Immature Stages of the Harvester Ant *Messor aciculatus* (Hymenoptera, Formicidae)

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Immature Stages of the Harvester Ant *Messor aciculatus* (Hymenoptera, Formicidae)[1,2]

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Synopsis The immature stages of the worker of *Messor aciculatus* are described. Three larval instars are distinguished and illustrated. The number of larval instars among ants and the distinguishing characters are discussed.

Introduction

The larval instars have been described only in a few species of ants (WEIR, 1959; POLDI, 1965; PASSERA, 1968, 1974; BRUDER & GUPTA, 1972; DELAGE-DARCHEN, 1972; O'NEAL & MARKIN, 1975; TOHMÉ & TOHMÉ, 1975; MIZUTANI & YAMANE, 1978). Quick and easy determination of the developmental stages, especially of the larval instars is needed for the study of colony development by means of the age distribution and also for other ecological purposes. Since the number of larval instars has been unknown for *Messor aciculatus*, I have determined it by observations of molting, and distinguished between different instars by convenient characters. I discuss the number of larval instars among ants and the distinguishing characters.

Materials and Methods

Thirty three and 14 dealated females were collected after their mating flights on April 17–24, 1974 and April 16, 1975, respectively on the campus of Kyoto University, Kyoto. They were claustrally reared in the laboratory as described by ONOYAMA (1981) to establish colonies from mid April to mid December in 1974, or from mid April in 1975 to early February in 1976. During the development of brood, molting was noted as exactly as possible to determine the number of larval instars, and morphological characteristics (chaetotaxy especially) of newly molted larvae were examined with the aid of a stereoscopic microscope under 40 times magnification.

Microscope slides were prepared for exuviae of 1 first, 3 second, and 4 third instars, which were collected in June, 1975 during the rearing and had been preserved in 75% alcoholic solution; and for 12 first, 5 second, and 19 third instars preserved in 75% alcoholic solution, which were obtained by Mr. A. TAKI in June

1) Ecological studies on the harvester ant *Messor aciculatus*, II.

2) Contribution from the Laboratory of Animal Ecology, Department of Zoology, Kyoto University, No. 446.

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and July in 1977 by similar rearing of dealated females from Kyoto. The slides were microscopically observed under 100 to 600 times magnification.

Measurements were made for the following living and preserved materials: 15 eggs, 11 first, 16 second, and 9 third instars. I follow WHEELER and WHEELER (1976) in terminology and measurements for larvae.

Egg to Pupal Stages

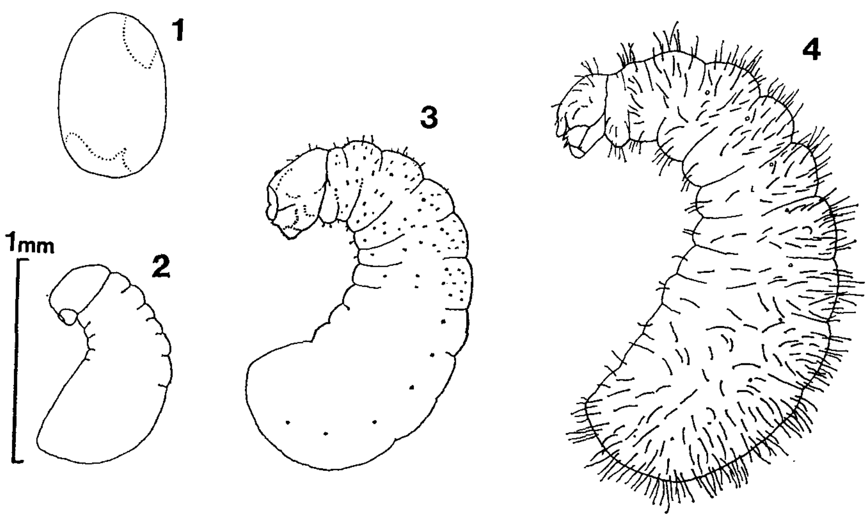
1. *Egg* (Fig. 1)

Elliptical, 0.75–0.81 mm high and 0.53–0.61 mm in diameter; opaque and milky white. In advanced stages it becomes transparent in part, especially at the top and bottom. So-called trophic eggs, which the colony founding queens lay, are milky white and very soft like jelly, about 1/3 to 1/2 times as large as the normal egg (rarely almost equal in size). They were soon consumed by their queens. It took about 30 minutes for the eclosion from the egg in two cases observed.

2. *Larva*

First instar (Figs. 2, 6A–B). Cranium width 0.24–0.30 mm. Practically naked; head and prothorax (or to abdominal somite I) with a few very minute hairs. Mandibles with one acute or blunt medial tooth (Figs. 6A, B), having no recognizable spinules on the basal half of medial surface. Maxillary palp and galea shorter than those of second instar.

Second instar (Figs. 3, 6C, 7A–C). Cranium width 0.29–0.33 mm. Head and body hairs sparse and short, of two types: (1) simple, minute to short (Figs. 7A–B), (2) tip frayed (bifid or trifid), short (Fig. 7C). Short hairs on head, thorax,



Figs. 1–4. Egg and larval instars of *Messor aciculatus*. —— 1, Egg; 2, first instar; 3, second instar; 4, third instar.

and abdominal somite I longest on pro- and mesothoracic dorsa. Minute hairs on abdominal somite II. Mandibles with several spinules on the basal half of medial surface in addition to one medial tooth (Fig. 6C). Maxillary palp a rather wide frustum; galea a slender frustum. Both shorter than those of third instar.

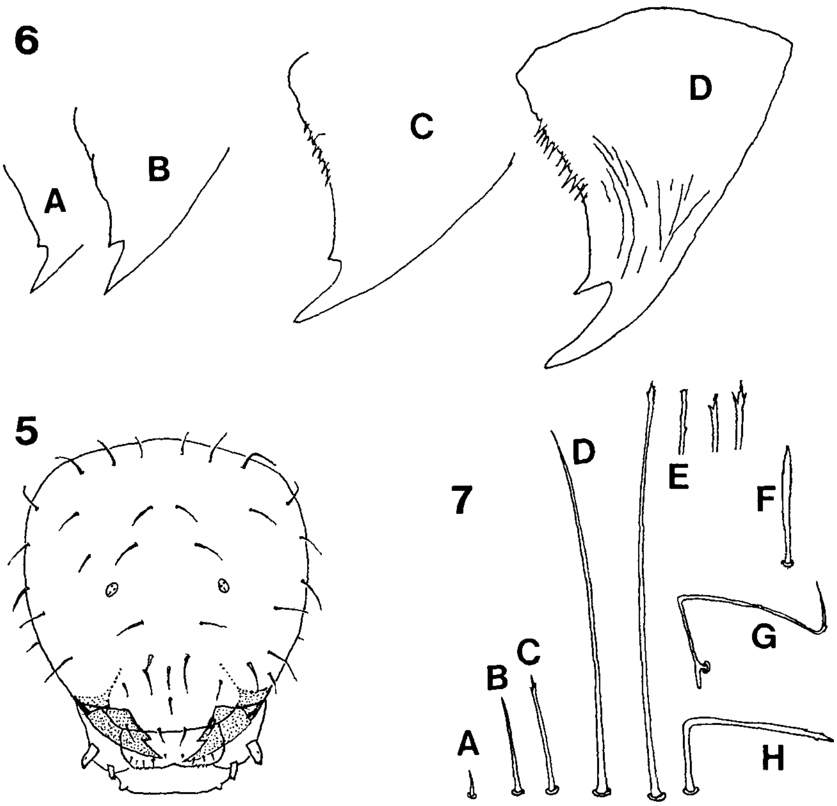
Third instar (Figs. 4–5, 6D, 7D–H). Straight length 1.4–2.6 mm. Body profile pogonomyrmecoid; diameter greatest at abdominal somite IV or V, 0.55–0.91 mm in lateral view. Body hairs moderately abundant on the whole surface, of four types: (1) long, simple, slightly curved or straight (Fig. 7D), (2) long, with the tip denticulate, bifid, or trifid (Fig. 7E), (3) shorter spatulate (Fig 7F) on the ventral surface of thorax and abdominal somites I to VII, (4) atypical, bent near the base with or without a few denticles near the tip (Fig. 7H), or with a projection at the bend and curved again near the tip (Fig. 7G). In some larvae hairs of type (1) dominate on the dorsal surface, but in others those of type (2) do. Head moderately large; cranium subhexagonal. Cranium width 0.33–0.37 mm. Head hairs shorter, of types (1) and (2); type (4) is rarely seen. Antennae each with three sensilla. Labrum short, about 2.5 times as wide as long, feebly bilobed; each lobe with 5 minute hairs on the lower half; 6 sensilla on the ventral border of each lobe. Mandibles small, moderately sclerotized; apex slender and curved medially; one acute medial tooth; basal half of medial surface with several long spinules. Maxillae lobose; palps paxilliform, each with 4–5 small sensilla. Galea digitiform, with two small apical sensilla. Labial palp a low frustum, with probably five (at least four) small sensilla. Opening of sericteries a short transverse slit.

Prepupa. Thorax swollen, mesothorax about the same as abdominal somite IV or V in diameter. Head and thorax transparent in part. The prepupa hardly shows a response to tactile stimulus, whereas the third instar moves its body by a touch. However, the distinction between the third instar and the prepupa became obscure when they were frequently examined.

3. *Pupa*

The prepupa took about 40 minutes for ecdysis in two examples observed. Ecdysis occurred as follows. (1) The thoracic dorsum rises. (2) The skin is torn at the median line of thorax, and the head and thoracic dorsum of the pupa appear. (3) Immediately the molting pupa moves its gaster back and forth or right and left. (4) Fore legs, antennae, middle legs, and gaster come out of the exuvia. (5) At last the exuvia adheres to the tip of hind legs. (6) The pupa moves its gaster for some time after the ecdysis.

The pupal stage is divided into the following five substages, although the distinction between a substage and the next one is not clear. P_1 whole body is milky white; P_2 all ommatidia of eyes are blacked; P_3 the masticatory margin of mandibles are brown in a straight line; P_4 the mandibular dentition (with 8–9 teeth) is clearly seen; P_5 whole body is almost black.



Figs. 5–7. Head, mandibles, and hairs of larvae. —— 5, Head of third instar in frontal view; 6, left mandible of first (A, B), second (C), and third instars (D); 7, body hairs of second (A–C) and third instars (D–H).

Number of Larval Instars and Distinguishing Characters

The number of larval instars of the worker of *M. aciculatus* proved to be three by observations of molting and larval morphology. The larval instar may be easily determined under a stereoscopic microscope of 40 times magnification as follows:

(1) practically naked . . . first instar;

(2) head and thorax sparsely short-haired . . . second instar;

(3) head and body rather densely long-haired . . . third instar.

The early larvae in Taki (1976) include both the first and second instars, and the late larvae are the third instars.

Almost all eggs laid by the colony founding females developed into adult workers. Rarely males were produced: 3 males (from 2 colonies) out of 178 adults (20 colonies) in 1974 and 1 male out of 98 (11 colonies) in 1975. The prepupa of the male may be a little larger than that of the worker. However, males could not be certainly distinguished from workers before the pupal stage. Thus the number of larval instars in the male is probably the same as in the worker.

Table 1 gives the numbers of larval instars in ants and the distinguishing characters used. The number of larval instars ranges from three to five. Although BERNARD (1951) supposed it to be usually four and more rarely five, several myrmicine species have only three larval instars.

The distinction between larval instars has been made by measurements (head width, head length, mandibular size, and spiracle size), morphology of mouth parts (mandible, maxilla, and labium), chaetotaxy (form, density, and distribution of hairs), or by combinations of these. External measurements are unreliable in *M. aciculatus* because of overlapping values of contiguous stages as in other species (MIZUTANI & YAMANE, 1978; TOHMÉ & TOHMÉ, 1975), although the number of larval instars may be inferred from the frequency distribution of head widths or lengths. Measuring the head width or length, etc., is a time-consuming procedure. Observation of mouth parts requires mounted specimens (hence inapplicable to living materials) and is not an easy task. In *M. aciculatus* the mandibular shape is useless to distinguish between the second and third larval instars (Fig. 6).

Chaetotaxy is most useful and easy to use in *M. aciculatus*. Especially hair

Table 1. Number of larval instars in ants and the distinguishing characters. F, Female; M, male; S, soldier; W, worker.

Species	No. of instars	Caste	Characters used	Author
Ponerinae				
Brachyponera chinensis	4	W	Head width	KÔRIBA, 1963
Myrmicinae				
Myrmica rubra (=*ruginodis*)	3	W	Hair density	WEIR, 1959
Myrmica ruginodis	3	W	Hair density, maxillary palp, galea	MIZUTANI & YAMANE, 1978
Aphaenogaster rudis	≧4	W	Chaetotaxy	WHEELER & WHEELER, 1953
Messor aciculatus	3	W	Chaetotaxy	This report
Pheidole pallidula	3	SW	Hair form, mandible, spiracle size	PASSERA, 1974
Tetramorium caespitum	3	W	Hair form	POLDI, 1965
	3	W	Head width, mandible, maxilla, chaetotaxy	BRUDER & GUPTA, 1972
Solenopsis invicta	4	FMW	Mandible, labrum, maxilla, labium	O'NEAL & MARKIN, 1975
Crematogaster stadelmanni	3	FMW	Chaetotaxy, mandible size	DELAGE-DARCHEN, 1972
Formicinae				
Plagiolepis pygmaea	5	W	Chaetotaxy, body form	PASSERA, 1968
Acantholepis frauenfeldi	5	W	Chaetotaxy	TOHMÉ & TOHMÉ, 1975
Formica japonica	≧3	M	Head length	IMAI, 1965
Polyrhachis lamellidens	4	W	Head width, hair form	KOHRIBA, 1963

density (together with the area clothed with hairs) is a good character. This character is often used in various ant species. Generally, the hair density (and also the haired area) increases with the larval development. The same has been observed in *Camponotus japonicus* and *C. obscuripes*, both with four or more larval instars (ONOYAMA, unpublished). It might be said that, in some myrmicine ants, the whole body of the larva comes to be clothed with long hairs in the final instar. This tendency suggests that *Aphaenogaster rudis* has four larval instars according to the description of WHEELER and WHEELER (1953).

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