

The Ant Larvae of the Subfamily Formicinae

PARTS I AND II

By

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THE ANT LARVAE OF THE SUBFAMILY FORMICINAE¹

PART II

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Tribe *Oecophyllini* Emery

Genus *Oecophylla* F. Smith

Sausage-shaped; slightly curved ventrally; terete; diameter nearly uniform, greatest at the fourth abdominal somite, diminishing slightly toward either end. Head on the anterior end; no neck. Anus postero-ventral. Segmentation indistinct. Integumentary spinules coarse and isolated or in short rows. Body hairs very few, minute, simple, acute. Cranium subtrapezoidal in anterior view, slightly narrowed ventrally, dorsal corners broadly rounded. Antennae minute. Head hairs few, very short, simple, acute. Labrum small, bilobed, with only two hairs on the anterior surface. Mandibles very small and feebly sclerotized; basal three-fifths broad and subtrapezoidal in anterior view; apical two-fifths forming a long straight slender sharp-pointed conical tooth; ridges few. Maxillae broad and apparently adnate; integument granular; palp a very small skewed peg; galea a very small knob. Labium a small frustum; palp a very small irregular projection; opening of sericteries narrow and salient.

This genus "comprises the famous and vicious 'tree-ants,' or 'tailor ants,' which make peculiar globular or elliptical nests of leaves on living trees. The leaves are spun together with films of white silk, which is supplied by the larvae" (Wheeler, 1922*a*, p. 225; see also p. 211). When a nest is to be constructed or repaired, workers pull leaves together and hold them in place, while other workers bring out larvae to be used as shuttles. Each larva is grasped tightly at its middle by the mandibles of the worker; its head is directed forward. Here attention should be called to the shape of the larva—nearly straight, with the head on the anterior end. This makes it possible

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for the worker to attain some degree of accuracy in attaching the silk—a greater degree at least than would be possible with a larva of the typical formicine shape, which has a flexible neck which is strongly curved ventrally. The worker touches the labium of the larva to one leaf, pausing long enough for the deposition of a little silk on its surface; then the larva is moved across the narrow gap to the neighboring leaf, spinning out a fine silken thread as it goes; there is another pause for attaching this thread to the second leaf; then back to the first leaf; and so on, until a delicate film or tissue “scmewhat resembling cigarette paper” (Green, 1896, p. ix) is fabricated.

We have cited below, under the discussions of species, the references from the literature on the use of larvae in nest construction. As Emery (1925, p. 51) so aptly expressed it, “aujourd’hui, les publications sur la nidification d’*Oecophylla* et des Fourmis qui suivent la même méthode . . . constituent une littérature assez considérable.” Whether *assez* is translated to *rather*, or to *enough*, this is still an understatement.

On the same page Emery also said: “Les larves d’*Oecophylla* ne filent pas de cocon, quoiqu’elles aient des glandes séricigènes très développées.” See also above under the subfamily.

Wheeler, 1915:—“It would seem that the habit of employing the larvae for spinning the nest tends to make them develop into adults of uniform stature and shape. It is not easy to understand why this should follow” (p. 332). “Apparently . . . in this genus the spinning habit has been shifted back *en bloc* to an early larval stage and is no longer manifested for cocooning in late larval life” (p. 333).

***Oecophylla smaragdina* (Fabricius)**

Plate V, figs. 17-20

Sausage-shaped; slightly curved ventrally; terete; diameter nearly uniform, greatest at the fourth abdominal somite, diminishing slightly toward either end. Head on the anterior end; no neck; posterior end round. Anus posteroventral. Leg vestiges present. Somites indistinct. Integument spinulose, the spinules coarse and isolated or in short rows. Body hairs very few, most numerous on the prothorax; minute (0.006–0.036 mm long), simple, slightly curved, acute; with alveolus and articular membrane. Cranium subtrapezoidal in anterior view, slightly narrowed ventrally, dorsal corners broadly rounded, about a third broader than long; gula with transverse spinulose ridges. Head hairs few, very short (0.036–0.045 mm), straight to slightly curved, simple, acute; alveolus and articular membrane present. Antennae minute, each with three sensilla. Labrum small; bilobed due to a wide impression of the ventral border; breadth (at base) twice the length; narrowed ventrally; anterior surface with two hairs and about six sensilla; ventral border with a few spinules; posterior surface spinulose, the spinules minute and in rows which radiate from the dorsolateral angles, the rows continuous near the base but broken distally; about 12 sensilla near the middle of the posterior surface. Mandibles very small; feebly sclerotized; wedge-shaped, with the edge medial; basal three-fifths very broad and subtrapezoidal in anterior view; apical two-fifths forming a long straight slender smooth sharp-pointed conical tooth; anterior and posterior surfaces with a few longi-

tudinal ridges. Maxillae broad and apparently adnate; surface conspicuously granular; palp a very small skewed peg bearing five sensilla; galea a very small knob bearing two sensilla. Labium a small frustum; anterior surface conspicuously granular; palp a very small irregular projection bearing four sensilla; opening of sericteries narrow and salient. Hypopharynx densely spinulose, the spinules arranged in subtransverse rows, the rows grouped in two subtriangles which have their bases near the middle. (Material studied: seven larvae from Assam, courtesy of Dr. A. C. Cole.)

Ridley (1890, p. 346) published the earliest account of the use of the larvae of this species in weaving. It had been assumed previously that the silk of the nest was secreted by the workers. Brief accounts of this function of the larvae were given by Ridley (1894, p. xxxii), Green (1896, p. ix and 1900), and Jacobson and Wasmann (1905, p. 133, referring to Ridley, 1890, and to Green, 1896).

Doflein's (1905) account is classic. It was translated by Wheeler (1910, pp. 218-220). Doflein's Fig. 3, showing a brigade of workers drawing the edges of leaves together while other workers manipulate the larvae, is reproduced by Wheeler (1910) as Fig. 122 on page 217; Fig. 4, showing a worker holding a larva in its mandibles, as Fig. 123 on page 219.

Bugnion (1909; 1923, p. 17-18=1924, p. 440-441) published brief accounts of weaving accompanied by a figure of a worker carrying a spinning larva (1909, Fig. 3=1923, Fig. 2=1924, Fig. 12; repeated by Forel, 1923, Fig. 14, p. 96 =1928, Vol. II, Fig. 130 on p. 278). He insisted that only young larvae (up to two or three millimeters in length) are used in weaving (1924, p. 446). "Les larves, en quantité énorme, aveugles et apodes, présentent les dimensions les plus diverses à partir des nouveau-nés groupés à proximité des paquets d'oeufs, jusqu'aux gros vers dodus de couleur blanche, longs de 11 à 12 mm., destinés à former des nymphes femelles" (1923, p. 25 = 1924, p. 424).

Subsequent brief accounts were published by Bischoff, 1927, p. 303; Brun, 1924, pp. 53-57; Forel, 1923, pp. 96-99 (=1928, Vol. II, pp. 278-281); Goetsch, 1937, p. 50; Jacobson and Wasmann, 1905, pp. 133-134; Jacobson, 1907, p. 36; Lefroy and Howlett, 1909, p. 231; Lefroy, 1923, p. 527; Mann, 1934, p. 187; Schwarz, 1946, p. 114; and probably many others.

Doflein's two figures have been copied by Berlese (1925), Brun (1924), Escherich (1906 and 1917), Forel (1923), Wheeler (1910) and probably by others. Doflein's Fig. 3 has been copied by Forel (1928), Goetsch (1937), Metcalf and Flint (1932), Roughley (1947) and Schwarz (1946). Sharp published a figure (1909, Fig. 60 on p. 147) of a worker using a larva for spinning. Mann's paper (1934) includes a colored reproduction (Pl. IV) by Hashime Murayama depicting workers and larvae engaged in nest construction.

Forel and Jacobson, 1909, p. 238: The larvae are passive while weaving; the workers themselves apply the larval mouthparts to the point to which the thread is to be attached.

It has been suggested that the larvae are unable to spin cocoons, because their supply of raw material is used up in nest construction (Green, 1904, pp. 73-74; Bugnion, 1909, p. 512, 1923, p. 26 and 1924, p. 449), but Wheeler (1915, p. 326) questioned this interpretation.

Lefroy and Howlett have figured (1909, Fig. 135 on p. 233) a "queen watching over larvae when commencing to found a new nest." (Referred to by Wheeler, 1915, p. 330.) "A colony will have many small depots on one tree, each consisting of a number of leaves webbed together and containing a colony of Coccids or a store of dead dry insects. If one is opened and patiently watched, it will be seen that the workers draw the leaves together by their mandibles and legs, while others, from inside, web them together with silk produced from a larva held in the jaws" (pp. 230-231).

"They also use these grubs to spin webs when fortifying the tree in which they live against the small ants with which they are continually at war. Leaf stipules, dirt, small stones, etc., are brought by the 'red ants' and inserted in the web spun with the aid of the small grubs. On the tree I am watching now there is nearly a complete circle around the trunk (a foot or more in diameter)" (Green, 1896, p. ix). This was translated freely (but incorrectly) and with some embellishment by Chun (1903, p. 129) and by Jacobson and Wasmann (1905, p. 134).

Doflein's figure of a larva of this species (1906, p. 487) shows the highly developed salivary glands. It has been copied by Forel (1923, Fig. 11B=1928, Vol. II, Fig. 133), Karawaiew (1906, Fig. 13) and Wheeler (1910, Fig. 124D). Karawaiew (1929, p. 255) discusses the histology of the salivary glands, which produce the silk.

Long (1901) reports the use of this species, both adults and brood, as human food in the province of Bastar (India). Larvae and pupae are used as fish bait in eastern Bengal (Dutt, 1912, p. 259).

Oecophylla smaragdina subnitida Emery

"In the nest of the tailor ant was an amazing little moth (*Liphyra brassolis*). . . . The little caterpillar. . . feeds on the larvae of the ants" (Mann, 1948, p. 307).

Oecophylla smaragdina virescens (Fabricius)

The earliest account of the use of larvae of this ant in nest weaving is apparently that of Saville-Kent (1897, pp. 253-254); it is illustrated by three crude figures on Plate IX—(1) ants holding leaves together while one worker carries a larva, (2) a worker carrying a larva and (3) a larva. Dodd reported (1902*a*, p. 138) his original observations, which were quoted by Wheeler (1910, pp. 220-221). Wheeler also recorded original observations (1915, pp. 328-329); he described the larvae as "milk-white" and stated that "only very young larvae, about 2-3 mm. in length, were employed" in weaving. Brief accounts of weaving have been given by Dodd (1928, p. 128), O'Brien (1910, p. 670) and Roughley (1947, p. 177).

This ant also uses the larval silk in the construction of shelters for Homoptera and caterpillars (Dodd, 1902*a*, p. 138; Roughley, 1947, p. 179).

The colony-founding queen also employs her first larvae in the construction of her first woven nest (Dodd, 1928, p. 125; Wheeler, 1915, p. 330).

Dodd (1902*b*, pp. 154-155) suspected the caterpillars of *Liphyra brassolis* Westwood of feeding on the larvae of this ant. (Mentioned by Wheeler, 1910, p. 359)

Roughley (1947, p. 179) reported that the larvae of *virescens* were used as human food by the aborigines of northern Queensland; they were "eaten raw, sometimes after rolling them into a ball between the palms of the hands."

Oecophylla longinoda (Latreille)

Apparently similar to *smaragdina*. (Material studied: 11 damaged integuments from the Congo.)

Chun (1903, p. 129) noted that the spinning glands were enormously developed. (Referred to by Jacobson and Wasmann, 1905, p. 135, by Karawaiew, 1906, p. 371 and by Wheeler, 1910, p. 218).

Eidmann, 1944, p. 461: "Die Seide entstammt den Spinndrüsen der Larven, die von den Ameisen wie Weberschiffchen benutzt werden, ein interessanter Fall der Verwendung eines 'Werkzeuges' im Tierreich."

Kohl (1906, pp. 167-168) observed the use of larvae in weaving.

Tribe Camponotini Forel

Thorax and first abdominal somite forming a short stout neck, which is sharply marked off from the rest of the abdomen and which is strongly curved ventrally, so strongly in fact that the mouth parts may be directed posterodorsally and can even be applied to the ventral surface of the anterior abdominal somites. Rest of abdomen elongate-subellipsoidal and straight; diameter greatest at the fourth and fifth abdominal somites, decreasing but slightly toward either end. The posterior half of the ventral surface of the second abdominal somite is raised to form a transverse welt and, on either side, ridges from this welt extend forward to form the sides of a trough, the praesaepium. Anus subterminal. Segmentation distinct. Floor of praesaepium spinulose. Body densely and uniformly covered with short hairs, except on the ventral surface of the thorax and abdominal somites I and II where they become sparse. Five types of hair-shapes occur in the tribe: (1) branched (typically with 2 to 6 branches, but there may be as many as 12); (2) simple, short and slightly curved; (3) simple, long and whip-like; (4) denticulate; (5) uncinat. One type, the branched in most species, is numerically predominant; other types are sparsely represented. Branched and simple hairs are generally the shortest, whip-like and uncinat hairs the longest; denticulate hairs are usually intermediate. Branched hairs have all branches in the same plane and they are so attached to the integument that this plane is transverse. Typically a species has three of these five types, but the number ranges from one to four; thus no species has all types. Head hairs numerous; a conspicuous naked area in the form of an inverted V. Four types of head hairs occur in the tribe: (1) branched (typically bifid or trifid, but there are also four-branched), (2) simple, (3) whip-like, (4) denticulate. A species usually has two of these types but may have one, three or four. Labrum subparabolic in anterior view; somewhat broader (at base) than long; chiloscleres present; posterior surface with numerous (16-30) sensilla. Mandibles rather small; basal third broad and rather thick; distal two-thirds thin and blade-like; apical tooth abruptly marked off, short and slightly

curved anteriorly; lateral outline saddle-shaped; middle half of mesal border denticulate. Maxillae swollen ventrolaterally; apex in the form of a slender cone which is directed medially; mesal surface with rows of minute spinules. Anterior surface of labium spinulose.

This tribe presents two distinctive features which are worthy of special consideration:

Chiloscleres.—We have coined this term from the Greek *cheilos*, lip, and *skleros*, hard, to designate the pair of conspicuous dark brown spots, one at either side of the labrum. Each chilosclere consists of a bar along the lateral margin of the labrum; from this a branch bar extends (almost at a right angle) out to the anterior surface, where it fades out; these bars are apparently formed from enormously thickened and hardened portions of the cuticula. See text fig. 2.

The chiloscleres were figured for *Polyrhachis muelleri* by Karawaiew (1906); for *Camponotus aelhiops* ("var. *concava*" and "var. *andria*") by Menozzi (1936); for *C. (Colobopsis) schmitzi* by Stärcke (1933). Menozzi referred to them as strongly chitinized thickenings ("ispessimento fortemente chitinizzato"), Stärcke as "bord chitineux du labrum".

We have no clue as to the function of the chiloscleres but are inclined to the opinion that they are parts of the trophorhinium; by rubbing the roughened anterior surface of the mandibles, which they probably do when the latter are moved from side to side, they would aid in the trituration of food. Chiloscleres are not present in young larvae.

Praesaepium.—We have taken this Latin word meaning trough or manger to designate the shallow depression on the ventral surface of certain anterior abdominal somites. The most common form is probably typified by the praesaepium of *Camponotus (Myrmaphaenus) novogranadensis*. Here the posterior half of somite II is raised to form a transverse welt; on either side ridges from this welt extend forward to form the sides of the trough. The structure attains its most elaborate form in the subgenus *Colobopsis* where the anterior border of somite II is produced anteriorly to form a thick transverse welt which overhangs the depressed ventral surface of somite I. This is reminiscent of the trophothylax of pseudomyrmine larvae (Wheeler and Bailey, 1920) and probably serves the same function in a rudimentary way. In the subgenus *Camponotus* the praesaepium is probably temporary; there are no welts but the ventral surface of somite II is capable of being depressed to form a crude sort of trough.

The praesaepium is apparently lacking in young larvae and in mature larvae ready to pupate.

The floor of the praesaepium is always conspicuously spinulose. Some observations (from the notebook of the senior author, 1920) on a living larva of *Camponotus americanus* in an artificial nest, are pertinent here: "The mature larva (length 4.5 mm) lay on its back with its neck strongly curved ventrally and its head resting in the shallow trough. The trough was filled with a clear fluid in which the mouth parts were immersed. There was also in this liquid immediately under the mouth a small brownish-yellow pellet. When examined under the microscope this pellet was found to consist of a tangled mass of hairs, a few of them branched, but most of them long and uncinat

like those of the young larvae. The mandibles were moving rhythmically from side to side, but they did not meet. In all probability the larva had just finished making a meal of some of its younger siblings."

The genera of this tribe are so similar that we cannot distinguish them; hence we have not attempted to key them. *Colobopsis* is, however exceptional: differences of generic magnitude separate it not only from the other subgenera of *Camponotus* but also from other genera of Camponotini.

Genus *Camponotus* Mayr

Head small. Cranium subrectangular in anterior view, with all corners rounded. Antennae small. Gula spinulose. Head hairs long. Mandibles with only a few longitudinal ridges; a few of those on the anterior surface bear minute spinules; most of those on the posterior surface bear a comb of long spinules. Labial palps a pair of low knobs.

Adlerz, 1886:—"The larvae are more flattened than those of most other ants and are also very flexible and active. The hairy covering, especially on the smaller larvae, is composed of closely set branched hairs with finely attenuated ends, and scattered among these on the dorsal surface are long bent hairs in which the ends are barb-like and bent back; and which hook on to one another" (p. 293, translated from the Swedish by Professor Edith E. Larson). Hairs with long thin, fine-pointed branches are characteristic of this genus (p. 51). "The body is flattened and its anterior third is strongly bent ventrally. . . . The bent head is often seen touching the ventral side of the body, the same condition as in the embryonic stage. These larvae are very active" (p. 52). The larval period in an incipient colony lasted about 30 days (p. 53). Internal anatomy, pp. 58-64.

Clausen (1940, p. 221):—"The eucharid genus *Silbula* appears to be most frequently associated with *Camponotus*. As far as known, eucharid larvae are parasitic upon the mature larvae and pupae of ants.

Dodd (1906, p. 123) has recorded *Schizaspidia doddi* Bingham with *Camponotus* sp. from Queensland. Presumably the eucharid larvae were parasitic on the ant larvae.

Emery, 1899, p. 5:—"The mandibles of ponerine larvae are much larger than those of the larvae of *Camponotus*."

Emery, 1925, p. 6:—"See above under the subfamily."

Forel, 1874, p. 388 = 1920, p. 265-6:—"Chez les *Camponotus* [les larves] ont la peau flasque, et sont comprimées dans le sens qui va du dos au ventre; leur partie buccale est brusquement recourbée, tandis que le reste du corps est droit. Les larves sont très mobiles."

Furniss, 1944, Fig. 1 J on p. 4:—"Photograph of a larva of *Camponotus* sp. in side view."

Gantes, 1949: "Plus évolués: les larves sont moins agiles. Je ne les pas vues manger seules. Les mandibules sont plus massives. Les poils plus clairsemés. . . On trouve des poils en crosse chez les jeunes larves" (p. 88). "Ces poils chez la larve néonate sont répartis sur le dos et tout autour du bout de l'abdomen, puis aux stades suivants on ne les a plus que dorsalement et sur les derniers segments abdominaux. Chez la larve adulte il n'y en a plus" (p. 87).

Goetsch, 1930:—"Die Fütterung zum mindesten für die Grösse der Larven eine Rolle spielen Kann" (p. 384). A diet of animal food (or a mixed diet) produces larger larvae than a vegetarian diet. This is shown by profiles of queen larvae, (Fig. 10-12, p. 385).

Muir (1911, p. 61) referred to large jet black ants which tunneled in dead tree trunks. "Bears . . . roughly devour the eggs, larvae, parent ants and the rotten or sound wood of the cells, all in one spicy acid hash. The Digger Indians also are fond of the larvae and even of the perfect ants, so I have been told by old mountaineers."

Parker and Thompson (1925, p. 393) have reported *Stilbula cynipiformis* Rossi with *Camponotus* sp.; presumably the eucharid larva had been parasitic on the ant larva.

Wheeler, 1933a, p. 10:—Colony-founding queens of *Camponotus* may devour some of their own larvae.

Subgenus *Camponotus* Mayr

Praesaepium less elaborate and probably not permanent.

Camponotus noveboracensis (Fitch)

(Plate V, figs. 1-13)

Thorax and first abdominal somite forming a short stout neck, which is sharply marked off from the rest of the abdomen and which is strongly curved ventrally, so strongly, in fact, that the mouth parts may be directed posterodorsally and can even be applied to the ventral surface of the anterior abdominal somites. Rest of abdomen elongate-subellipsoidal; diameter greatest at the fourth and fifth abdominal somites, decreasing but slightly toward either end. The prothorax bears a pair of lateral swellings and (adjacent to the head) a ventral swelling. Ventral surface of second abdominal somite capable of being depressed to form a trough (the praesaepium) in which the head of the larva often rests. Posterior end round-pointed. Anus subterminal. Leg vestiges present. Thirteen differentiated somites. Body densely

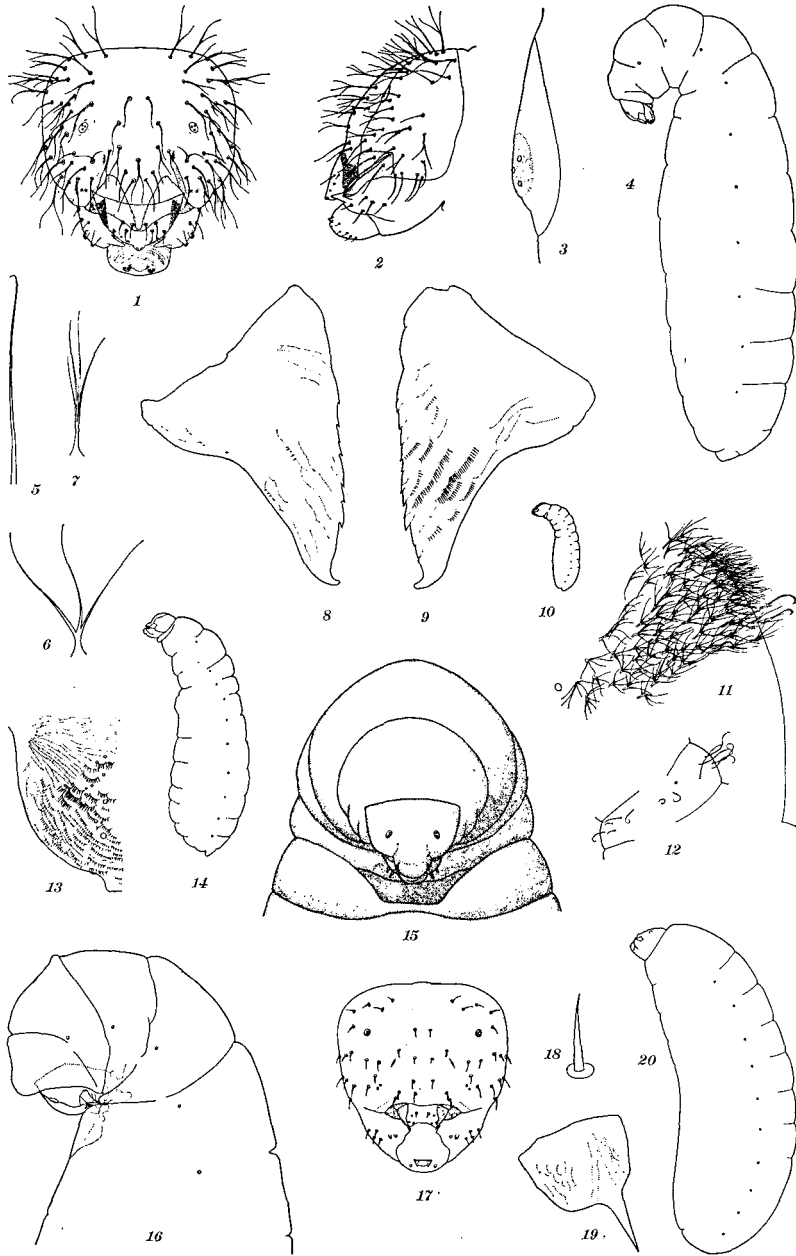
EXPLANATION OF PLATE V

Camponotus noveboracensis (Fitch). FIG. 1, head in anterior view, $\times 44$. FIG. 2, Head in side view, $\times 44$. FIG. 3, Left antenna in side view, $\times 185$. FIG. 4, Larva in side view (hairs omitted), $\times 8$. FIG. 5, Uncinate body hair, $\times 121$. FIG. 6, Branched body hair, $\times 121$. FIG. 7, Branched hair in edge view, $\times 121$. FIG. 8, Right mandible in anterior view, $\times 185$. FIG. 9, Right mandible in posterior view, $\times 185$. FIG. 10, Very young larva (1.5 mm) in side view (hairs omitted), $\times 8$. FIG. 11, Dorsal surface of abdominal somite I in side view showing spiracle and adjacent hairs (other hairs omitted), $\times 44$. FIG. 12, Abdominal somite I of very young larva in side view, showing spiracle and hairs, $\times 44$. FIG. 13, Left half of labrum in posterior view, $\times 118$.

Camponotus (Myrmaphaenus) novogranadensis Mayr. FIG. 14, An extended larva in side view (hairs omitted), showing the praesaepium, $\times 10$.

Camponotus (Myrmentoma) nearcticus Emery. FIG. 15, Head and anterior end (hairs omitted), showing praesaepium, $\times 22$. FIG. 16, Head and anterior end (hairs omitted), in phantom view showing mouth parts in praesaepium, $\times 22$.

Oecophylla smaragdina (Fabricius). FIG. 17, Head in anterior view, $\times 44$. FIG. 18, Body hair, $\times 370$. FIG. 19, Right mandible in anterior view, $\times 185$. FIG. 20, Larva in side view (hairs too small to show at this magnification), $\times 10$.



and uniformly covered with short hairs, except on the ventral surface of the thorax and abdominal somites I and II where they become sparse. Hairs of two types: (1) length 0.07–0.18 mm, 2 to 6-branched, all branches in the same plane, generally distributed over the body; (2) length 0.18–0.26 mm, one-hooked unciniate hairs, a few near the middle of the dorsal and lateral surfaces of each abdominal somite. Body hairs apparently without alveolus and articular membrane. Integument of abdominal somites VIII–X and of the ventral surface of the thorax and abdominal somites I and II spinulose, the spinules minute and in short transverse rows. Head small; cranium subrectangular in anterior view, with all corners rounded; slightly broader than long; gula spinulose, the spinules minute and in short transverse rows. Head hairs numerous; long (0.12–0.21 mm); 2 to 3-branched, with the branches long; alveolus and articular membrane present; naked area conspicuous, in the form of an inverted V. Antennae small, each mounted on a low convexity and bearing three sensilla. Labrum subparabolic in anterior view with a small median lobe protruding ventrally; breadth (at base) 1.3X length; anterior surface with 12 hairs and (on or near the ventral border) ten sensilla; posterior surface spinulose, the spinules minute and arranged in rows which radiate from the dorsolateral angles, the rows continuous near the base but broken distally; posterior surface with about 30 sensilla; chiloscleres present. Mandibles rather small; moderately sclerotized; subtriangular in anterior view; basal third broad and rather thick; distal two-thirds thin, blade-like and slightly curved anteriorly; apical tooth short, smooth, round-pointed and curved medially; lateral outline saddle-shaped; middle half of mesal border denticulate; anterior surface with a few short longitudinal ridges on some of which are mounted minute spinules; posterior surface of blade with a few longitudinal ridges, on most of which are mounted combs of rather long spinules. Maxillae swollen ventrolaterally; apex in the form of a slender cone which is directed medially; mesal surface roughened with short rows of minute spinules; palp a small peg bearing four apical and one lateral sensilla; galea a cone bearing two apical sensilla. Labium with the anterior surface spinulose, the spinules short and in transverse rows; palp a low knob bearing five sensilla; opening of sericteries wide and salient, with two projections. Hypopharynx densely spinulose, the spinules arranged in subtransverse rows, the rows grouped in two subtriangles which have their bases near the middle. (Material studied: numerous larvae from New Hampshire, New York and North Dakota.)

Wheeler (1907, p. 16) recorded *Pseudochalcura gibbosa* Provancher from the cocoons of this ant in Michigan. The eucharid larvae were presumably parasitic on the ant larvae.

First-instar larva.—Length 1.4–1.6 mm. Thorax stout and bent ventrally; abdomen somewhat stouter, straight, tapering slightly toward either end. Anus subterminal, with large prominent lips. The prothorax bears a pair of lateral swelling and (adjacent to the head) a ventral swelling. Praesaepium lacking. Thirteen differentiated somites. Body hairs sparse and moderately long, of two types: (1) one-hooked unciniate hairs, with the tips curled, about 0.13 mm long, a few on each somite, the more conspicuous type; (2) simple flexuous

hairs, 0.05–0.11 mm long, apparently restricted to ventral surface. Integument of the dorsal surface sparsely spinulose, the spinules minute and in short transverse rows. Head relatively large. Head hairs moderately numerous, short to moderately long (0.009–0.11 mm), of two types: (1) simple and (2) one-hooked uncinata hairs (with the tips more curled than those of body hairs). Each antenna represented by three raised sensilla. Labrum without chiloscleres. Mandibles with the apical tooth vestigial. Maxillae with the apex a frustum; palp a cluster of five raised sensilla; galea a frustum with two sensilla. Labial palp a low conoid with five sensilla; opening of sericteries not evident. Other characters similar to those in the mature larva. (Larvae still in the egg shell, but ready to hatch, are similar to the larvae described above; length of egg 1.2 mm.)

Second-instar larva.—Length 1.7–1.8 mm. Body shape as in first-instar larva but with the abdomen somewhat more voluminous. Body densely and uniformly covered with rather long hairs, except on the ventral surface of the thorax and abdominal somites I and II where they are sparse. Hairs of three types: (1) one-hooked uncinata hairs with the tips curled, 0.14–0.27 mm long, a few on each somite; (2) flexuous hairs, 0.018–0.11 mm long, generally distributed; (3) 2 to 3-branched hairs, 0.07–0.11 mm, generally distributed but lacking on the ventral surface of the thorax. Integument of the dorsal surface of the abdomen spinulose, the spinules minute and in short transverse rows. Head relatively large; gula spinulose. Head hairs numerous; simple and flexuous, rarely 2-branched, 0.07–0.14 mm long. Each antenna represented by three raised sensilla. Labrum without chiloscleres. Apical tooth of mandible vestigial. Opening of sericteries represented by a pair of slight swellings. Otherwise similar to the mature larva.

Camponotus americanus Mayr

Text fig. 1

See above under tribe Camponotini.

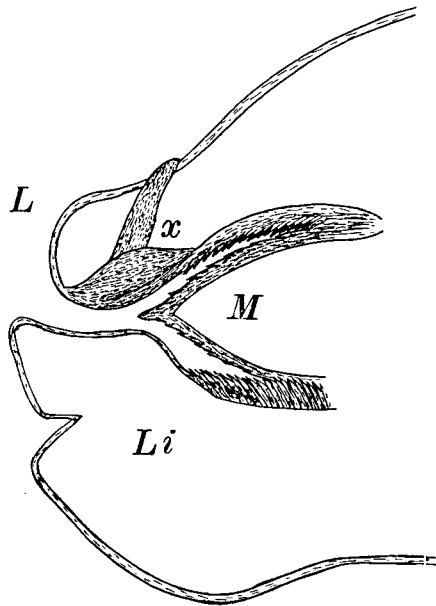
Wheeler, 1910, Fig. 45 on p. 79: Photograph (indistinct) of younger and older larvae.

Camponotus herculeanus (Linnaeus)

Similar to *noveboracensis* except as follows: body hairs more abundant; uncinata hairs shorter (about 0.14 mm); anterior surface of labrum with about nine hairs and (on or near the ventral border) about 12 sensilla. (Material studied: several larvae from Michigan.)

Eidmann, 1928a:—"Die Ameisenlarven sind bekanntlich fusslos und wenn überhaupt, dann nur in beschränkter Masse der Ortsbewegung fähig. Sie können sich nicht an den rauhen Wänden anklammern, wie ihre Pflegeschwestern und müssten daher in den engen hohen Kammern am Grunde hoch übereinandergestapelt liegen, was für ihre Ernährung und Wartung sicherlich höchst unzuweckmässig wäre. . . Hafthaare. . . finden sich auf der Rückseite der Abdominalsegmente. Die Thorakalsegmente sind völlig frei davon, ebenso die Ventralseite des Abdomens, abgesehen von den letzten Segmenten, auf deren Ventralseite die Region der Hafthaare um die hintere Rundung des

Abdomens herum eine Strecke weit übergreift. Die Hafthaare zeichnen sich durch ihre Länge und Dicke vor den übrigen Haarkleid der Larven aus, das als gleichmässig dichter Pelz von kurzen Haaren den gesamten Larvenkörper überzieht. Die Spitze der Hafthaare ist zu einem krallenartigen, spitzen Gebilde umgebogen, mit dem ein festes Verankern in einer rauhen Unterlage wohl möglich erscheint. . . Die Hafthaare sind ziemlich spärlich in dem Haarkleid verteilt und lassen keinerlei Regelmässigkeit in ihrer Anordnung erkennen. Ihre Länge beträgt das Doppelte bis Dreifache der kurzen Haare, die Krümmung zeigt nach den verschiedensten Richtungen. In dem kurzen Pelzkleid der Larven finden sich neben einfachen Haaren in grosser Zahl eigentümliche



TEXT FIG. 1. *Camponotus americanus* Mayr. Longitudinal section through head, $\times 358$; L, labrum; x, chilosclere; M, mandible; Li, labium.

baumförmig verästelte Haare von der gleichen Länge wie jene. Es ist sehr leicht möglich, dass die Larven mit Hilfe der Hafthaare an den Wandungen der Kammern aufgehängt werden, gesehen habe ich es nicht, und es wird auch nicht sehr leicht festzustellen sein. Man wird zu diesem Zweck Beobachtungen in künstlichen Nestern anstellen müssen, die entsprechend gebaut sind. Ich habe zwar *C. ligniperda* jahrelang im Versuchsnest gehalten, doch waren diese nicht geeignet (es waren horizontale Gipsnester) um gerade über diesen Punkt Aufschluss zu erhalten. Ich glaube nicht, dass es gelingen wird, ein natürliches Nest in einem lebenden Stamm so schnell zu öffnen, um die Larven noch in ihrer natürlichen Lage beobachten zu können. Die Wirkung der Hafthaare lässt sich, selbst an konserviertem Larvenmaterial noch

sehr schön erkennen. Kleine Watteflöckchen oder ähnliche Fremdkörper haften sehr fest an dem Larvenkörper und die Larven selbst hängen fest aneinander. Letztere Eigentümlichkeit, das Zusammenklumpen der Larven vermöge der Hafthaare ist biologisch von Bedeutung, besonders für den Transport kleiner Larven und die rasche Räumung des Nestes bei Gefahr. Wir finden daher auch Hafthaare bei den Larven erdbewohnender Ameisen (*Pheidole*, *Solenopsis*, u. a.) Das Vorkommen der Hafthaare bei den Larven der Rossameise Kann daher zwar kein sicherer Beweis dafür sein, dass dieselben zum Aufhängen an den steilen Kammerwänden dienen; doch erscheint dies unter den obwaltenden Verhältnissen sehr wahrscheinlich." (pp. 237-240). Fig. 7 on p. 239: larval hairs.

Eidmann, 1943, pp. 250-254:—Young larvae (*kleine Eilarven*) overwinter in the nest.

Goetsch, 1937, p. 137: life cycle—egg 16-27 days, larva 8-15 days, pupa 14-92 days.

Stärcke, 1933, pp. 30-31: See under *C. (Colobopsis) schmitzi*. Stärcke (1939, p. XIX):—The antennae have the cuticle very convex.

***Camponotus herculeanus obscuripes* Mayr**

Clausen (1941, p. 57) recorded this ant as the host of *Stilbula tenuicornis* (Ashmead) in Korea; presumably the eucharid larvae were parasitic on the ant larvae.

***Camponotus japonicus* Mayr**

Clausen (1923) reported the eucharid *Schizaspidia tenuicornis* Ashmead as ectoparasitic on the larvae and pupae of this ant in Japan. In 1941 (p. 57) he listed this ant as host of this same eucharid.

***Camponotus ligniperdus* (Latreille)**

Adlerz, 1886, Pl. VII: Fig. 7, larva in side view; Fig. 8, branched hair (repeated Escherich, 1906, Fig. 32 and 1917, Figure 38A); Fig. 8a, tip of uncinata hair; Figs. 10, 11, and 12 deal with internal anatomy.

Eidmann, 1926;—Fig. 3 on pp. 788 and 789, semidiagrammatic drawings of all the larvae of an incipient colony on eight different days between August 4 and May 29. Fig. 4 on p. 793, photograph of a queen carrying a larva. Fig. 5 on p. 794, a colony-founding queen with larvae (repeated Wheeler 1933a, Fig. 2.)

Emery, 1899, p. 7:—"La larva del *C. ligniperda* figurata dall'Adlerz non è ipocefala."

Mayr, 1855, p. 283:—"Mit abstehenden Haaren bekleidet, welche . . . baumförmig verzweigt sind, indem sie entweder schon am Grunde oder von diesem etwas weiter entfernt, lange Aeste austreiben."

Skwarra, 1927, p. 84:—This ant is listed as a host of the chrysomelid larva *Clytra quadripunctata* L. See under *Formica rufa*.

***Camponotus pennsylvanicus* (DeGeer)**

Similar to *noveboracensis* except as follows: body hairs mostly bifid, a few simple, rarely trifid; uncinata hairs shorter (about 0.12 mm) and apparently replaced laterally by long simple or denticulate hairs; head hairs shorter, simple or with the tips 2 to 3-branched; anterior surface

of labrum with eight hairs and (on or near the ventral border) 12 sensilla. (Material studied: several larvae from New York and Massachusetts.)

Pricer, 1908:—The first larvae of an incipient colony "grew very rapidly, almost doubling in size in a single day, and the rate of growth decreased gradually as other larvae appeared to demand food and care. By September 1, the change in size was scarcely perceptible in a week's time" (p. 179). The life cycle in an incipient colony was found to be: egg 24 days, larva 21 days, pupa 21 days, total 66 days (p. 180). "In outdoor nests some larvae spend the winter in a state of arrested development, and I have kept one colony. . . in an artificial nest all winter in the insectory and no growth could be noticed in the larvae until about March 1, when they suddenly began to grow at about the usual summer rate" (p. 180). The number of larvae in incipient colonies varied from eight to 32 (Table I, p. 183). The number of larvae in established colonies ranged from 74 to 867 (Table III on p. 185). The relation of number of larvae to colony size was discussed on pages 187 and 192.

Schneirla & Chace, 1951:—The photographs on pages 228, 229, 230 and 232 include larvae.

Wheeler, 1910, Fig. 105 on p. 189: photograph of a cluster of small larvae in an incipient colony. (Repeated Emery 1915, Fig. 13; Wheeler, 1926, Fig. 33 on p. 244; Wheeler, 1928a, Pl. XXIX, Fig. 47.)

***Camponotus pennsylvanicus ferrugineus* (Fabricius)**

Pricer, 1908:—The number of larvae in established colonies ranged from 75 to 1330 (Table IV on p. 185). The relation of number of larvae to colony size was discussed on pages 187 and 192.

Tanquary, 1913, Pl. LXII Fig. 25: embryo just before hatching, showing internal anatomy.

Subgenus ***Colobopsis*** Mayr

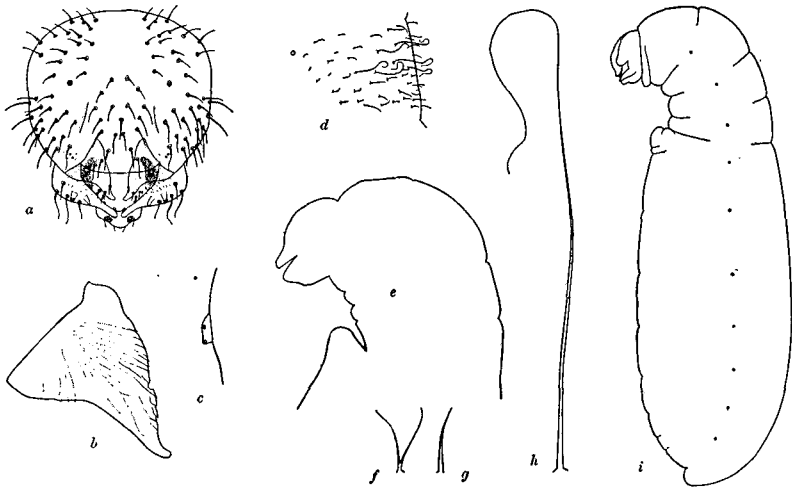
Abdomen (except somite I) subellipsoidal and rather stout; diameter greatest at the fourth and fifth abdominal somites; tapering but slightly toward the anterior end and more rapidly toward the posterior end. The praesaepium, which is formed from the depressed ventral surface of the metathorax and abdominal somite I lacks side-walls, but its posterior border is overhung by the anterior border of abdominal somite II to form a sort of pocket. Segmentation indistinct. Tenth abdominal somite forming a hemispherical button which is directed posteroventrally; anus immediately anterior to this button. Body hairs sparse, and uniformly distributed: of three types—mostly (1) simple or (2) bifid, but (3) a few very long and whip-like; none uncinata. Cranium suboctagonal in anterior view, with the corners rounded; slightly narrowed below. Antennae minute, peg-like. Head hairs short. Mandibles with only a few longitudinal ridges; some of those on the anterior surface bear minute spinules; most of those on the posterior surface bear a comb of longer spinules. Labium small; palp a slight elevation.

***Camponotus (Colobopsis) mississippiensis* M. R. Smith**

Text fig. 2

Thorax and first abdominal somite forming a short, stout neck.

which is sharply marked off from the rest of the abdomen and which is strongly curved ventrally, so strongly, in fact, that the mouth parts may be directed posterodorsally and can even be applied to the ventral surface of the anterior abdominal somites. Rest of the abdomen subellipsoidal and rather stout; diameter greatest at the fourth and fifth abdominal somites; tapering but slightly toward the anterior end and more rapidly toward the posterior end. Adjacent to the head the prothorax bears a ventral swelling. The praesaepium, which is formed from the depressed ventral surface of the metathorax and abdominal somite I, lacks side-walls, but its posterior border is overhung



TEXT FIG. 2. *Camponotus (Colobopsis) mississippiensis* M. R. Smith. *a*, head in anterior view, $\times 60$; *b*, right mandible in anterior view, $\times 185$; *c*, left antenna in side view, $\times 185$; *d*, dorsal surface of abdominal somite II in side view, showing spiracle and hairs, $\times 44$; *e*, optical section of anterior end to show praesaepium, $\times 28$; *f* and *g*, short body hairs, $\times 242$; *h*, long body hair, $\times 242$; *i*, larva in side view (hairs omitted), $\times 20$.

by the anterior border of abdominal somite II to form a sort of pocket. Segmentation indistinct. Tenth abdominal somite forming a hemispherical button which is directed posteroventrally; anus subterminal and immediately anterior to this button. Body hairs short, sparse, uniformly distributed and without alveolus or articular membrane; of three types: (1) the majority are simple or (2) 2-branched and 0.035–0.07 mm long; (3) a few very long (about 0.25 mm), whip-like hairs on the dorsa of abdominal somites II–VIII. Integument of abdominal somites VIII–X and of the ventral surface of the thorax and abdominal somites I and II with minute spinules in short transverse rows. Cranium suboctagonal in anterior view, with the corners rounded, slightly narrowed below; slightly broader than long. Head hairs numerous, short (0.036–0.054 mm); of two types: (1) mostly simple, (2) rarely 2-branched; alveolus and articular membrane present; naked

area conspicuous, in the form of an inverted V. Antennae minute, each a small peg bearing three sensilla. Labrum subparabolic in anterior view, breadth (at base) 1.5X the length; anterior surface with eight short, simple hairs and two sensilla; four projecting sensilla on the ventral border; posterior surface spinulose, the spinules minute and in rows which radiate from the dorsolateral angles, the rows continuous near the base but broken distally; posterior surface with about eight sensilla on each half; chiloscleres present. Mandibles rather small; moderately sclerotized; subtriangular in anterior view; basal third broad, somewhat thick and wedge-shaped; distal two-thirds thin, blade-like and slightly curved anteriorly; apical tooth short, smooth, round-pointed and curved medially; lateral outline saddle-shaped; middle half of mesal border denticulate; anterior surface with a few short longitudinal ridges, on some of which are mounted minute spinules; posterior surface of blade with a few longitudinal ridges, on most of which are combs of rather long spinules. Maxillae swollen ventrolaterally; apex in the form of a long and rather slender conoid which is directed ventrally and medially; mesal surface with a patch of minute spinules in short rows; palp a skewed peg bearing four apical and one lateral sensilla; galea finger-like with two apical sensilla. Labium small; anterior surface sparsely spinulose; each palp a slight elevation bearing five sensilla; opening of sericteries a transverse slit on the anterior surface. Hypopharynx densely spinulose, the spinules arranged in subtransverse rows, the rows grouped in two subtriangles which have their bases near the middle. (Material studied: seven larvae from Mississippi, collected by Dr. W. S. Creighton.)

Camponotus (Colobopsis) culmicola Wheeler

Apparently similar to *mississippiensis*, except that the antennae have two sensilla each. (Material studied: three damaged integuments from the Bahamas.)

Camponotus (Colobopsis) gasseri Forel

Similar to *mississippiensis*, except in the following details: Body hairs sparser; whip-like hairs much longer (about 0.5 mm); other hairs much shorter (0.009–0.027 mm). Antennae about three times as large. Anterior surface of labrum with six hairs and four sensilla. Maxillary palp finger-shaped with one of its apical sensilla large and peg-like. (Material studied: six damaged integuments from South Australia.)

Camponotus (Colobopsis) quadriceps (F. Smith)

Dahl, 1901, p. 31:—"Das Weibchen und die jungen Larven nähren sich einerseits von dem Mark [von *Endospermum formicarum* Becc.], andererseits von den Zellwucherungen an der Mündung und wohl auch von dem Saft, welcher an der Mündung auf fortgesetzten Reiz in geringer Menge ausfliessen dürfte."

Camponotus (Colobopsis) vitreus (F. Smith)

Emery, 1899:—"Un grado minore, ma pure ben marcato d'ipocefalia si osserva. . . Però, se si prescinde dalla forma breve e tozza e dalla posizione del capo, queste larve non differiscono notevolmente da quelle

delle altre Camponotinae. Le mandibole sono piccole e quasi interamente nascoste nell'interno della bocca; le mascelle e il labbro inferiore hanno forma ritondata; le sporgenze coniche, due per ciascuna mascella e un paio solo nel labbro inferiore, sono minute e semplici. . . . Il *C. vitreus* non forma bozzolo per metamorfosarsi; le sue pupe sono nude" (p. 7). Pl. II, Fig. 11a, larvae in side view; b, head in side view, enlarged; c, head in anterior view, enlarged. (Figures b and c repeated by Escherich, 1906, Fig. 31, and 1917, Fig. 37B.)

Camponotus (Colobopsis) schmitzi Stärcke

Stärcke, 1933: "Stature ordinaire des larves de *Camponotus*, cylindrique, étendue, extrémité craniale courbée de presque en demicercle jusque 90 degrés. Extrémité caudale projetée un peu du côté ventral, soutenant l'orifice anal. *Chaetotaxie*. Comme je ne connais pas la larve d'autres *Colobopsis*, je compare avec *Camponotus herculeanus*. La chaetotaxie des *Camponotus* comprend: (1) des acrochètes longues, bifurquées ou bifides jusque multifides, placées densément; (2) des oncochètes très longues, simples, à leur extrémité courbées en crosse. Cette chaetotaxie se retrouve chez *C. schmitzi*, avec quelques traits particuliers cependant. Les acrochètes ont leur solidité normale seulement aux extrémités craniales et caudales, sur le reste du corps ils sont fort minces, à tronçon court et fin, se ramifiant en filaments raides mais très fins et dont les extrémités sont si fines qu'on les décèle seulement en employant les objectifs d'immersion. Quelque-fois ces filaments sont capricieusement frisés, comme des chambrières. Tandis que, dans *C. herculeanus*, seulement sur la tête ces acrochètes à chambrières sont remplacées par des acrochètes plus courtes, ramifiées en tronc d'arbre bombardé, ou bien bifurquées ou bifides, dans *C. schmitzi* c'est aussi près de l'extrémité caudale qu'on trouve cette forme-là et même des acrochètes simples, présentent cependant, comme celles de la tête, à leurs sommets des traces de ramification multiple ou de la dentelure irrégulière, visibles à l'immersion. Ces acrochètes en hydre ou en tronc ramifié d'arbre bombardé de l'extrémité caudale sont beaucoup plus solides que les autres. Chez *C. herculeanus* les acrochètes de la tête sont pour la plupart encore distinctement et longuement bifurquées et longues comme la moitié de la tête, à l'exception de quelques-unes, surtout situées sur le clypéus et les parties buccales. Les oncochètes sont chez *C. schmitzi* aussi plus minces et plus flexibles (que chez *herculeanus*), en chambrière elles aussi; elles ne possèdent pas l'extrémité en crosse. A remarquer est encore qu'on trouve sur le prothorax parmi les acrochètes courtes et multifides ou ramifiées quelques acrochètes longues, simples, minces et très raides. En somme les poils sont chez la larve de *C. schmitzi* particulièrement courts et flexibles, ce qu'on pourrait considérer comme une adaption aux nids dans les tiges creuses. *Pièces buccales*. *Mandibules* d'un point de vue frontal, peu projetées, armées d'une dent, terminale, obtuse et un peu crochue en bec de hibou. (Chez *C. herculeanus* la mandibule est grande et à dents multiples disposées en scie). Le plan dorsal porte une vingtaine de papilles solides, un peu pointues. Les sommets des papilles situées au bord interne, font un peu saillie, comme des dents fines et obtuses. Le plan inférieur porte aussi des rugosités régulières. La moitié postérieure porte dessous du

côté interne un système de rides très fines et parallèles qui s'étendent sur les deux ailes dans lesquelles la basis de la mandibule se prolonge en haut et en bas. La mandibule possède ainsi la forme d'une pyramide trilatérale à plans excavés et partout munis de dents resp. rugosités, aptes à broyer. *Maxilles* assez sveltes, tours à sensilles toutes les deux d'égale hauteur et de force égale, hautes, surpassant les mandibules. Le plan dorsal des maxilles montre sur sa moitié distale également des plis irréguliers. Cette rugosité des maxilles se rencontre rarement. *Labrum très particulier*. Ses bords droit et gauche sont largement durcis par une bande brune irrégulière de chitine, montrant quatre ou cinq rides longitudinales fines. Contre ce renfort le plan supérieur de la mandibule peut frotter. Le bord antérieur présente une deuxième particularité: il porte auprès du milieu deux papilles à sensilles de chaque côté, munies chacune d'un fort nerf sensible avec apparatus ganglionnaire. Je n'ai jamais remarqué ces papilles-là chez les autres larves de fourmis, qui les possèdent seulement sur le labium, une de chaque côté, ce qui est d'ailleurs également le cas chez *C. schmitzi*. On peut supposer que l'innervation sensible extraordinaire du labrum chez *C. schmitzi* se rapporte à sa fonction d'apparat broyeur chez cette espèce. Les courts muscles clipéo-labraux médians sont fortement développés. *Labium* n'offre rien d'extraordinaire.. *Trophorhinium* extraordinairement développé; plis inclinés vers l'extérieur, sa prolongeant un peu sur la maxille. Dessous du labrum avec quelques plis semblables, également inclinés en avant" (pp. 30-31). Internal anatomy p. 31. Photomicrographs of larva [semipupa ?] in profile, Fig. 4; of anterior end of same enlarged, Fig. 5; of labrum, Fig. 6; of the "bord chitineuse du labrum," Fig. 7; of the mouth parts in side view, Fig. 8 [the outline of the mandible seems to be inaccurate]; of mouth parts in anterior view, Fig. 9; of an antenna, Fig. 10; of "trophorhinium" [hypopharynx ?] in profile, Fig. 11; hypopharynx, Fig. 12; "fines rides du plan inférieur de la mandibule" [hypopharynx?], Fig. 13.

Camponotus (Colobopsis) sp.

Hutchins (1935, p. 172) described the larvae as "white and spindle-shaped, smaller at one end than the other."

Subgenus **Myrmamblys** Forel

Camponotus (Myrmamblys) vividus (F. Smith)

Similar to *noveboracensis* except as follows: head hairs about half as numerous; anterior surface of labrum with about 12 hairs and (on or near the ventral border) 12 sensilla; distal half of mandibles narrower and straight. (Material studied: damaged integuments of five heads and a part of one body from the Congo.)

Subgenus **Myrmaphaenus** Emery

Camponotus (Myrmaphaenus) novogranadensis Mayr

Plate V, fig. 14

Similar to *noveboracensis* except as follows: Praesepium better developed and apparently permanent; the posterior half of the ventral surface of abdominal somite II is raised to form a transverse welt and,

on either side, ridges from this welt extend forward to form the sides of the praesaepium. The floor of the praesaepium (and also the ventral surface of the first abdominal somite and of the thorax) is furnished with short transverse rows of minute spinules. Only about seven differentiated somites. Body hairs 2 to 4-branched, length 0.036-0.12 mm, a few with alveolus and articular membrane; no uncinete hairs. Head hairs shorter. Anterior surface of labrum with seven or eight hairs and about ten sensilla; six projecting sensilla on the ventral border. Maxillary palp longer and conical, with four apical and one lateral sensilla; galea digitiform, with two apical sensilla. (Material studied: numerous larvae from the Panama Canal Zone.)

In the newly hatched larva (length about 1 mm; the egg is 0.75 mm long) the thorax and abdominal somites I, II, VIII, IX and X bear many 1-hooked uncinete hairs (about 0.072 mm long), which have alveoli and articular membranes; these somites are also moderately well supplied with shorter (0.018-0.054 mm) 1 to 4-branched hairs, some with, some without alveoli and articular membranes. Abdominal somites III-VII are nearly naked but do have a few short (0.027-0.054 mm) simple hairs, which have alveoli and articular membranes. The five anterior somites are more distinct than the others. Most head hairs are uncinete, with denticulate shaft, about 0.072 mm long; there are also a few 1 to 3-branched hairs, about 0.05 mm long; all head hairs have alveoli and articular membranes.

Subgenus *Myrmentoma* Forel

Camponotus (Myrmentoma) nearcticus Emery

(Plate V, figs. 15-16)

Similar to *noveboracensis* except for the following details: Praesaepium as in *novogranadensis*. About six differentiated somites. Body hairs shorter (0.035-0.07 mm); no uncinete hairs on abdominal somites IX and X; uncinete hairs and a few of the branched hairs with alveolus and articular membrane. Head hairs shorter (0.054-0.1 mm); mostly simple and whip-like; a few 2-branched. Anterior surface of labrum with about ten hairs and six small sensilla; ventral border with six projecting sensilla. (Material studied: numerous larvae from Texas.)

Subgenus *Myrmeurynota* Forel

Camponotus (Myrmeurynota) linnaei Forel

Similar to *noveboracensis* except for the following details: Praesaepium similar to that of *novogranadensis*. Branched body hairs shorter (0.054-0.072 mm), without alveolus or articular membrane; on abdominal somites VIII-X about a third of the hairs are denticulate and 0.07-0.1 mm long; all other somites have each a few denticulate hairs about 0.08 mm long; a few of the denticulate hairs have alveolus and articular membrane; apparently no uncinete hairs. Cranium transversely subelliptical in anterior view. Head hairs more numerous; of two types: (1) 2 to 3-branched, about 0.035 mm long and (2) denticulate, about 0.07 mm long. Anterior surface of labrum with eight hairs and four small sensilla; ventral border with six projecting sensilla.

Maxillary palp a subcone bearing four apical and one lateral sensilla; galea finger-like. (Material studied: several larvae from Panama and from the Panama Canal Zone.)

Subgenus **Myrmobrachys** Forel

Camponotus (Myrmobrachys) planatus Roger

Similar to *noveboracensis* except for the following details: Praesaepium similar to that of *novogranadensis*. Body hairs of three types: (1) mostly 2 to 4-branched, 0.036–0.13 mm, without alveolus and articular membrane; (2) the thoracic and abdominal somites VIII–X have each a few denticulate hairs, about 0.09 mm long; (3) on each of the other abdominal somites there are a few uncinata hairs, about 0.16 mm long; types (2) and (3) have alveoli and articular membranes. Head hairs of three types: (1) simple, (2) denticulate, and (3) 2 to 3-branched; 0.035–0.1 mm long. Anterior surface of labrum with ten hairs and 2 to 4 small sensilla; ventral border with six projecting sensilla. Maxillary palp a cone, with four apical and one lateral sensilla; galea finger-like, with two apical sensilla. (Material studied: numerous larvae from Cuba.)

Camponotus (Myrmobrachys) brevis obscurifrons Santschi

Similar to *planatus*. (Material studied: numerous larvae from the Panama Canal Zone.)

Camponotus (Myrmobrachys) canescens Mayr

Similar to *planatus*. (Material studied: several larvae from Panama)

Camponotus (Myrmobrachys) formiciformis Forel

Wheeler, 1915, p. 332:—"Although I did not see the larvae in the act of being used as shuttles in the construction of the [silken] nest, there can be no doubt that they are thus employed. The pupae were all enclosed in white cocoons like those of other small species of *Camponotus*." The workers are monomorphic; see under *senex* below.

Camponotus (Myrmobrachys) senex (F. Smith)

Forel (1905, p. 170), referring to this species and its subspecies *textor* Forel:—"Die Ameisen bauten weitere Nebennester, indem sie ihre spinnenden Larven im Maul hielten, und dieselben in Zick-Zack-Linie hin und her bewegten, sodass von innen heraus das feine und dichte Gewebe entstand und, Gänge und Kammern bildend, immer weiter ausgedehnt wurde." (Referred to by Bischoff, 1927, pp. 304–305; Brun, 1924, p. 57; Emery, 1925, p. 162; Forel, 1923, pp. 99–100 = 1928, Vol. II, pp. 281–282; Wheeler, 1915, p. 331.) Wheeler also stated that the workers were "practically monomorphic, so that it would seem that the habit of employing the larvae for spinning the nest tends to make them develop into adults of uniform stature and shape. It is not easy to understand why this should follow." (p. 332). "More mature larvae are used as shuttles and the cocoon-spinning instincts have not been suppressed" (p. 333).

Camponotus (Myrmobrachys) zoc Forel

Similar to *planatus*. (Material studied: numerous larvae from the Panama Canal Zone.)

Subgenus **Myrmocladoecus** Wheeler**Camponotus (Myrmocladoecus) latangulus** Roger

Similar to *noveboracensis* except for the following details: Body hairs of three types: (1) mostly 2 to 4-branched, 0.054–0.09 mm long; (2) simple, 0.07–0.09 mm long, a few on each thoracic somite and many on abdominal somites VIII–X; (3) one-hooked uncinuate hairs, about 0.19 mm long, a few on the dorsa of each of the abdominal somites I–VII; alveolus and articular membrane present in the second and third types. Head hairs short (0.054–0.08 mm); of two types: (1) simple and (2) bifid. Anterior surface of labrum with nine hairs and four small sensilla; ventral border with six projecting sensilla. Maxillary palp digitiform, with four apical and one lateral sensilla; galea digitiform with two apical sensilla. (Material studied: four damaged integuments from British Guiana.)

Subgenus **Myrmophyma** Forel**Camponotus (Myrmophyma) aeniopilosus** Mayr

Similar to *noveboracensis* except as follows: Praesaepium similar to that in *novogranadensis*. Body hairs of two types; (1) mostly 2 to 4-branched, 0.054–0.07 mm long, without alveolus and articular membrane; (2) on each somite are a few longer hairs (0.11–0.16 mm), which are simple, branched or denticulate and have aveoli and articular membranes. Head hairs more numerous, shorter (0.054–0.09 mm) and of three types: (1) simple, (2) denticulate, (3) 2 to 3-branched. Anterior surface of labrum with ten hairs and ten sensilla; ventral border with four projecting sensilla. Apical tooth of mandible more slender and nearly twice as long. Maxillary palp a frustum bearing four apical and one lateral sensilla; galea digitiform. (Material studied: three integuments from Queensland.)

Camponotus (Myrmophyma) claripes piperatus Wheeler

Wheeler (1933*b*) described a mermithergate of this ant and inferred that the ant larva had been parasitized by the nematode larva.

Subgenus **Myrmosphincta** Forel**Camponotus (Myrmosphincta) sexguttatus** (Fabricius)

Similar to *noveboracensis* except for the following details: Praesaepium similar to that in *novogranadensis*. Body hairs of six types: mostly (1) 2 to 4-branched, 0.036–0.054 mm long; a few (2) simple or (3) denticulate hairs which are 0.07–0.1 mm long; a few (4) simple or (5) denticulate hairs, 0.11–0.16 mm long, on thorax and abdominal somite I and VIII–X; (6) a few uncinuate hairs, 0.11–0.16 mm long, on abdominal somites II–VII; types (1), (2), and (3) do not have alveolus and articular membrane, the other types have these structures. Head hairs shorter (0.036–0.13 mm), of three types: (1) simple, (2) denticulate,

(3) 2 to 3-branched. Anterior surface of labrum with eight hairs and four small sensilla; ventral border with six projecting sensilla. Maxillary palp digitiform, with three apical and two lateral sensilla. (Material studied: numerous larvae from Puerto Rico, British Guiana and the Panama Canal Zone.)

Subgenus **Myrmothrix** Forel

Camponotus (Myrmothrix) abdominalis (Fabricius)

Similar to *noveboracensis* except in the following details: Praesaepium similar to that in *novogranadensis*. Body hairs of two types: (1) mostly 2- to 7-branched, about 0.07 mm long; (2) denticulate hairs, about half as numerous, 0.072–0.11 mm long; all without alveolus or articular membrane. Head hairs of two types: (1) mostly denticulate, 0.07–0.16 mm long; (2) about six 3 to 4-branched hairs, about 0.07 mm long. Anterior surface of labrum with ten hairs and eight sensilla; ventral border with six projecting sensilla. Maxillary palp digitiform, with three apical and two subapical sensilla; galea digitiform. (Material studied: several larvae from the Panama Canal Zone.)

Camponotus (Myrmothrix) abdominalis stercorarius Forel

Very similar to *abdominalis*, but with the body hairs slightly longer (0.07–0.18 mm) and the head hairs slightly shorter (0.05–0.11 mm) and somewhat more numerous. (Material studied: numerous larvae from Panama.)

Wheeler (1933b) described a mermithergate of this ant and inferred that the larva had been parasitized by the nematode larva.

Subgenus **Myrmotrema** Forel

Camponotus (Myrmotrema) foraminosus Forel

Similar to *noveboracensis* except as follows: Praesaepium similar to that of *novogranadensis*. Body hairs of three types; (1) mostly 2 to 4-branched, 0.054–0.07 mm long, without alveolus and articular membrane; (2) a few longer hairs (about 0.1 mm) on the thorax and abdominal somites VIII–X are simple or denticulate or branched; (3) the few one-hooked uncinata hairs on abdominal somites I–VII are 0.12–0.14 mm long; types (2) and (3) have alveolus and articular membrane. Head hairs more numerous and of three types: (1) simple, (2) denticulate and (3) branched. Anterior surface of labrum with about 11 hairs and two small sensilla; ventral border with six projecting sensilla. Maxillary palp digitiform, with four apical and one lateral sensilla; galea digitiform. (Material studied: three integuments; source unknown.)

Subgenus **Tanaemyrmex** Ashmead

Camponotus (Tanaemyrmex) sansabeanus (Buckley)

Similar to *noveboracensis* except in the following details: Praesaepium similar to that in *novogranadensis*. Body hairs of two types: (1) 2 to 4-branched, 0.09–0.11 mm long, without alveolus or articular membrane, the most numerous type; (2) a few 2 to 4-branched, 0.12–0.14 mm long, with alveolus and articular membrane. Entire integu-

ment spinulose, the spinules minute and in short transverse rows. Head hairs shorter (0.07–0.11 mm). Anterior surface of labrum with 11 hairs and six sensilla; ventral border with six projecting sensilla. Mandibles with the apical tooth distinctly narrower and longer. Maxillary palp with one projecting apical, three subapical and one lateral sensilla; galea digitiform. (Material studied: numerous larvae from Oklahoma.)

Camponotus (Tanaemyrmex) simillimus indianus Forel

Similar to *noveboracensis* except in the following details: Praesepium similar to that in *novogranadensis*. Body hairs of three types: (1) numerous, 2 to 4-branched, 0.07–0.11 mm long; (2) numerous, simple, 0.11–0.14 mm long; (3) few, denticulate, 0.11–0.19 mm long; alveolus and articular membrane are lacking except in the longer denticulate hairs. Head hairs of three types: (1) simple, (2) denticulate, (3) branched. Anterior surface of labrum with nine hairs and four sensilla; ventral border with six projecting sensilla. Maxillary palp digitiform, with two apical, two subapical and one lateral sensilla; galea digitiform. (Material studied: numerous larvae from the Panama Canal Zone.)

Camponotus (Tanaemyrmex) aegyptiacus Emery.

“Des mandibules relativement peu développées, des poils ramifiés sur la tête. L’orifice salivaire est bien visible. Sur le corps, poils ramifiés particuliers” (Athias-Henriot, 1947, pp. 251–252).

Camponotus (Tanaemyrmex) aethiops (Latreille)

Parker (1932) recorded this ant as the host of *Stilbula cynipiformis* Rossi in France. The eucharid larvae were parasitic on the ant larvae and pupae. An ant larva bearing a planidium is shown in side view in Fig. 1 on p. 3. This same eucharid has also been reported with these ants: *Camponotus marginatus* (Latreille) by Fahringer and Tolg, 1912, p. 250; *Camponotus maculatus sanctus* Forel by Fahringer, 1922; *Camponotus maculatus* F. in Dalmatia by Ruschka, 1924, p. 89. Probably all three are *aethiops*.

Camponotus (Tanaemyrmex) aethiops concava Forel

Menozi, 1936:—“Descrivo la larva adulta di questo *Camponotus*: Essa è di colore biancastro, col capo ocreo, le mandibole quasi del tutto testacee, eccettuato una porzione apicale più scura. Setole biancastre. La forma generale del corpo è subclaviforme, coi segmenti tutti distinti. Il capo visto di lato appare molto più alto che lungo. Guardato dorsalmente il cranio è ristretto in avanti, coi margini laterali subarrotondati e convergenti anteriormente, il margine posteriore è cubtroncato, la sua superficie è provvista di numerose setole distribuite come nella figura citata. Placchette antennali ovali, fornite, ciascuna, di tre sensilli. Il labbro superiore ha la forma di un semicerchio, rinforzato per ciascun lato, alla base, da un ispessimento fortemente chitinizzato, mentre al margine anteriore si trova un gruppo di tre grosse papille sporgenti oltre il margine stesso. Sulla superficie dorsale esso è provvisto di otto setole delle quali, due, poste ai lati ed a metà della linea mediana longitudinale, mentre le altre sei, divise in due

gruppi di tre setole, sono collocate immediatamente al disopra delle papille sopracitate; ventralmente ha diversi sensilli e numerose produzioni tegumentali spiniformi, i primi distribuiti lungo il margine anteriore, le altre in quasi tutta la superficie mediana e sublaterale. Le mandibole sono un poco più lunghe della loro larghezza prossimale, di forma triangolare, coll'apice subacuto e alquanto ricurvo verso l'interno; il margine masticatorio è tagliente e provvisto di una leggera prominenza odontoide posta alla base del terzo anteriore. Le mascelle hanno ognuna quattro setole, poste posteriormente ed ai lati dell'appendice distale mascellare e del palpo. Questi è un poco più breve e più sottile dell'appendice, del resto di forma simile a quest'ultima, ed entrambi forniti all'apice di tre sensilli placoidi. Il labbro inferiore è sempre più sporgente del labbro superiore e, come questo, ha forma semicircolare e fornito di due setole situate come si vede nella figura citata. I palpi labiali sono rappresentati ciascuno da un articolo subconico, molto più breve, ma più grosso, del palpo mascellare, e provvisti anch'essi all'apice di tre sensilli. Fra i palpi labiali, un poco più posteriormente ad essi, sorgono i due piccoli tubuli delle filiere. Tutto il corpo della larva ha una fitta pubescenza formata da peli bifidi, trifidi o, più raramente, quadrifidi. Sistema tracheale olopneustico con 10 paia di spiracoli. Lunghezza della larva adulta mm. 7, 3-7,8" (pp. 301-302). Fig. XVIII, p. 301; larva in side view; head in anterior view; branched hairs.

Camponotus (Tanaemyrmex) aethiops andria Forel

Menozi, 1936:—"Descrizione della larva adulta:—Forma, colore e pubescenza eguale a quella della larva del *C. aethiops* v. *concava*. Il cranio visto dal dorso presenta una forma pressapoco simile a quella della larva ora citata, con setole distribuite come appare nella figura XIX, 1. Le placchette antennali sono subtriangolari, più lunghe che larghe, ognuna con tre sensilli. Il labbro superiore visto ad un forte ingrandimento, appare di forma trapezoidale, coi lati subarrotondati e rinforzati, ciascuno, da un ispessimento chitinizzato del tutto simile a quello che si osserva nella larva del *C. aethiops* v. *concava*. Dorsalmente, in avanti, esso è fornito di 8 setole, due submediane, le altre sei sono divise in due gruppi di tre setole, distribuite fra la setola submediana e l'ispessimento chitinizzato. Dietro a ciascun gruppo di queste setole è posto un sensillo papilliforme, che non sono riuscito a rintracciare nella larva del *C. aethiops* v. *concava*, mentre in prossimità del margine anteriore del labbro, a ciascuno dei lati della linea mediana longitudinale, si trova un gruppo di tre sensilli placoidi. Ventralmente è provvisto delle solite formazioni tegumentali e di sensilli, e delle sei grosse papille, divise in due gruppi di tre, che sporgono oltre il margine anteriore. Le mandibole sono robuste, più lunghe che larghe col margine masticatorio, visto dal dorso, semplicemente tagliente e coll'apice ottuso e leggermente ricurvo verso l'interno; ventralmente, nella porzione mediana, esse presentano una serie di lamine chitinizzate, poste ad embrice, e delle quali alcune sporgono colla loro punta oltre il margine masticatorio inferiore, in modo che, viste dal dorso, si potrebbero dire armate da una serie di piccoli denti. Le mascelle hanno lo stipite terminato da un grosso mucrone il quale generalmente nella prepara-

zione in toto del capo rimane nascosto sotto il labbro inferiore: dorsalmente esse sono provviste di tre setole, mentre al ventre ne hanno un numero maggiore e distribuite come si vede nella figura citata. Il processo distale delle mascelle ed il palpo sono piuttosto gracili, il primo più lungo del secondo e forniti entrambi all'apice di tre sensilli. Il labbro inferiore è fortemente trasverso e provvisto di 8 setole, delle quali 6 sparse nella superficie centrale, ed una per ogni lato del margine anteriore. I palpi labiali sono subcilindrici, poco più lunghi che larghi e provvisti all'apice di tre sensilli, simili a quelli dei palpi mascellari. Tubi delle filiere di forma triangolare e connessi tra di loro da una sottile banderella sclerificata. Lunghezza della larva matura mm. 7, 5-8" (pp. 302-303). Fig. XIX, p. 303: head in anterior view; labrum in anterior view; mandible in posterior view; maxillae and labium in posterior view; labium in anterior view.

Camponotus (Tanaemyrmex) compressus foleyi Santschi

Athias-Henriot, 1947: internal anatomy—pp. 253, 254, 256, 260, 263, 264 and 266 and Fig. 4 on p. 262, "Surtout carnivore" (p. 260).

Camponotus (Tanaemyrmex) consobrinus Erichson

Wheeler (1933*b*) described mermithergates of this ant and inferred that the ant larvae had been parasitized by the nematode larvae.

Camponotus (Tanaemyrmex) fumidus vittata Forel

"Die älteren Larven sind von einem dichten Pelz verzweigter Haare bedeckt, der dem ersten Larvenstadium noch fehlt" (Eidmann, 1936, p. 93).

Camponotus (Tanaemyrmex) pompeius cassius Wheeler

Wheeler (1928*b* and 1929*b*) described a mermithergate of this ant and inferred that its larva had been parasitized by the nematode larva.

Camponotus (Tanaemyrmex) punctulatus minutior Forel

Wheeler (1929*b* and 1933*b*) described a mermithergate of this ant and inferred that its larva had been parasitized by the nematode larva.

Camponotus (Tanaemyrmex) sylvaticus barbaricus Emery

Athias-Henriot, 1947:—"Le corps de la larve est allongé et présente une courbure très accentuée au niveau du troisième segment thoracique, de sorte que la tête et une bonne partie du thorax sont repliées et appliquées contre la face ventrale de l'abdomen. La tête est bien différenciée, relativement volumineuse, massive. Les mandibules sont très développées. On peut y distinguer deux parties: [1] Une zone masticatrice incolore ou peu colorée, portant de fortes dents sur son bord interne. Ces dents sont émoussées, mais sont pourvues sur un côté de fines denticulations pectinées. [2] Le bord externe très épais, arqué, pointu, coloré en brun; il se sépare en deux branches insérées profondément dans la tête. Du niveau de la base de cette mandibule, de chaque côté, partent des lames chitineuses striées qui forment une voûte pharyngienne (épipharynx). Les maxilles sont des mamelons peu proéminents portant deux grands palpes. Le labium

porte l'orifice salivaire médian et deux petits palpes. Au niveau de la bouche, on voit des ornementations particulières, qui se continuent par le plancher du pharynx. C'est alors l'hypopharynx. Toute la tête porte des macrochètes simples, peu nombreux. Les anneaux thoraciques et abdominaux (7) sont bien visibles et séparés par des contractions. Tout le corps porte des macrochètes simples, nombreux, et le thorax, des macrochètes ramifiés" (pp. 250-251). Internal anatomy: pages 257, 260, 263 and 264, "Surtout carnivore" (p. 260).

Gantes, 1949:—"Ce sont de très grosses larves, dépassant 1 cm., mais les jeunes larves n'ont que 2 mm. L'aspect général du corps est celui de *Plagiolepis*, plus massif cependant que les trois précédents. Le corps est recouvert de poils ramifiés surtout, les poils simples sont plus rares: 1. *Poils ramifiés* mesurant 0 mm. 116; ils s'élèvent au-dessus de la peau par un tronc court et épais divisé en 2 ou 3 troncs secondaires qui à leur tour donnent des branches très fines à l'extrémité. Ces poils, vers le bout de l'abdomen, sont en rangs transversaux et longitudinaux. 2. *Poils simples*, raides, légèrement arqués, de 0 mm. 073, clairsemés sur tout le corps. La tête est massive, même forme que chez *Plagiolepis*, avec labre à un seul lobe qui porte huit poils dorsalement: trois presque vers le milieu et en avant et un en arrière pour chaque moitié. Ventralement sur le bord antérieur, on a six papilles sensorielles à une sensille chacune: au milieu sont les deux plus hautes et diminuent de chaque côté. Les mandibules sont grandes, 0 mm. 147: ce sont des triangles massifs dont la base s'insère dans la tête et l'apex se termine par une pointe émoussée; convexes extérieurement, légèrement creusées à la partie interne qui est garnie de dents émoussées en rangs verticaux. Les autres pièces buccales n'ont rien de particulier. La tête est recouverte de poils ramifiés dont le tronc principal s'élève plus haut avant de se diviser en quatre branches au plus. Ils mesurent 0 mm. 119. Chez une jeune larve, on trouve des *poils en crosse* de 0 mm. 161 de long, répartis dorsalement sur les segments abdominaux. Sur la tête on trouve des poils simples, très longs, 0 mm. 124, des poils bifurqués plus courts, 0 mm. 069. Les mandibules, de 0 mm. 064, sont très claires, plus massives et n'ont qu'une rangée de dents émoussées" (p. 78). Pl. II, fig. IV: labrum, mandible and hairs.

Genus *Calomyrmex* Emery

Cranium transversely subelliptical in anterior view. Antennae moderately large. Gula spinulose. Head hairs moderately long. Mandibles with numerous longitudinal ridges, some of which bear minute spinules. Maxillary palp a tall frustum; galea similar. Labial palp a low knob.

Calomyrmex albopilosus (Mayr)

Plate VI, figs. 1-6

Body shape probably as in *Camponotus s. str.* Praesaepium probably more like that of *C. (Myrmaphaenus) novogranadensis*. Body densely and uniformly covered with short hairs, except on the ventral surface of the thorax and abdominal somites I and II where they become sparse. Hairs of four types: (1) 1 to 7-branched, the simple hairs restricted

to the ventral surface of the thorax and abdominal somites I and II, length 0.09–0.13 mm, without alveolus and articular membrane, the most numerous type; (2) 2 to 4-branched, ~~hairs~~ about 0.13 mm long, a few on the thorax and abdominal somite I, with alveolus and articular membrane; (3) a few denticulate, about 0.2 mm long, on abdominal somites VII–X, with alveolus and articular membrane; (4) a few one-hooked unciniate hairs on abdominal somite II–VI, about 0.29 mm long, with alveolus and articular membrane. Integument of abdominal somite X and ventral surface of thorax and abdominal somites I and II spinulose, the spinules minute and in short transverse rows. Cranium transversely subelliptical in anterior view, breadth 1.5X the length; gula with short transverse rows of minute spinules. Head hairs numerous, moderately long (0.054–0.13 mm), mostly simple, a few 2-branched, with alveolus and articular membrane; naked area conspicuous in the form of an inverted V. Antennae with three sensilla each. Labrum subparabolic in anterior view; breadth (at base) 1.4X the length; anterior surface with eight simple hairs and four sensilla; ventral border with six slightly projecting sensilla; posterior surface spinulose, the spinules minute and arranged in rows which radiate from the dorsolateral angles, the rows continuous near the base but broken distally; posterior surface with about 20 sensilla; chilosclerites present. Mandibles rather small; moderately sclerotized; subtriangular in anterior view; basal third broad, somewhat thick and wedge-shaped; distal two-thirds thin and blade-like; apical tooth smooth, round-pointed and curved medially; lateral outline saddle-shaped; middle half of mesal border denticulate; anterior and posterior surfaces roughened with numerous longitudinal ridges, on some of which are mounted minute spinules. Maxillae swollen ventrolaterally; apex in the form of a cone which is directed medially; mesal surface spinulose, spinules minute and in short longitudinal rows; palp a tall frustum, with four apical and one lateral sensilla; galea a taller frustum with two apical sensilla. Labium with the anterior surface spinulose, the spinules minute and in short transverse rows; palp a low peg, with five sensilla; opening of sericteries wide and salient, with two projections. Hypopharynx densely spinulose, the spinules arranged in subtransverse rows, the rows grouped in two subtriangles which have their bases near the middle. (Material studied: three damaged integuments from Queensland.)

Calomyrmex splendidus purpureus (Mayr)

Brues (1934, p. 207) recorded *Schizaspidia calomyrmecis* Brues "still enclosed in the cocoon" of this ant from West Australia; the eucharid larvae were probably parasitic on the ant larvae.

Genus **Dendromyrmex** Emery

Uncinate hairs lacking. Cranium transversely subelliptical in anterior view. Antennae small. Head hairs moderately long. Mandibles with numerous longitudinal and transverse ridges, some of which bear minute spinules. Maxillary palp a tall frustum; galea finger-like. Labial palp a skewed peg.

Dendromyrmex fabricii pictus Wheeler

Plate VI, figs. 7-11

Body-shape probably as in *Camponotus s. str.* Praesaepium probably more like that of *C. (Myrmaphaenus) novogranadensis*. Body densely and uniformly covered with short hairs except on the ventral surface of the thorax and abdominal somites I and II where they become sparse. Hairs of three types: (1) 2 to 4-branched, 0.09-0.13 mm long, without alveolus or articular membrane, the most numerous type; (2) a few 2-branched hairs on each thoracic somite, about 0.11 mm long, with alveolus and articular membrane; (3) a few simple slightly curved hairs on each abdominal somite, about 0.14 mm long, with alveolus and articular membrane. Integument of the posterior abdominal somites and of the ventral surface of the thorax and abdominal somites I and II with minute spinules in short transverse rows. Cranium transversely subelliptical, breadth 1.4X the length. Head hairs numerous, moderately long (0.054-0.14 mm), mostly denticulate, a few branched; with alveolus and articular membrane; naked area conspicuous in the form of an inverted V. Antennae small, each mounted on a low convexity and bearing three sensilla. Labrum sub-parabolic in anterior view; breadth (at base) 1.5x the length; anterior surface with seven simple hairs and eight small sensilla; ventral border with six projecting sensilla; posterior surface spinulose, the spinules minute and in rows which radiate from the dorsolateral angles, the rows continuous near the base but broken distally; posterior surface with about 20 sensilla; chiloscleres present. Mandibles rather small and moderately sclerotized; basal third somewhat thick and wedge-shaped; distal two-thirds thin and blade-like; apical tooth short, smooth, round-pointed and curved medially; lateral outline saddle-shaped; middle half of mesal border denticulate; anterior and posterior surfaces with numerous longitudinal and subtransverse ridges, some of which bear minute spinules. Maxillae swollen ventrolaterally; apex in the form of a cone which is directed medially; mesal surface spinulose,

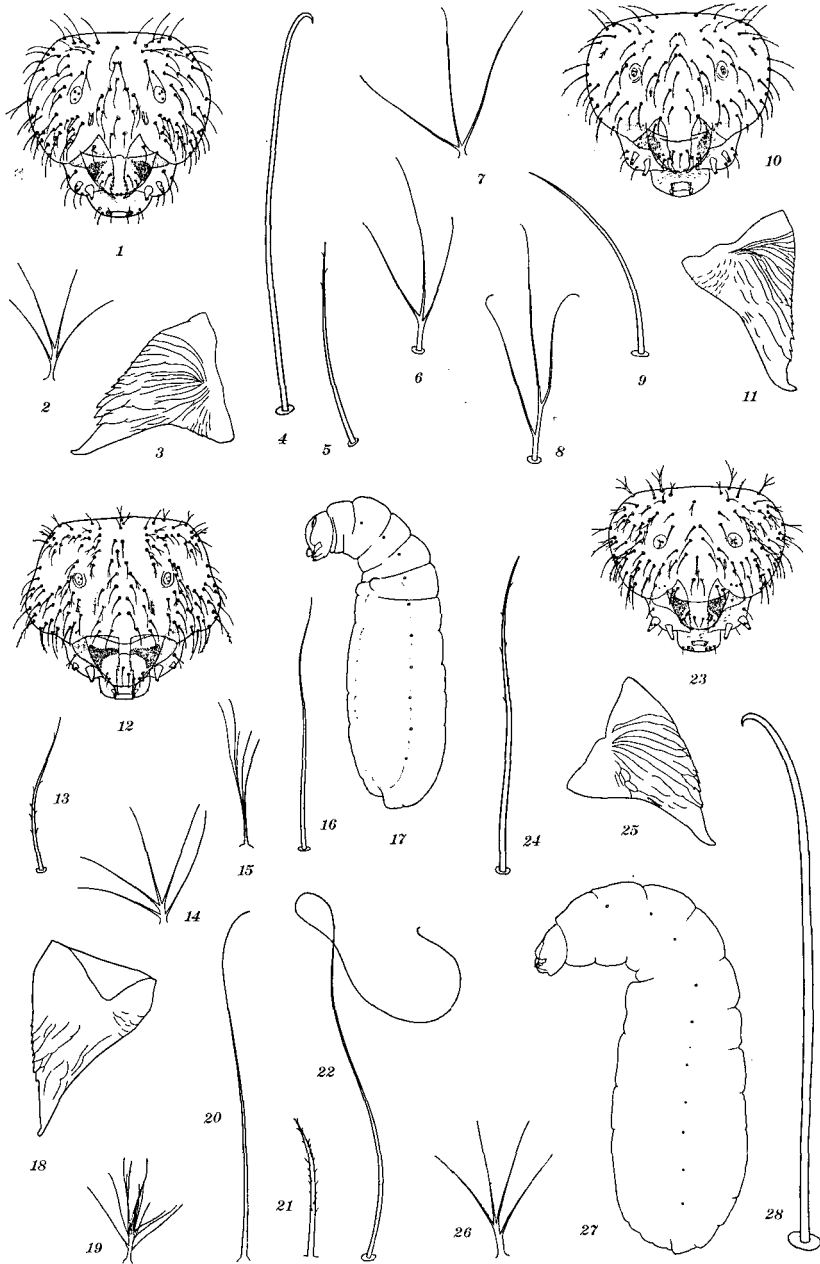
EXPLANATION OF PLATE VI

Calomyrmex albopilosus (Mayr). FIG. 1. Head in anterior view, $\times 40$. FIG. 2. Branched body hair, $\times 185$. FIG. 3. Left mandible in anterior view, $\times 118$. FIGS. 4-6. Three body hairs with alveolus and articular membrane, $\times 185$.

Dendromyrmex fabricii pictus Wheeler. FIG. 7. Branched body hair, $\times 235$. FIGS. 8 and 9. Two body hairs with alveolus and articular membrane, $\times 235$. FIG. 10. Head in anterior view, $\times 40$. FIG. 11. Right mandible in anterior view, $\times 118$.

Polyrhachis (Chariomyrma) hookeri Lowne. FIG. 12. Head in anterior view, $\times 44$. FIG. 13. Denticulate hair, $\times 185$. FIG. 14. Branched body hair, $\times 185$. FIG. 15. The same in edge view, $\times 185$. FIG. 16. Simple body hair, $\times 185$. FIG. 17. Larva in side view (hairs omitted), $\times 10$. FIG. 18. Left mandible in anterior view, $\times 118$.

Polyrhachis (Myrma) gagates F. Smith. FIGS. 19-22. Four body hairs, $\times 95$. *Echinopla* sp. FIG. 23. Head in anterior view, $\times 36$. FIG. 24. Denticulate body hair, $\times 235$. FIG. 25. Right mandible in anterior view, $\times 118$. FIG. 26. Branched body hair, $\times 235$; FIG. 27. Larva in side view (hairs omitted), $\times 10$. FIG. 28. Uncinate body hair, $\times 235$.



the spinules minute and in short longitudinal rows; palp an elongate frustum, with two apical, two subapical and one lateral sensilla; galea finger-like, with two apical sensilla. Labium with anterior and posterior surfaces roughened with short transverse rows of minute spinules; palp a skewed peg bearing four apical and one lateral sensilla; opening of sericteries wide and salient, with two projections. Hypopharynx densely spinulose, the spinules minute and arranged in subtransverse rows, the rows grouped in two subtriangles which have their bases near the middle. (Material studied: three damaged integuments from Brazil.)

Genus *Echinopla* F. Smith

Abdomen (except somite I) subellipsoidal and rather stout; diameter greatest at the sixth abdominal somite; tapering but slightly toward the anterior end and more rapidly toward the posterior end. Anus terminal with a conspicuous posterior lip. Cranium subtrapezoidal in anterior view, narrowed below, with the dorsal angles broadly rounded. Antennae small. Head hairs rather short. Mandibles with numerous longitudinal ridges, some of which bear minute spinules. Maxillary palp a slender subcone, as long as the galea, which is finger-like. Labial palp a short peg.

Echinopla sp.

Plate VI, figs. 23-28

Thorax and first abdominal somite forming a short stout neck, which is sharply marked off from the rest of the abdomen and which is strongly curved ventrally. Rest of abdomen subellipsoidal and rather stout; diameter greatest at the sixth abdominal somite; tapering but slightly toward the anterior end and more rapidly toward the posterior end. Praesaepium well developed and apparently permanent; the posterior half of abdominal somite II is raised to form a transverse welt and, on either side, ridges extend forward from this welt to form the sides of the praesaepium. The floor of the praesaepium (and also the ventral surface of the first abdominal somite and of the thorax) is furnished with short transverse rows of minute spinules. Posterior end rounded; anus terminal, with a conspicuous posterior lip. Thirteen differentiated somites. Body densely and uniformly covered with short hairs, except on the ventral surface of the thorax and abdominal somites I and II where they become sparse. Hairs of three types: (1) 4 to 6-branched, 0.09-0.12 mm long, without alveolus and articular membrane, the most abundant type; (2) denticulate, 0.11-0.19 mm long, with alveolus and articular membrane, most numerous on the prothorax and abdominal somites VIII-X; (3) long (about 0.3 mm) one-hooked uncinat hairs, with alveolus and articular membrane, a few each on the dorsal and lateral surfaces of abdominal somites II-V. Cranium subtrapezoidal in anterior view but with the dorsal angles broadly rounded; narrowed ventrally; breadth 1.4X the length. Head hairs rather short (0.054-0.11 mm); numerous; of three types-(1) simple, (2) denticulate, (3) 2 to 4-branched; alveolus and articular membrane present. Antennae small, mounted on low convexities,

with three sensilla each. Labrum subparabolic in anterior view; anterior surface with seven short simple hairs and six sensilla; ventral border with six projecting sensilla; posterior surface spinulose, the spinules minute and arranged in rows which radiate from the dorso-lateral angles, the rows continuous near the base but broken distally; posterior surface with about 20 sensilla; chiloscleres present. Mandibles rather small; moderately sclerotized; subtriangular in anterior view; basal third broad, somewhat thick; distal two-thirds thin, blade-like and slightly curved anteriorly; apical tooth smooth round-pointed and curved medially; lateral outline saddle-shaped; middle half of mesal border denticulate; anterior and posterior surfaces with longitudinal ridges, some of which bear minute spinules. Maxillae swollen ventrolaterally; apex in the form of a cone which is directed medially; mesal surface with minute spinules in longitudinal rows; palp a slender subcone as long as the galea, with two apical and three lateral sensilla; galea digitiform, with two apical sensilla. Labium with the anterior surface spinulose, the spinules minute and in short transverse rows; palp a short peg bearing five sensilla. Hypopharynx densely spinulose, the spinules arranged in subtransverse rows, the rows grouped in two subtriangles which have their bases near the middle. (Material studied; 12 larvae labelled "Lampongs, Wai Lima, S. Sumatra, Karny & Siebers.")

Genus *Polyrhachis* F. Smith

Cranium subtrapezoidal in anterior view, narrowed above. Antennae small. Gula spinulose. Head hairs moderately long. Mandibles with only a few longitudinal ridges, some of which bear minute spinules. Maxillary palp a stout-based skewed peg; galea a tall frustum. Labial palp a low knob.

Bischoff (1927, p. 303) and Brun (1924, p. 57) referred briefly to the employment of larvae in producing the silk used in the construction of the nest.

Emery, 1925:—"En général, les *Polyrhachis* construisent leurs nids dans le feuillage des arbres, quelques espèces dans la terre ou dans les tronc morts. La soie filée par les larves est un élément essentiel dans leur confection, soit pour assembler les feuilles dont est composé le volumineux nid multiloculaire de *P. dives*, . . . soit pour servir de trame à des nids petits et uniloculaires de nombreuses espèces, qui sont construits sur ou sous les feuilles. . . *P. simplex*. . . tapisse de soie une cavité souterraine" (p. 176). See also above under the subfamily.

Karawaiew, 1929, pp. 254-5:—"Der Grad der Entwicklung der Spinndrüsen bei den *Polyrhachis*-Arten gibt uns meines Erachtens in sämtlichen untersuchten Fällen einen tatsächlichen indirekten Beweis, dass es wirklich Weberameisen sind, hätten wir in den einzelnen Fällen auch nicht direkte Beobachtungen."

Wheeler, 1915:—"The larvae of the subgenus *Cyrtomyrma* "though actively sericparous in the construction of the nest, no longer spin a pupal envelope." (p. 331). In *Polyrhachis* "(excepting the species of *Cyrtomyrma*) more mature larvae are used as shuttles and the cocoon-spinning instincts have not been suppressed" (p. 333).

Subgenus **Chariomyrma** Forel**Polyrhachis (Chariomyrma) hookeri** Lowne

Plate VI, figs. 12-18

Thorax and first abdominal somite forming a short stout neck, which is sharply marked off from the rest of the abdomen and which is strongly curved ventrally. Rest of the abdomen elongate-subellipsoidal; diameter greatest at the fifth and sixth abdominal somites, decreasing but slightly toward either end. Adjacent to the head the prothorax bears a ventral swelling. Lateral longitudinal welts feebly developed. Praesaepium well developed and apparently permanent; the posterior half of abdominal somite II is raised to form a transverse welt and, on either side, ridges extend forward from this welt to form the sides of the praesaepium. The floor of the praesaepium (and also the whole integument of abdominal somite X and the ventral surface of the thorax) densely spinulose, the spinules minute and in transverse rows. Anus subterminal with a conspicuous posterior lip. Leg vestiges present. Eight to 13 differentiated somites. Body densely and uniformly covered with short hairs, except on the ventral surface of the thorax and abdominal somites I and II where they become sparse. Hairs of three types: (1) 2 to 6-branched, about 0.08 mm long, the branches whip-like, without alveolus and articular membrane, the most abundant type; (2) denticulate, about 0.11 mm long, with alveolus and articular membrane; (3) a few simple hairs about 0.13 mm long, on the ventral surface of the thorax and abdominal somites I and II, with alveolus and articular membrane. Head subtrapezoidal in anterior view, narrowed above, maximum breadth about 1.4X the length; frons bulging. Head hairs numerous, moderately long (0.07-0.11 mm), of three types: (1) simple, (2) denticulate and (3) 2 to 4-branched; with alveolus and articular membrane; naked area conspicuous, in the form of an inverted V. Antennae small, each mounted on a drumlin-shaped convexity and bearing three (rarely four) sensilla. Labrum subparabolic in anterior view; anterior surface with eight short simple hairs and about four sensilla; ventral border with six projecting sensilla; posterior surface spinulose, the spinules minute and arranged in rows which radiate from the dorsolateral angles, the rows continuous near the base but broken distally; posterior surface with about 30 sensilla; chiloscleres present. Mandibles moderately sclerotized; subtriangular in anterior view; basal third broad and somewhat thick, distal two-thirds thin, blade-like and slightly curved anteriorly; apical tooth small, smooth, round-pointed and curved medially; lateral outline sinuous, not saddle-shaped; middle half of mesal border denticulate; anterior and posterior surfaces with a few longitudinal ridges, some of which are spinulose. Maxillae swollen ventrolaterally; apex in the form of a cone which is directed medially; all surfaces (except the lateral) roughened with short rows of minute spinules; palp a frustum, with four apical and one lateral sensilla; galea a tall frustum, with two apical sensilla. Labium with all surfaces sparsely spinulose, the spinules minute and in short transverse rows; palp a low knob bearing five sensilla; opening of sericteries wide and salient, with two projections. Hypopharynx densely spinulose, the

spinules arranged in subtransverse rows, the rows grouped in two subtriangles which have their bases near the middle. (Material studied: five larvae and six damaged integuments from New South Wales.)

Polyrhachis (Chariomyrma) jerdoni Forel

Forel (1923, p. 99 = 1928, Vol. II, p. 281) stated that the larvae were used in weaving the nest.

Subgenus **Campomyrma** Wheeler

Polyrhachis (Campomyrma) femorata F. Smith

Apparently similar to *hookeri* except in the following particulars:—Body hairs slightly longer. Anterior surface of labrum with about 14 hairs and six sensilla; posterior surface with about 25 sensilla. Apical tooth of mandible wider and blunter. (Material studied: eight damaged integuments from New South Wales.)

Subgenus **Myrma** Billberg

Polyrhachis (Myrma) gagates F. Smith

Plate VI, figs. 19-22

Apparently similar to *hookeri* except in the following details:—Body hairs of four types: (1) 5 to 12-branched, 0.11–0.15 mm long; (2) denticulate, 0.18–0.3 mm long, the most numerous type; (3) whip-like hairs, about 0.5 mm long, a few on the ventral surface of the thorax and abdominal somites I and II; (4) very long (about 1.0 mm) whip-like hairs on the dorsa of some somites. Entire integument spinulose, the spinules minute and in short transverse rows. Head hairs longer and all denticulate. Anterior surface of labrum with 14 hairs and ten sensilla. Apical tooth of mandible shorter, wider and blunter. (Material studied: four damaged integuments from the Congo.)

Polyrhachis (Myrma) laboriosa F. Smith

Similar to *hookeri* except in the following details:—Body hairs of four types: (1) 12-branched, 0.05–0.1 mm long, the most abundant type; (2) denticulate hairs, 0.05–0.2 mm long, shortest in the middle of the body; (3) a few whip-like hairs on the ventral surface of the thorax and abdominal somites I and II, 0.11–0.35 mm long; (4) a few whip-like hairs on the dorsa of each of abdominal somites II–VI, about 0.9 mm long. Anterior surface of labrum with 12 hairs and ten sensilla. Apical tooth of mandible shorter, wider and blunter. (Material studied: two larvae from the Congo.)

Polyrhachis (Myrma) militaris cupreopubescens Forel

Apparently similar to *hookeri* except in the following details:—Body hairs of four types: (1) 5 to 12-branched, 0.075–0.15 mm long; (2) denticulate, 0.15–0.26 mm long; (3) whip-like hairs, about 0.23 mm long, a few on the ventral surface of the thorax and abdominal somites I and II; (4) whip-like hairs, about 1.0 mm long, a few each on the dorsal surface of abdominal somites II–VII. Head hairs all long (0.11–0.21 mm) and denticulate. Anterior surface of labrum

with 16 hairs and four sensilla; ventral border with four projecting sensilla. (Material studied: four damaged integuments from the Congo.)

Subgenus **Myrmatopa** Forel

Polyrhachis (Myrmatopa) sp.

Similar to *hookeri* except in the following details:—Body hairs sparser, of four types: (1) simple, 0.036–0.11 mm, fairly uniformly distributed except on the ventral surface of the thorax and abdominal somites I and II, without alveolus and articular membrane; the most abundant type; (2) simple, a few on each somite, about 0.09 mm long, with alveolus and articular membrane; (3) denticulate, about 0.054 mm long, a few on abdominal somites VIII–X, with alveolus and articular membrane; (4) one-hooked uncinuate hairs, about 0.15 mm long, a few each on abdominal somites V–VII, with alveolus and articular membrane. Head hairs simple, fewer and shorter (0.035–0.09 mm). Labrum with ten hairs and ten sensilla on the anterior surface. Mandibles with a wider and blunter apical tooth. (Material studied: 12 larvae from the Philippine Islands).

Young larva:—Length 2 mm. The five anterior somites have nearly the same diameter; rest of abdomen slightly swollen. Anus ventral. Head wider than prothorax. Body hairs short, moderately numerous on the thorax and first two abdominal somites, sparse elsewhere. Hairs of three types: (1) short (0.009–0.054 mm) simple spikes, without alveolus and articular membrane, the most abundant type; (2) simple spikes, about 0.07 mm long, with alveolus and articular membrane, a few on each somite; (3) one-hooked uncinuate hairs, about 0.11–0.14 mm long, with alveolus and articular membrane, a few each on the dorsa of abdominal somites III–IX. Integument of ventral surface of thorax and first two abdominal somites and the dorsal surface of abdominal somites VIII–X spinulose, the spinules minute and in short transverse rows. Labrum with the chiloscleres feebly developed. Opening of sericteries represented by two rounded knobs.

Polyrhachis (Myrmatopa) schang Forel

Karawaiew has figured (1929, Fig. 1 on p. 253) a profile enclosing the spinning glands of what he calls var. *parvicella*; the glands are described on page 252.

Subgenus **Myrmhopla** Forel

Polyrhachis (Myrmhopla) dives F. Smith

Similar to *hookeri* except as follows:—Body hairs of four types: (1) denticulate, 0.054–0.09 mm long, with rather long side branches, without alveolus and articular membrane, the most abundant type; (2) denticulate, 0.11–0.18 mm long, with alveolus and articular membrane, a few on each somite; (3) one-hooked uncinuate hairs about 0.28 mm long, with alveolus and articular membrane, a few on the eighth abdominal somite; (4) simple hairs, 0.09–0.25 mm long, with alveolus and articular membrane, a few on the venter of the thorax and abdominal somites I–III. Head subrectangular in anterior view. Head hairs of

two types: (1) simple and (2) denticulate. Anterior surface of labrum with ten hairs and ten sensilla; ventral border with four projecting sensilla; posterior surface with about 16 sensilla. Apical tooth of mandible longer and wider. (Material studied: five integuments from China.)

Young larva.—Length 0.4 mm. Body hairs of three types: (1) 2 to 5-branched hairs, 0.018–0.054 mm long, most numerous on the thorax, fewer on the abdomen, none on abdominal somites VIII–X; (2) whip-like hairs, 0.036–0.18 mm long, most abundant and longest on the dorsa of abdominal somites II–VI; (3) one-hooked uncinata hairs, 0.09–0.18 mm long, on all somites, but most numerous on the thorax and abdominal somites V–X. Labrum with ten hairs and four sensilla on anterior surface. Mandible with apical tooth vestigial. Opening of sericteries represented by a pair of low swellings.

As in *Oecophylla*, the larvae of this species are used as shuttles to furnish the silk for weaving the nests and the shelters for Homoptera (*Nebennester*). This habit was first reported by Jacobson and Wasmann (1905) and was referred to again by Jacobson (1907, p. 36), by Emery (1925, p. 176) and by Forel (1923, p. 101 = 1928, Vol. II, p. 283).

Forel and Jacobson (1909).—The nest entrances were closed at night by silken webs spun by the larvae (p. 237). The larvae of *Oecophylla smargdina* were passive; the worker applied the larval mouth parts to the point where the thread was to be attached. When the worker of *dives* held a larva in its mandibles, the head of the latter was alternately protruded and retracted; consequently the worker held the larva near the point to which the thread was to be attached (p. 238).

Karawaiew (1929) (Fig. 8 on p. 255): a profile enclosing the spinning glands of what he called var. *rectispina*; the glands were discussed on page 254.

Wheeler, G. C. & E. H. 1924.—Two females of the eucharid *Schizaspidia polyrhachicida* G. C. & E. H. Wheeler were found in a cocoon of this ant from the Philippine Islands; presumably the eucharid larvae had been parasitic on the ant larva.

(*Polyrhachis* (*Myrmhopla*) *armata* (LeGuillou))

Karawaiew figured (1929, Fig. 2 on p. 253) a profile enclosing spinning glands; the glands were discussed on page 252.

Polyrhachis (*Myrmhopla*) *muelleri* Forel

Karawaiew, 1906:—"Von den jüngsten Larven dieser Ameise besass ich eine von $5\frac{1}{2}$ mm Länge und eine andere von ungefähr $6\frac{1}{2}$ mm. Erstere. . . gehört zu dem orthognathen Typus, ist sichelförmig gebogen und besitzt. . . 13 deutlich abgegrenzte Segmente. . . Wir sehen dass die Mundteile im allgemeinen sehr schwach ausgebildet sind; stärker ausgebildet sind nur die zahnartigen, dunkelbraun aussehenden Mandibeln. . . Die übrigen Mundteile glaube ich deuten zu müssen als Oberlippe. Maxillen, Seitenteile der Unterlippe mit je einem Paar stumpfer Warzen und Zunge. Die Haut der Larve ist mit kleinen Härchen dicht bedeckt, welche am Ende je 2–4 haarförmige Verzweigungen abgeben. Ausser diesen Härchen gibt es aber auf der Rückenseite noch spärlichere, unregelmässige zerstreute längere

und dickere etwas wellenartig verlaufende Hafthaare deren Ende wie ein Hammelhorn eingerollt ist" (p. 371). Fig. 4, larva in side view; Fig. 5, head in side view; Fig. 6, head in anterior view; Fig. 7, mandibles and labrum in anterior view; Fig. 8, body hairs. The salivary glands are described (p. 373) and figured (Fig. 10, repeated by Wheeler, 1910 as Fig. 124A on p. 222) and referred to by Karawaiew in 1929 (p. 253).

Polyrhachis (Myrmhopla) sexspinosa (Latreille)

Karawaiew figured (1929, Fig. 3 on p. 253) a profile enclosing spinning glands; the glands were described on page 253.

Polyrhachis (Myrmhopla) simplex Mayr

The larvae are used in nest-weaving just as in *Oecophylla*. A good account of this behavior was given by Lefroy and Howlett (1909, p. 232; copied by Dutt, 1912, p. 266). Hingston (1923, pp. 98-103) has written a long and interesting account of the use of larvae in the construction of byres; "the pointed head of the larva is made to project in front; it is very flexible and no doubt sensitive too, and it bends and turns to affix the thread wherever the worker may require" (p. 99).

Lefroy and Howlett, 1909, Fig. 129 on p. 226, a larva in side view; repeated by Lefroy, 1923, Fig. 178 on p. 525.

Polyrhachis (Myrmhopla) tibialis F. Smith

Karawaiew figured (1929, fig. 6 on p. 254) a profile enclosing spinning glands of what he calls var. *orientalis*; the glands are discussed on page 254.

Polyrhachis (Myrmhopla) wheeleri Mann

"When the first larvae are hatched, the mother uses their spinning abilities to line the nest with silk" (Mann, 1948, p. 306).

Subgenus **Myrmothrinax** Forel

Polyrhachis (Myrmothrinax) frauenfeldi Mayr

Karawaiew has figured (1929, Fig. 4 on p. 254) a profile containing the spinning glands; the glands are described on page 253.

Subgenus **Polyrhachis** F. Smith

Polyrhachis (Polyrhachis) lamellidens F. Smith

Yano, 1911:—"Larva long. Short hairs all over the body, growing in two rows on each somite. Hooked hairs about three times as long as the short hairs. Dorsal surface of thorax hairy. When young the larvae have very few hooked hairs. These are of use in hanging the larvae to the walls of the nest and also in attaching them in the cocoon" (p. 251, translated from the Japanese). Fig. 12, a larva in side view.

Subgenus?

Polyrhachis (subgenus?) *mystica* Karawaiew and *P.* (subgenus?) *tubifex* Karawaiew.—Karawaiew (1929) has figured profiles enclosing spinning glands (Figs. 7 and 5); the glands are described on pages 254 and 253.

DISCUSSION

The larvae of the Formicinae do not constitute a homogeneous group as do the larvae of certain other groups, for example, the Dorylinae, the Cerapachyinae, the Dolichoderinae and the Attini. This is perhaps to be expected since they are a much larger group. No character is distinctive, nor even any small group of characters. Our characterization of the subfamily includes numerous characters and many of these involve alternatives. Even then several exceptional genera are not covered.

With respect to degrees of specialization formicine larvae may be grouped thus:—

I. Melophorini—the most generalized; resembling closely the ponerine Ectatomma.

II. Plagiolepidini, Gesomyrmicini, Gigantiopini, Formicini—intermediate.

III. Camponotini—the most specialized as to elaboration of structure.

IV. Brachymyrmicini, Prenolepidini—transitional from II to V; the body shape is dolichoderine, but otherwise the anatomy is formicine.

V. Myrmelachistini, Oecophyllini—the most specialized by reduction; closely resembling the dolichoderines.

On the basis of larval characters, then, the following phylogenetic hypothesis might be justified. The Formicinae arose through the Melophorini from the ponerine Ectatommini. The main stem led through (or near) the Plagiolepidini, Gesomyrmicini, Gigantiopini and Formicini to the Camponotini. Side branches might lead through (or near) the Brachymyrmicini and Prenolepidini to the Myrmelachistini. The Oecophyllini should probably be placed on a spur all by themselves.

We have found it possible (but not always easy) to characterize the tribes, as is evidenced by our key. Of all the groups of ant larvae that we have studied the tribe Camponotini is perhaps the easiest to characterize, partly because it is homogeneous and partly because it has three unique characters which are easily seen: body shape, the chiloscleres and the praesaepium.

Genera likewise are easily defined and differentiated, except in the Camponotini. In this tribe the genera are so similar that we cannot differentiate them; hence they do not appear in our key.

Although we have studied large numbers of species in certain genera (*Formica*, *Lasius*, *Camponotus*) we do not deem it feasible to differentiate species. Before attempting such differentiation we would need more species and more material in each species. Then the study of only one large genus would require more time than we have devoted here to the entire subfamily. We might point out, however, that we have not found in the Formicinae any cases of congeneric species separated by characters of generic magnitude, such as we found in the Attini and Ponerinae.

SUMMARY

The larvae of 64 species in 18 genera are described and illustrated; all known references to formicine larvae in the literature are cited, bringing the total considered up to 117 species in 23 genera. A bibliography is appended. The larvae of the Formicinae do not constitute a homogeneous group and consequently are difficult to characterize as a subfamily. Tribes and genera (except in the Camponotini) are relatively easy to distinguish and define. In general, larval taxonomy parallels rather closely adult taxonomy. *Melophorus* is the most primitive genus and resembles rather closely the ponerine genus *Ectatomma*. The Camponotini are the most specialized, although *Myrmelachista* and *Oecophylla* are highly specialized by reduction.

A BIBLIOGRAPHY OF THE LARVAE OF THE FORMICINAE

- Adlerz, G.** 1886. Myrmecologiska Studier II. Svenska Myror och deras Lefnadsförhållanden. Bihang till K. Svenska Vet.-Akad. Handl., 11: 1-329, 7 pls.
- Athias-Henriot, C.** 1947. Recherches sur les larves de quelques fourmis d'Algérie. Bull. Biol. France Belgique 81: 247-272, 5 figs.
- Bedel, M. L.** 1895. [The hosts of *Chalcidura bedeli*.] Bull. Soc. Entom. France 64: xxxv-xxxvi.
- Berlese, A.** 1909. Gli insetti, Vol. I. x+1004 pp., 10 pls., 1292 figs. Milano: Società Editrice Libreria.
1925. Gli insetti, Vol. II. ix+992 pp., 7 pls., 895 text figs. Milano: Società Editrice Libreria.
- Bernard, F.** 1948. Les insectes sociaux du Fezzân. Comportement et biogéographie. Inst. Rech. Sahariennes Univ. d'Alger. Mission Sci. du Fezzân 1944-1945. V. Zoologie (Arthropodes, 1): 86-201, 2 pls., 10 text figs.
- Bischoff, H.** 1927. Biologie der Hymenopteren: eine Naturgeschichte der Hautflügler. viii+598 pp., 244 figs. Berlin: Julius Springer.
- Brues, C. T.** 1934. Some new eucharidid parasites of Australian ants. Bull. Brooklyn Entom. Soc. 29: 201-207, 3 figs.
- Brun, R.** 1924. Das Leben der Ameisen. 211 pp., 60 figs. Leipzig & Berlin: B. G. Teubner.
- Buchsbaum, R.** 1948. Animals without backbones. (Rev. ed.) xiii+405 pp., illus. Chicago: Univ. Chicago Press.
- Bugnion, E.** 1909. La fourmi rouge de Ceylan (*Oecophylla smaragdina*). Arch. Sci. Phys. et Nat. (Genève) 28: 511-513, 3 figs. (Reprinted: C. R. Soc. Helvétique Sci. Nat. 92. Session: 105-107, 3 figs. 1909.)
1923. La fourmi fileuse de Ceylan (*Oecophylla smaragdina* F., sous-fam. Camponotinae For.). Riviera Scientifique 10: 17-32, 3 figs.
1924. L'*Oecophylla* de Ceylan (*Oecophylla smaragdina* F., sous-fam. Camponotinae For.). Bull. Soc. Zool. France 49: 422-457, 13 figs.
- Bünzli, G. H.** 1935. Untersuchungen über coxiphile Ameisen aus dem Kaffeefeldern von Surinam. Mitt. Schweiz. Entom. Ges. 16: 453-593, 50 figs.
- Chun, C.** 1903. Aus den Tiefen des Weltmeeres (2 ed.). ix+592 pp., illus. Jena: Gustav Fischer.
- Clausen, C. P.** 1923. The biology of *Schizaspidia tenuicornis* Ashm., a eucharidid parasite of Camponotus. Ann. Entom. Soc. Amer. 16: 195-217, 2 pls.
1940. Entomophagous insects. x+688 pp., 257 figs. New York: McGraw-Hill Book Co., Inc.
1941. The habits of the Eucharidae. Psyche 48: 57-69.
- Dahl, F.** 1901. Das Leben der Ameisen im Bismarck-Archipel, nach eigenen Beobachtungen vergleichend dargestellt. Mitt. Zool. Mus. Berlin 2, 1: 1-69, 1 pl.
- Dewitz, H.** 1878. Beiträge zur postembryonalen Gliedmassenbildung bei den Insecten. Zeitschr. Wiss. Zool. 30: suppl. 78-105.
- De Geer, K.** 1778. Mémoires pour servir à l'histoire des insectes 7.

- Dodd, F. P.** 1902a. Notes on the Queensland green tree ants (*Oecophylla smaragdina*, Fab. ?). Victorian Nat. 18: 136-140.
 1902b. Contribution to the life history of *Liphyras brassolis*, Westw. Entom. 35: 153-156.
 1906. Notes upon some remarkable parasitic insects from North Queensland. With an appendix containing descriptions of new species by Col. Chas. T. Bingham and Dr. Benno Wandolleck. Trans. Entom. Soc. London: pp. 119-132, 2 figs.
 1928. The green tree-ants of tropical Australia. Victorian Nat. 45: 124-132, 1 pl.
- Doflein, F.** 1905. Beobachtungen an den Weberameisen (*Oecophylla smaragdina*). Biol. Centralbl. 25: 497-507, 5 figs.
 1906. Ostasienfahrt. Leipzig & Berlin: Teubner.
- Donisthorpe, H.** 1915. British ants, their life-history and classification. xv+379 pp., 18 pls., 92 text figs. Plymouth: Wm. Brendon & Son, Ltd.
 1927a. British ants, their life-history and classification (2 ed.). xv+436 pp., 18 pls., 93 text figs. London: George Routledge & Sons, Ltd.
 1927b. The guests of British ants, their habits and life-histories. xxiii+244 pp., 16 pls., 55 text figs. London: George Routledge & Sons, Ltd.
- Dutt, G. R.** 1912. Life histories of Indian insects. Mem. Dept. Agric. India, Entom. Ser. 4: 183-267, 4 pls., 22 text figs.
- Eidmann, H.** 1926. Die Koloniegründung der einheimischen Ameisen. Zeitschr. Vergl. Physiol. 3: 776-826, 15 figs.
 1928a. Zur Kenntnis der Biologie der Rossameise (*Camponotus herculeanus* L.). Zeitschr. Angew. Entom. 14: 229-253, 9 figs.
 1928b. Weitere Beobachtungen über die Koloniegründung einheimischer Ameisen. Zeitschr. Vergl. Physiol. 7: 39-55, 2 figs.
 1929. Die Koloniegründung von *Formica fusca* L. nebst Untersuchungen über den Brutpflegeinstinkt von *Formica rufa* L. Zool. Anz. 82: 99-114, 3 figs.
 1936. Ökologisch-faunistische Studien an südbrasilianischen Ameisen. Arb. Phys. Angew. Entom. Berlin-Dahlem 3: 26-48, 81-114, 1 pl., 5 text figs.
 1943. Die Überwinterung der Ameisen. Zeitschr. Morph. u. Ökol. Tiere 39: 217-275, 14 text figs.
 1944. Die Ameisenfauna von Fernando Poo. Zool. Jahrb. Abt. Syst. Ökol. Geog. Tiere 76: 413-490, 1 pl., 17 text figs.
- Emery, C.** 1899. Intorno alle larve di alcune formiche. Mem. R. Accad. Sci. Ist. Bologna 8: 3-10, 2 pls.
 1915. La vita delle formiche. vii+251 pp., 77 figs. Forino: Fratelli Bocca.
 1925. Fam. Formicidae, Subfam. Formicinae. Genera Insectorum. Fasc. 183: 302 pp., 4 pls.
- Escherich, K.** 1906. Die Ameise. Schilderung ihrer Lebensweise. xx+232 pp., 68 figs. Braunschweig: Friedr. Vieweg & Sohn.
 1917. Die Ameise (2 ed.). xvi+348 pp., 98 figs. Braunschweig: Friedr. Vieweg & Sohn.
- Fahringer, J.** 1922. Beiträge zur Kenntnis der Lebensweise einiger Chalciden. Zeitschr. Wiss. Insektenbiologie 17: 41-47.
- Fahringer, J., and F. Tölg.** 1912. Beiträge zur Kenntnis der Lebensweise und Entwicklungsgeschichte einiger Hautflügler. Verhandl. Naturfor. Ver. Brünn 50: 242-269, 2 pls.
- Fielde, A. M.** 1905. The sense of smell in ants. The Independent, Aug. 17, 1905, pp. 375-378, illus.
- Forbes, S. A.** 1908. Habits and behavior of the corn-field ant, *Lasius niger americanus*. Univ. Illinois Agric. Exper. Sta. Bull. 131: 30-45, 1 pl.
- Forel, A.** 1874. Les fourmis de la Suisse. Nouv. Mém. Soc. Helv. Sc. Nat. Zurich 26: 447 pp., 2 pls.
 1905. Einige biologische Beobachtungen des Herrn Prof. Dr. E. Göldi an brasilianischen Ameisen. Biol. Centralbl. 25: 170-181, 7 figs.
 1920. Les fourmis de la Suisse (2 ed.). 333 pp., 49 figs. La Chaux-de-Fond: Le Flambeau.
 1921. Le monde social des fourmis du globe comparé à celui de l'homme. Tome I. xiv+192 pp., 1 pl., 2 col. pls., 30 text figs. Genève: Librairie Kundig.

1922. Le monde social des fourmis du globe comparé à celui de l'homme. Tome III. vii+227 pp., 8 pls., 2 col. pls., 28 text figs. Genève: Librairie Kundig.
1923. Le monde social des fourmis du globe comparé à celui de l'homme. Tome V. vi+174 pp., 1 pl., 2 col. pls., 30 text figs. Genève: Librairie Kundig.
1928. The social world of ants compared with that of men. Translated by C. K. Ogden. 2 vol., 551 & 445 pp., 24 pls. (8 col.), 138 text figs. London & New York: G. P. Putnam's Sons, Ltd.
- Forel, A., and E. Jacobson.** 1909. Ameisen aus Java: und Krakatau. Notes from the Leyden Museum 31: 221-253.
- Furniss, R. L.** 1944. Carpenter ant control in Oregon. Oregon Agric. Exper. Sta. Cir. 158: 12 pp., 4 figs.
- Gantes, H.** 1949. Morphologie externe et croissance de quelques larves de Formicidés. Bull. Soc. Hist. Nat. Afrique du Nord 4: 71-97, 6 pls.
- Goetsch, W.** 1930. Beiträge zur Biologie körnersammelnder Ameisen. II. Zeitschr. Morph. Ökol. der Tiere 16: 371-452, 21 figs.
1937. Die Staaten der Ameisen. vii & 159 pp., 84 illus. Berlin: Julius Springer.
- Goot, P. van der.** 1915. Over de biologie der gramang-mier (*Plagiolepis longipes* Jerd.). Meded. Proefst. Midden-Java (Salatiga) No. 19: 60 pp.
1916. Verdere onderzoekingen omtrent de oeconomische beteekenis der gramang-mier. Meded. Proefst. Midden-Java (Salatiga) No. 22: 120 pp., 6 pls.
- Gösswald, K.** 1932. Ökologische Studien über die Ameisenfauna des mittleren Maingebietes. Zeitschr. Wiss. Zool. 142: 1-156.
- 1934-35. Ueber Ameisengäste und -schmarotzer des mittleren Maingebietes. Entom. Zeitschr. 48: 119-120, 125-127, 133-134, 142-143, 165-167, 175-176, 181-182, 13-15.
- Green, E. E.** 1896. [On *Oecophylla smaragdina*.]. Trans. Entom. Soc. London 1896: Proceedings, ix-x.
1900. Note on the web-spinning habits of the "red ant," *Oecophylla smaragdina*. Jour. Bombay Nat. Hist. Soc. 13: 181.
1904. Pupae of the "red ant" (*Oecophylla smaragdina*). Spolia Zeylanica 1: 73-74, 1 fig.
- Haviland, E. E.** 1947. Biology and control of the Allegheny mound ant. Jour. Econ. Entom. 40: 413-419.
- Herbert, H. J.** 1934. The ant: a 100% communist. Better Homes & Gardens, Oct., 1934: 20-21, 80-82, illus.
- Hingston, R. W. G.** 1923. A naturalist in Hindustan. 292 pp., illus. London: H. F. & G. Witherby.
- Hutchins, R. E.** 1935. Colobopsis, an ant of interesting habits. Nature Magazine 25: 172-173, 5 figs.
- Jacobson, E.** 1907. Notes on web-spinning ants. Victorian Naturalist 24: 36-38.
- Jacobson, E., and E. Wasmann.** 1905. Beobachtungen ueber *Polyrhachis dives* auf Java, die ihre Larven zum Spinnen der Nester benutzt. Notes from the Leyden Museum 25: 133-140.
- Janet, E.** 1897. Etudes sur les fourmis, les guêpes et les abeilles. Note 13. Sur le *Lasius mixtus*, l'*Antennophorus uhlmanni*, etc., 62 pp., 16 figs. Limoges: H. Ducourtieux.
1904. Observations sur les fourmis. 68 pp., 7 pls., 11 text figs. Limoges: Ducourtieux & Gout.
- Karawaiew, W.** 1898. Die nachembryonale Entwicklung von *Lasius flavus*. Zeitschr. Wiss. Zool. 64: 385-478, 4 pls., 15 text figs.
1900. [The internal metamorphosis and the anatomical peculiarities of the heart in the larvae of ants. (In Russian.)] Zapiski Kievskavo Obschestva Estestvoispytately 16: xli-xlii.
1906. Systematisch-Biologisches über drei Ameisen aus Buitenzorg. Zeitschr. Wiss. Insektenbiologie. 2: 369-376, 16 figs.
1929. Die Spinndrüsen der Weberameisen. Zool. Anz. 82: 247-256, 8 figs.
- Kellogg, V.** 1905. American insects. vii+674 pp., 13 pls., 812 text figs. New York: Henry Holt & Co.
- Kohl, H. J.** 1906. Zur Biologie der spinnenden Ameisen. Natur und Offenbarung 52: 166-169.

- Krausse, A.** 1929. Ameisenkunde. 172 pp., illus. Stuttgart: Alfred Kernen.
- Leeuwenhoeck, A. van.** 1719. *Arcana Naturae*. Vol. II.
- Lefroy, H. M.** 1923. Manual of entomology. xvi+552 pp., 179 figs. New York: Longmans, Green & Co.
- Lefroy, H. M. and F. M. Howlett.** 1909. Indian insect life. xii+786 pp., 84 col. pls., 536 text figs. Agric. Res. Inst. (Pusa). Calcutta and Simla: Thacker, Spink & Co.
- Long, A. M.** 1901. Red ants as an article of food. Jour. Bombay Nat. Hist. Soc. 13: 536.
- Lubbock, J.** 1882. Ants, bees, and wasps. xix+448 pp., 5 col. pls., 3 text figs. New York: D. Appelton & Co.
- Mann, W. M.** 1934. Stalking ants, savage and civilized. National Geogr. Mag. 66: 171-192, illus.
1948. Ant hill odyssey. 338 pp., 6 illus., 5 maps. Boston: Little, Brown & Co.
- Mayr, G.** 1855. Formicina austriaca. Beschreibung der bisher im österreichischen Kaiserstaate aufgefundenen Ameisen, etc. Verh. Zool. Bot. Gesell. Wien 5: 273-478, 1 pl.
- McCook, H. C.** 1882. The honey ants of the Garden of the Gods and the occident ant of the American plains. 188 pp., 13 pls. Philadelphia: J. B. Lippincott & Co.
- Menozzi, C.** 1936. Nuovi contributi alla conoscenza della fauna delle isole italiane dell'Egeo. VI. Hymenoptera—Formicidae. Boll. Lab. Zool. Gen. Agric. R. Ist. Sup. Agric. Portici 29: 262-311, 19 figs.
- Metcalf, C. L. and W. P. Flint.** 1932. Fundamentals of insect life. xi+581 pp., 315 figs. New York: McGraw-Hill Book Co., Inc.
- Muir, J.** 1911. My first summer in the Sierra. 354 pp., illus. Boston and New York: Houghton Mifflin Co.
- O'Brien, R. A.** 1910. Remarks on the habits of the green tree-ant of Australia. Proc. Zool. Soc. London 1910: 669-670.
- Park, O.** 1929. Ecological observations upon the myrmecocoles of *Formica ulkei* Emery, especially *Leptinus testaceus* Mueller. Psyche 36: 195-215, 1 fig.
1932. The myrmecocoles of *Lasius umbratus mixtus aphidicola* Walsh. Ann. Entom. Soc. Amer. 25: 77-88, 4 figs.
1935. Beetles associated with the mound-building ant, *Formica ulkei* Emery. Psyche 42: 216-231, 2 figs.
1947. The pselaphid at home and abroad. Sci. Monthly 65: 27-42, 6 figs.
- Parker, H. L.** 1932. Notes on a collecting spot in France and a chalcid larva (*Stilbula cynipiformis* Rossi). (Hymenop.: Eucharidae). Entom. News 43: 1-6, 3 figs.
- Parker, H. L. and W. R. Thompson.** 1925. Notes on the larvae of the Chalcidoidea. Ann. Entom. Soc. Amer. 18: 384-395, 3 pls.
- Peirson, H. B.** 1923. Insects attacking forest and shade trees. Maine Forest Service (Augusta) Bull. No. 1: 56 pp., 8 pls.
- Pérez, C.** 1903. Contribution à l'étude des métamorphoses. Bull. Sci. France Belgique 37: 195-427, 3 pls., 32 text figs.
- Pricer, J. L.** 1908. The life history of the carpenter ant. Biol. Bull. 14: 177-218, 7 figs.
- Ratzeburg, F. T. C.** 1832. Über die Entwicklung der fusslosen Hymenopteren-Larven, mit besonderer Rücksicht auf die Gattung *Formica*. Nova Acta Acad. Nat. Curios. (Bonn) 16: 145-176, 1 pl.
- Ridley, H. N.** 1890. On the habits of the caringa (*Formica gracilipes* Gray). Jour. Straits Branch Roy. Asiat. Soc. (Singapore) pp. 345-347.
1894. [Note on *Oecophylla smaragdina*.] Trans. Entom. Soc. London (Proc.) pp. xxxii-xxxiii.
- Roughley, T. C.** 1947. Wonders of the Great Barrier Reef. xiii+282 pp., 36 col. pls., 15 pls., 2 maps. New York: Charles Scribner's Sons.
- Ruschka, F.** 1924. Die europäisch-mediterranen Eucharidinae und Perilampinae. Deutsch. Entom. Zeitschr. 1924: 82-96, 12 figs.
- Sanderson, E. D.** 1912. Insect pests of farm, garden and orchard. xii+684 pp., 513 figs. New York: John Wiley & Sons.
- Sanderson, E. D. and L. M. Peairs.** 1921. Insect pests of farm, garden and orchard (2 ed.). vi+707 pp., 601 figs. New York: John Wiley & Sons, Inc.
- Saville-Kent, W.** 1897. The naturalist in Australia. 302 pp., 59 pls., 100 text figs. London: Chapman & Hall, Ltd.

- Schneiria, T. C., and L. M. Chace.** 1951. Carpenter ants. Nat. Hist. (New York) 60: 227-233, illus.
- Schwarz, H. F.** 1946. Bees, wasps and ants—Order Hymenoptera, in Curran, C. H., Insects of the Pacific World, xv+317 pp., 97 figs. [Ants—pp. 109-114, 2 figs.] New York: The Macmillan Co.
- Sharp, D.** 1909. Cambridge Natural History, Insects, Part II. xii+626 pp., 293 figs. London: Macmillan & Co., Ltd.
- Skwarra, E.** 1927. Über die Ernährungsweise der Larven von *Clytra quadripunctata* L. Zool. Anz. 71: 83-96.
- Stärcke, A.** 1933. Un nouveau *Camponotus* de Bornéo, habitant les tiges creuses de Nepenthes. Naturhistorisch Maandblad (Maastricht) 22: 29-31, 2 pls.
1939. Le faisceau des ocelles et la fonction qu'il nous suggère, avec un appendice sur l'antenne larvale des fourmis. Tijdschrift voor Entom. 82: XIX-XXVII, 5 figs.
- Talbot, M.** 1943. Population studies of the ant, *Prenolepis imparis* Say. Ecology 24: 31-44, 4 figs.
- Tanquary, M. C.** 1913. Biological and embryological studies on the Formicidae. Bull. Illinois State Lab. Nat. Hist. 9: 417-479, 8 pls.
- Wasmann, E.** 1894. Kritisches Verzeichniss der myrmecophilen und termitophilen Arthropoden. Mit Angabe der Lebensweise und Beschreibung neuer Arten. xvi+231 pp. Berlin.
- Weber, N. A.** 1935. The biology of the thatching ant, *Formica rufa obscuripes* Forel, in North Dakota. Ecological Monographs 5: 165-206, 6 figs.
1944. The neotropical coccid-tending ants of the genus *Acropyga* Roger. Ann. Entom. Soc. Amer. 37: 89-122, 1 pl.
- Weber, N. A. and J. L. Anderson.** 1950. Studies on Central African ants of the genus *Pseudolasius* Emery. Am. Mus. Novitates, No. 1443: 7 pp., 21 figs.
- Wellhouse, W. H.** 1926. How insects live: an elementary entomology. xv+435 pp., 333 figs. New York: The Macmillan Co.
- Wheeler, G. C.** 1938. Are ant larvae apodous? Psyche 45: 139-145, 2 pls.
- Wheeler, G. C. and E. H. Wheeler.** 1924. A new species of *Schizaspidia* (Eucharidae), with notes on a eulophid ant parasite. Psyche 31: 49-56, 2 figs.
- Wheeler, W. M.** 1900. A study of some Texan Ponerinae. Biol. Bull. 2: 1-31, 10 figs.
1907. The polymorphism of ants, with an account of some singular abnormalities due to parasitism. Bull. Amer. Mus. Nat. Hist. 23: 1-93, 6 pls.
1910. Ants, their structure, development and behavior. xxv+663 pp., 286 figs. New York: Columbia Univ. Press.
1914. The ants of the Baltic Amber. Schriften der Physikalisch-ökonomischen Gesellschaft zu Königsberg 1. Pr. 55: 1-142, 66 figs.
1915. On the presence and absence of cocoons among ants, the nest-spinning habits of the larvae and the significance of the black cocoons among certain Australian species. Ann. Entom. Soc. Amer. 8: 323-342, 5 figs.
1917. The Australian ant-genus *Myrmecorhynchus* (Ern. André) and its position in the subfamily Camponotinae. Trans. R. Soc. S. Australia 41: 14-19, 1 pl.
1920. The subfamilies of Formicidae, and other taxonomic notes. Psyche 27: 46-55, 3 figs.
1922. The ants collected by the American Museum Congo Expedition. Bull. Amer. Mus. Nat. Hist. 45: 39-269, 22 pls., 76 text figs., 41 maps.
1922b. Observations on Gigantiops destructor Fabricius and other leaping ants. Biol. Bull. 42: 185-201, 3 figs.
1923a. Social life among the insects. V. Parasitic ants and ant guests. Sci. Month. 16: 5-33, 15 figs.
1923b. Social life among the insects. vii+375 pp., 116 figs. New York: Harcourt, Brace & Co.
1926. Les sociétés d'insectes: leur origine-leur évolution. xii+468 pp., 61 figs. Paris: Gaston Doin & Cie.
1928a. The social insects, their origin and evolution. xviii+378 pp., 79 figs. New York: Harcourt, Brace & Co.
1928b. Mermis parasitism and intercastes among ants. Jour. Exper. Zool. 50: 165-237, 17 figs.
1929a. The identity of the ant genera *Gesomyrmex* Mayr and *Dimorphomyrmex* Ernest André. Psyche 36: 1-12, 1 fig.

- 1929b. A *Camponotus* mermithergate from Argentina. *Psyche* 36: 102-106, 1 fig.
1930. Two mermithergates of *Ectatomma*. *Psyche* 37: 48-54, 1 fig.
- 1933a. Colony-founding among ants, with an account of some primitive Australian species. x+179 pp., 29 figs. Cambridge: Harvard Univ. Press.
- 1933b. Mermis parasitism in some Australian and Mexican ants. *Psyche* 40: 20-31, 3 figs.
1937. Mosaics and other anomalies among ants. 95 pp., 18 figs. Cambridge: Harvard Univ. Press.
- Wheeler, W. M. and I. W. Bailey.** 1920. The feeding habits of pseudomyrmine and other ants. *Trans. Amer. Phil. Soc. (Art. 4)*: 235-279, 5 pls., 6 text figs.
- Yano, M.** 1911. [Japanese spined ants.] *Dobutsu-gaku Zashi [Jour. Zool.]* 23: 249-256, 2 pls.