PRE-EMERGENCE FERTILISATION OF MEGARHYSSA NORTONI NORTONI (HYMENOPTERA : ICHNEUMONIDAE)

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SUMMARY

Male **Megarhyssa nortoni nortoni** congregate around sites of future emergence of females and insert their abdomens into the exit burrows. Females subjected to such male attention have produced female offspring, thus demonstrating that insemination can occur before emergence from the wood.

INTRODUCTION

The large ichneumonid **Megarhyssa nortoni nortoni** (Cresson) was imported from North America in 1962, 1963 and 1964 for biological control of the wood wasp **Sirex noctilio** F. It has been bred at the Forest Research Institute (FRI), and is known to be established in two of the sixteen forests in which it has been liberated since 1964. In spring the females drill their ovipositors into wood, paralyse and lay eggs on **Sirex** larvae. Upon hatching, the **Megarhyssa** larvae consume their hosts and then remain quiescent until the following spring when, after pupation, the adults emerge from the wood. The peak emergence of males occurs from one to three weeks before that of females.

In the FRI insectary from mid-October to the end of December 1969, 40 males and 130 females emerged from **Pinus ponderosa** logs which had been used for oviposition by **Megarhyssa** females in 1968. On 10 occasions between 10 and 26 November 1969 males were seen to be attracted to certain places on the logs.

MALE BEHAVIOUR

On 10 November one male **M. nortoni** was seen with the tip of its sharply bent abdomen just under a flake of bark. It was joined by another male which assumed a similar attitude (Fig. 1). After 10 minutes the first male moved off and after another 20 minutes the other male departed. During the time they were on the bark they occasionally lifted their abdomens from the surface and then replaced them in a slightly different spot. When both had left, the area (about 25mm in diameter) was marked with a circle. The following day an exit hole had appeared within the circle. The size of the hole indicated that a **Megarhyssa,** probably a female, had emerged.

A watch was kept for similar activity and on 19 November six males were seen clustered around one spot on the bark. All had their abdomens curved in an arc or sharply bent, with the tips resting on the bark or pushed into fissures. Occasionally during the next two hours a male would walk away and then return to the group using his antennae to locate a fissure in which to insert his abdomen (Fig. 2). Three males then left. Two of those remaining were close together and had the three terminal segments of their abdomens in a crevice, while 10mm away on the other side of the bark flake a male had the whole of its abdomen, except for the first two segments, hidden in a fissure. Several times in the next 30 minutes the three males changed places with each other, their abdomens always being reinserted under the same flake of

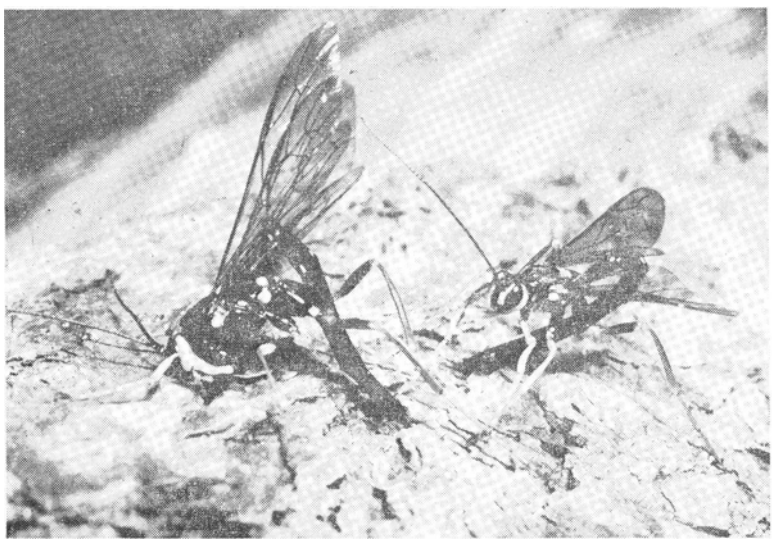

Fig. 1: Precopulatory activity. Two male **M. nortoni** with the tips of their abdomens under a flake of bark.

Fig. 2: An aggregation of six male **M. nortoni.** The specimen on the left is using antennae to locate bark fissure, and the other five have their abdomens inserted. Note the three abdomens close together at centre of picture.

bark. Towards the end of the period two of the males had their abdomens completely in the wood; all that could be seen of each insect was its head, thorax and wings. Their' bodies were so far in the wood that their wings were bent forward They withdrew and 10 minutes after they had departed the head of a female became visible in a crevice at the side of the bark flake. It took 11 minutes for the female to complete her exit hole, and a further 3 minutes to fully emerge. Then, after resting for 2 minutes alongside the hole she walked up the log. A male flew to her and mating lasted

4.5 seconds. One minute later mating with another male occurred for 30 seconds. The female used her legs to groom her antennae, body and ovipositor, and then walked slowly onto the ceiling of the insectary. Ten minutes later two males made unsuccessful attempts at copulation.

TABLE 1

Date	Greatest number of males at site of female emergence	Number of males in insectary
10/11/69	2	4
19/11/69 a.m.	6	18
,, p.m.	2	18
20/11/69 a.m.	12	16
,, p.m.	6	16
21/11/69 a.m.	7	16
,, a.m.	1	16
24/11/69 p.m.	3	10
,, p.m.	1	10
26/11/69	6	7

Table 1: Male **M. nortoni** present in FRI insectary and at ten female emergence sites.

The behaviour described above was typical of that seen at the eight other emergence sites. The largest aggregation consisted of 12 males, and of these as many as 10 at once had their abdomens forced into crevices. The total number of males in the insectary at the time was 16. At one aggregation site the bark was carefully removed with a knife to reveal an exit tunnel in the wood with the head of a female about 2mm below the lip of the hole. A male then pushed all his abdomen, except for the first segment, past the head of the female and down the tunnel. In another instance when a female was ready to emerge a male inserted all his abdomen into the completed exit hole and remained in position for almost 18 minutes. The longest time from when an aggregation was first seen, to emergence of the female, was 6 hours 23 minutes, but the actual time would have been greater since males were already in position when observation started.

In all aggregations there was no aggressive behaviour between males. They crowded and occasionally walked over each other, but no individual attempted to dominate or drive away others. Before the female had broken through to the surface the males used natural crevices in attempts to get their abdomens down into the exit burrow. When a hole through the bark had been made by the female then this was utilized. During insertion of the male abdomen the female either continued to enlarge the hole, or remained still for all or part of the time.

DISCUSSION

The possibility that such activity by male **Megarhyssa** could lead to fertilisation of the female before emergence has been mentioned by Harrington (1887), Gade (in Barlow 1921), and Champlain (1921). This supposition was questioned by Heatwole **et al.** (1962) because of the greater length of the female abdomen compared with that of the male, and the fact that the normal copulatory position used above the surface of the wood could not be employed in the exit burrow. All observations by these writers were on one or more of the North American species, **Megarhyssa atrata lineata** Porter, **M. macrurus lunator** (F.), and **M. greenei greenei** Viereck parasitic on **Tremex columba** (L.), a siricid whose larvae inhabit dead hardwood trees. Neither this siricid nor its parasites are present in New Zealand.

The abdomens of male **M. nortoni** in the insectary varied in length from 27mm to 34mm, and the distance from the front of the head to gonopore of the females ranged from 30mm to 36mm. Since the males were sometimes so far in that the rear of their thoraces were pushed down into the exit tunnel it would have been possible, if length of abdomen were the only criterion, for coupling to occur between some individuals. In normal copulation above the surface of the wood the male grasps the female from above and curves his abdomen around her body to connect with the anteriorly opening gonopore. The position for any coupling in the exit burrow could not be seen. However, on one occasion when the head of the female was completely visible, the male had his abdomen down the dorsal surface of the female's head and thorax, but it is not known whether there was enough room for it to pass around the female abdomen. The abdomen of the male is capable of sharp flexure between its basal segments (Fig. 1). This and its dorso-ventrally compressed shape make it suitable for being thrust into bark fissures and down alongside the female when she is in the exit burrow.

To discover if fertilisation had occurred before emergence four of the females which had been the cause of male aggregation were captured as soon as they came out of the wood, and before they could be mounted by males. One was dissected but no spermatozoa could be found. The other three were released in another compartment of the insectary onto **P. ponderosa** logs containing **Sirex** larvae. Oviposition occurred. The logs had been obtained from an area where **M. nortoni** had not been released so any progeny would be from the insectary females. In November 1970 two males and three females emerged. **Since Megarhyssa** has a haplo-diploid method of sex determination, with females arising from fertilised eggs, the production of female offspring proved that copulation must have occurred before the parent female left the exit tunnel.

The stimulus to aggregate was so strong that on several occasions the majority of males in the insectary were drawn to a site of future female emergence (Table 1). The cause of attraction has been shown by Heatwole **et al.** (1964) to be the chewing noises, or possibly the vibration of the substrate, produced by the female when making her emergence tunnel. In the insectary only female **M. nortoni** emerged at the sites of observed male aggregations and so it is not known whether the chewing of males, or of other wood inhabiting insects, when making their exit burrows could also be an attractant. It is known that **M. greenei** males have been attracted to emergence chewing of a beetle and an **Ibalia** sp. (Heatwole **et al.** 1964). Another feature recorded by these authors, the mounting of each other of males during periods of intense excitement when the female had broken through to the surface, was not seen amongst **M. nortoni** males.

The attraction to emerging females enables mating to take place as soon as possible. However, attraction to the emergence site is not as important as was believed by Abbott (1934) and Harrington (1887) who state that males will only copulate with newly emerged females. In the insectary, mating is often seen between males and females that are several days old, and is frequently noted amongst specimens held in mailing boxes prior to release in the forest.

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REFERENCES

ABBOTT, C. E., 1934: Notes on **Megarhyssa lunator. Psyche 41:** 238-240.

BARLOW, J., 1921: The mating habits of **Megarhyssa** (Hymenoptera : Ichneumonidae). **Ent. News 32:** 291.

CHAMPLAIN, A. B., 1921: The curious mating habit of **Megarhyssa atrata** (Fab.) (Hymenoptera : Ichneumonidae). **Ent. News 32:** 241.

HARRINGTON, W. H., 1887: The nuptials of **Thalessa. Can. Ent. 19:** 206-209.

HEATWOLE, H., DAVIS, D. M. & WENNER, A. M., 1962: The behaviour of **Megarhyssa,** a genus of parasitic hymenopterans (Ichneumonidae : Ephialitinae). **Z. Tierpsychol. 19:** 652-664.

1964: Detection of mates and hosts by parasitic insects of the genus **Megarhyssa** (Hymenoptera : Ichneumonidae). **Am. Midl. Nat. 71:** 374-381.