about 5 hr and in larva 4 presumably about 5 hr. The time needed for sand collection, plastering and entrance closing is in larva 1 about 4 hr, in larva 3 about 5 hr and in larva 4 presumably about 4.5 hr. The time elapsed from the perfect closure of the anterior opening till the complete desiccation was not exactly measured, but is presumed from the extent of my observations it is about 3-4 hr.

The size of the cocoons was directly measured, the length x maximum width being in cocoon 1: 13x5, in cocoon 3: 14x6 and in cocoon 4: 13x4.5 mm.

As to the so-called respiration pore examination was made. At the central zone of cocoon 1 and of cocoon 3 there were 2 pit-like hollows, but none was observed on cocoon 4. After the imagoes emerged the cocoons were cut open and the inner side was

examined. There was, however, no such a particular structure as observed in Bembix niponica, only thickly covered with silk secretion. The apparent pit-like hollows were nothing else than the depressions between the somewhat large sand grains that were casually collected together.

Later process. The vials were preserved horizontally in a tin box and cares were taken to keep the larval cells in a proper moisture by poring drops of water from time to time on the cotton plugs. However, in the course of long preservation it was impossible to keep wet the inner sand fill by this means and it was dried and crumbled down. So I took the cocoons out of the observation vials, put them in a Petri-dish, the bottom of which was covered with a sheet of the Uretan gum. Each cocoon was marked and the inside of the Petri-dish was kept moistened by means of a water absorbed sponge.

On May 13, the next year, when I saw the dish two male wasps from cocoons 1 and 4 had already come out and were dead. They were still soft and it was presumed that their emergence took place two or three days before. But the wasp from cocoon 3 did not appear. So the cocoon were cut open and examined. The larva was dead in the prepupal stage. Possibly it was a female.

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\* (continued from p. 22) I could not meet with the wasp since my first visit. I did not capture any of the wasps that were making their nests observed by me. Strictly, therefore, I must confirm the species of the wasps that will emerge from the reared cocoons. However, as the wasp that must have appeared from the rotten log in my car during the transportation was a female of A. nipponia it seems almost doubtless that the wasp that made the nest in the log was A. nipponia.

The brood-cells were 9-12 × 15-20 mm in dimensions, while the tunnel was 5.5-6.0 mm in diameter, with the intercellular space about half the length of the cell, hence the nest was roughly moniliform.

The larval wasp does not eat the chitin parts of the prey which remain in pieces and are used by the waspling when it spins the cocoon to form a covering layer. But the pieces are not simply attached to the cocoon, but are inlaid or weaved in to the outer layer of it. When this outer layer is made up the waspling attaches thickly the silk threads over the inner surface of it. The cocoons are 7.0-7.5 × 14-15 mm in dimensions.

As to the species of the prey, 2 or 3 may be included, but they are not as yet identified. As to the egg of the wasp the strict position of its attachment to the prey was not confirmed. It is not firmly attached to the prey and easily detached from it and dropped off when taken out of the larval cell. But the larva from such a detached egg smoothly grows when it is put with the prey.

Judging from the present state of the cocoons and from the data of the collected specimens this species seems to appear once a year.

A P P E N D I X

ON THE NESTS OF ARGOGORYTES NIPPONIS TSUNEKI

Communications from Mr. T. Nambu to the Hym. Comm., No. 14, 1982 (in Japanese)

Comm. 1. (June 16, 1982).

On June 13 I went to the hill range at the northeastern part of the Chichibu district, Saitama Prefecture, to set some bamboo trap nests for the tiny wasps of Trypoxylon kedamanum Ts. During the course I happened to find a nest of Argogorytes nipponis Ts. dug in one of the abandoned rotten logs that had been used once for culturing the Japanese mushroom, Cortinellus shiitake. The log was completely decayed and the wood was very soft. The tunnel of the nest was duplicately bifurcated and included 15 larval cells inside. The prey belonged all to Cercopidae, all being the nymphs. The number per cell was from 9 to 13. At first I saw some Crabro-like wasps flying about around the pile of the logs. On capturing I knew that they were the wasps of Argogorytes and thought that they were possibly A. mystaceus grandis Gass. When examined under the microscope it was made clear that they belonged to A. nipponis Ts., a rather rare species in Japan. The nest observed: Fig. 15.

Comm. 2. (June 25, 1982).

On June 19 I went again to the pile of the rotten logs and found one more nest of this species. The tunnel of it was bifurcated and one of the branches again bifurcated and included 7 larval cells in all, each containing the prey of 12, 15, 13, 10, 15, 14 and 17, a total of 96 prey that were all nymphs of Cercopidae. The nest observed on the 13th included 15 cells and 169 prey, also all nymphs. I brought one of the logs to my house that was also nested by this species, but I leave it intact to examine the nest after the larvae spin their cocoons. Of the larvae from the previous nest that had been under my rearing all but one spun their cocoons.

In the hill side where the nests were discovered several other piles of the rotten logs were present. But at no other place than that above mentioned could I find the nest of this species. At the pile where I found the nests the logs were partly broken and scattered over the ground as if they were damaged by a bear that searched for the worms in the logs. All the nests that I found were made from the broken end of the log where the decayed and soft wooden tissue was exposed. In the intact logs the cut ends were strongly hardened and not the state to allow the wasps to dig into the wood, even though the inner tissue was heavily rotten and markedly softened. I, therefore, broke some logs by myself and placed them side by side for trapping the mother wasps. The log in which I found a nest on the 19th was so soft that it could be crumbled quite easily by my fingers and so moistened that the water oozed out of the tissue when pressed. The entrance plug of the nest was the same as that of the partition between the larval cells, consisting of crumbled wood particles.

Editor's remarks. In regard to his personal question the following was replied to him: Lack of the knowledge on the nest of A. mystaceus (L.), Tsuneki's report on ssp. grandis was erroneous in the identification of the wasp which was in reality G. tricinctus, doubt on the terricolous habits of mystaceus, (but some species without tarsal comb on the fore leg are terricolous, e.g. Psen (Mimmesa) atratinus etc.) and the observation of Adlerz on A. fargeii etc.

Comm. 3. (June 26, 1982).

The Gorytine specimens that I collected near the nesting site of nipponis were: A. mystaceus grandis (1 ♀), A. nipponis (3 ♀) and G. tricinctus (2 ♂).

Of the specimen of mystaceus I found a small clay clod attached to the apical half of its hind tibia. It was very similar to those of the newly emerged terricolous non-social bees. This seems to indicate that mystaceus grandis is terricolous.

Comm. 4. (July 6, 1982).

On July 4 I went again to the hill and cut open further one of the logs nested by A. nipponis. It had two nests. One of them was in the early course of nest construction, including a tunnel alone of 98 mm in length. The other contained 10 larval cells 6 of which were linearly arranged in the main tunnel, while others were in two short branch tunnels, each with 2 cells. In two cells out of the 10 the egg did not hatch out and the prey, 12 and 14 respectively, were putrid. In other 7 cells the completed cocoons were present, while in the remaining one only 2 fresh prey were placed, possibly in the course of provisionment. The plug at the entrance to this cell was considered to be a temporary closure, but it was somewhat firmly pressed.

Comm. 5. (July 23, 1982).

I visited the place several times further on Sunday, but (continued to p. 21\*)

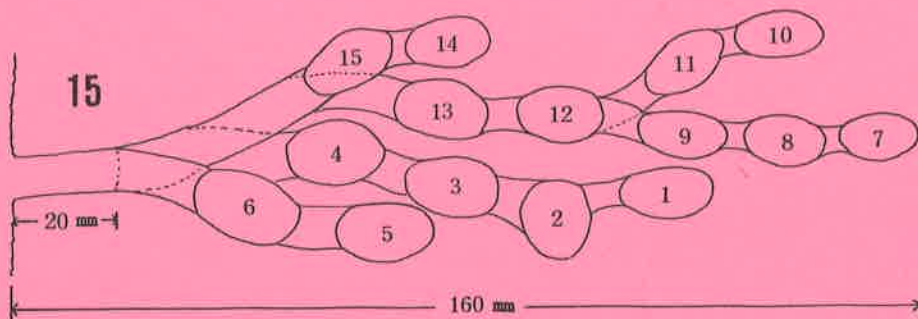


Fig. 15. A nest of *Argogorytes nipponis* Tsuneki.

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