Reprinted from JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY,
Vol. LXVI, September–December, 1958, pages 119–134.

A REVIEW OF THE SPECIES OF CREMATOGASTER, SENSU STRICTO, IN NORTH AMERICA (HYMENOPTERA: FORMICIDAE) PART I*

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Few groups of North American ants are as poorly understood taxonomically as *Crematogaster*. Ideas as to the identity and limits of some of our commoner widespread species have remained nebulous, and the "quadrinomial" system, formerly so widely used in myrmecology, may have led describers and reviewers toward only superficial examination of forms and the lumping of them under supposedly well known species as subspecies or mere varieties. At one time or another many of the forms have been lumped under *lineolata* (Say), but most of them show no more relation to typical *lineolata* than to any other species. Furthermore, several of these forms live side by side with *lineolata* in very similar ecological niches and yet do not intergrade with it, so far as I have been able to determine from a study of a large number of colonies and individuals. This seems ample evidence to consider them as "good" species.

The identity of four of the commonest and most widespread species, *lineolata* (Say), *cerasi* (Fitch), *laeviuscula* Mayr, and *clara* Mayr, seems to have been the subject of the greatest confusion and number of errors. This once resolved, the whole classification becomes easier to understand and falls readily into good order. Synonymy and discussions of each of these species will be found in Part III.

Previous to the publication of Dr. William S. Creighton's book on the ants of North America, 1950, no comprehensive treatment of *Crematogaster* had appeared since that of Emery, 1895. The attempt by Miss Jane Enzmann, 1946, to give a key, descriptions of new forms, and revisionary changes, could only have added to the confusion had it been accepted by American myrmecologists. Creighton, 1950, ably criticized this paper and there is no need for further comment here.

About 40 species are now known to me from North America

* Revised from a thesis presented at Cornell University, Ithaca, N. Y., in partial requirement for the degree of Doctor of Philosophy.

(including the West Indies and Mexico) and will be treated in this and following sections. Nearly half of the species are new to science. Thus *Crematogaster,* s. str., emerges as the third largest subgeneric group in North America from the point of view of number of species known. Only *Formica,* s. str. and *Pheidole,* s. str. have more. It is also my opinion that it is at least fourth, fifth, or sixth ranking in number of individuals and colonies from a continental standpoint. Only *Lasius* and *Formica* clearly outrank it in numbers and only *Camponotus,* s. lat., *Dorymyrmex, Pheidole* and *Solenopsis,* s. lat., seem to be rivals in this respect. This important genus in North America has not had the attention which it deserves.

The group is extremely adaptive. From the cypress swamps of the southeastern states to the cactus covered deserts of the southwest, there are one or more species present, each apparently well adapted to the particular environment. None of the species, however, seems to reach as far north or as high in altitude as some of the species of *Formica* or *Lasius* or several other genera.

ACKNOWLEDGMENTS AND BASIS OF STUDY

The material on which the study is based is as follows: The writer's personal collection of at least twenty thousand specimens, collected mostly in Iowa, Louisiana, Texas, Mississippi, Florida, New York, New Jersey, California, and Arizona, with scattered records in other states and in Mexico; several thousand specimens loaned by Dr. A. C. Cole and J. W. Jones, mostly from Tennessee, Utah, Idaho, Arizona, New Mexico, Colorado, and Florida; several hundred specimens from Arizona loaned by Dr. L. F. Byars; approximately 340 mounted specimens, mostly from California, Arizona, and Baja California, loaned by Dr. E. S. Ross of the California Academy of Natural Sciences; 860 mounted specimens, loaned from the National Museum and the collection of Dr. William M. Mann, at the kind recommendation of Dr. M. R. Smith; several hundred mounted specimens from the Museum of Comparative Zoology, loaned by Dr. William L. Brown, Jr., and the collection at Cornell University, which contains numerous mounted specimens.

I have become very indebted to Dr. William S. Creighton for the gift and loan of approximately five thousand specimens collected in the Southwestern States, in California, and in Mexico.

They were received too late to be included in the writer's unpublished thesis but have been treated in the present paper.

The writer has also been permitted to study the collections at the Museum of Comparative Zoology, Cambridge, Massachusetts, American Museum of Natural History, New York, N. Y., and the National Museum, Washington, D. C., through the kindness of Dr. Joseph Bequaert and Dr. William L. Brown, Jr., H. F. Schwarz and Dr. M. A. Cazier, and Dr. Marion R. Smith, respectively. To all of these men, the writer expresses his heartfelt appreciation. It is especially desired to tender appreciation to Dr. V. S. L. Pate, formerly of Cornell University, and Dr. Howard Evans, Department of Entomology, Cornell University, under whose direction the thesis which forms the basis for this paper was completed.

THE UNIQUE STING OF *Crematogaster*

The sting of *Crematogaster* is apparently unique in the Hymenoptera, and, since nothing seems to have been published about it, some description may not be out of place here.

Before describing the sting itself, it is necessary to show its relationship to other unique characters of *Crematogaster*. These ants have long been known to be able to swing their gasters up and over the thorax and head so that the tip of the gaster with its sting is presented in a cephalad direction. When in this defensive position a drop of liquid can be seen to exude from, and cling to, the sting. The singular position of the gaster is possible through several modifications. The dorsum of the petiole is flattened, the postpetiole is attached to the apparent anterior dorsum of the gaster rather than its base, and the gaster itself is flattened above, quite convex below, and capable of considerable flexion dorsally but very little ventrally. Thus when the animal takes its defensive position the petiole is raised until its dorsal face meets the declivous face of the epinotum, the postpetiolar attachment to the gaster permits a cephalad turning of the gaster, and the gaster itself is still farther flexed in that direction. Furthermore, nearly all species of *Crematogaster* (at least the North American group studied and various tropical species available to the author) have some very constant hairs or setae on the petiole and postpetiole, often only a single pair posteriodorsally. When in the defensive position, these setae

impinge or rest upon the surfaces of the succeeding parts, and therefore, I believe, act as kinesthetic sense organs, enabling the insect to know whether or not her gaster is in the right position.

Microscopic examination of the North American species and all others available shows that the sting is much flattened and enlarged at the tip, in fact spatulate, and so thin and delicate there that it may easily be bent back and forth with a needle without breaking, even in well dried specimens. Also, if live specimens are observed under high magnification, the poison droplet is seen to exude not from the tip or near it but from an opening just preceding the spatulate portion. I believe that these ants are quite unable to sting, but use their stings merely as an outlet for the defensive liquid, whose vile smell seems very obnoxious to insect enemies. The spatulate portion of the sting is probably an adaptation for increasing surface area and thus forms a base to which the poison droplet can cling. Some fine hairs which surround the cloacal opening probably act as guard hairs to prevent the droplet from spreading back on the surface of the gaster.

Upon dissection (*cerasi* used for this dissection) the sting is seen to consist of the usual parts, with shaft and stylet and two very slender, delicate lancets. The end of the stylet forms the spatulate portion. I believe the lancets to be non-functional.

In testing this concept of the inability of *Crematogaster* to sting, I have let them crawl on my hands many times while collecting. These ants then spread their legs and flatten themselves against the skin, and are able to deliver a sharp little nip with their strong mandibles alone, but I have never seen the tip of the gaster with its sting placed in contact with the skin. Indeed, for a long time I believed these ants incapable of flexing their gasters far enough ventrally to even touch the cloacal area to the surface upon which they were standing. But this is not correct, for in the case of one species at least, I have observed them thus bending their gasters, but for an altogether different purpose than that of stinging.

The species was *C. vermiculata* Emery which I have observed alive under magnification bending their gasters downward and touching the surface beneath in order to wipe poison droplets off their stings. They draw their whole bodies forward a little while doing this leaving a short wet line of poison. Probably this

habit is necessary so that the liquid will not harden on the sting and clog it. Possibly many or all of the other species will eventually be shown to have this habit.

I seriously doubt that these phenomena have been closely observed previously, and therefore believe that accounts of the "stinging" powers of *Crematogaster* must be mistrusted. The bite of *Crematogaster* is almost indistinguishable in sensation from a sharp prick as if with a sting. I imagine that the often very active and populous nests of *Crematogaster* in the tropics could make things interesting enough for a collector so that he would be little concerned as to whether he were being "bitten" or "stung".

HABITS

The habits of the North American species of *Crematogaster* have been the subject of several excellent papers, notably those of Wheeler, 1906 and 1919, so that there is little that the writer wishes to add. These ants' propensity for constructing little carton or earthen sheds for the protection of their aphid or coccid "cattle" or sometimes constructing large enough carton nests to serve as homes for themselves, has been well documented (Osten Sacken, 1862; Couper, 1863; Trelease, 1882; Atkinson, 1887; Comstock, *in litt.* to Wheeler; Wheeler, 1906, etc.). It should be pointed out, however, that much of this early work must now be rechecked, due to the lack of proper identification of the species involved. Wheeler first realized this in his 1919 paper describing *atkinsoni*, a species which has a much greater tendency to build carton nests than any other North American species, and he reversed his former opinion that the carton making habits of *"lineolata"* were vestigial instincts, left over from a tropical existence where this habit is the usual one, and now restricted to certain special conditions and occasions.

However, it is possible that Wheeler's 1906 opinions are not altogether implausible. I have seen many nests of *atkinsoni* around Miami, Florida, where this species had merely utilized available spaces in stumps and logs or hollow stems of bushes rather than build a carton nest, and as a corollary, I know of at least one well constructed nest from a region far out of the known range of *atkinsoni*, a carton nest in the Cornell University collection presented by Mr. Rhea from Reynoldsville, Jefferson County, Pennsylvania, altitude 1300 feet. My observations in

south Florida thus seem to lend some credence to Professor Atkinson's original view (1887) that high water levels had forced the ants to build a carton nest high above the ground rather than in the usual sites. Even *atkinsoni* apparently does not build its carton nest when it is not necessary, and it is apparent also, from the Reynoldsville, Pennsylvania nest, that on rare occasions at least, one of the northern species must be capable of constructing carton nests.

Wheeler, 1906, had also found some rather large carton masses under stones at about 7000 feet altitude in Colorado. These ants, identified by Wheeler as *lineolata,* were almost certainly not that species, however.

The small succursal nests or "tents" housing the "cattle" of the ants appear to be constructed by several species and to be of two types: those fashioned of wood and plant detritus, thus true carton, and those constructed of earth or sand. Wheeler, 1906, records that he was able to find these tents on only one occasion; this was in New Jersey and was the work of *pilosa* Emery, a species that prefers moist nesting situations. The writer observed several structures, apparently composed of earth, far out over the water on the cattails growing in Bayou Beouf near Alexandria, Louisiana. The architects were *clara* Mayr, another species which prefers swampy, moist nesting sites. But at this writing, it is impossible to fix the identification of the species involved in numerous other records. I should add too, that the above record for *clara* seems to be an unusual one, as I have never seen any other structures made by them in any other locality.

Most of the species march in long, narrow files, and gather what prey or dead insect material they can, but depend also on the secretions of aphids and coccids. Wheeler, 1910, records that he often found *punctulata* Emery attending dense herds of *Eriococcus texanus* on the roots of plants in central Texas. This habit has not been recorded for any other species.

A few of the species, notably *ashmeadi,* are aboreal, nesting in hollow twigs and branches. *C. sanguinea* and some of its relatives nest in twigs and branches and *Tillandsia. C. vermiculata* Emery is aboreal also. I found workers running on the trunk of a large cypress tree in a swamp near Alexandria, Louisiana, and assume, because the tree was surrounded by water, that they were nesting somewhere up in the tree. At Skene near Cleveland,

Mississippi, I found several polydomous colonies in dry trunk thorns of honeylocust in cypress swamps and observed them marching in files on cypress trees. The young colonies of C. *laeviuscula* Mayr are usually arboreal, nesting in cynipid galls and twigs and branches, but the largest colonies are often in rotten tree trunks or logs. *C. clara* utilizes a variety of arboreal and semi-arboreal nesting sites such as cane stems, rotten limbs and tree trunks, rotten logs and stumps.

In the western deserts several of the species which occur there have achieved notable ecological adaptation by living in the lower stems and roots or in the soil among the roots of such common desert plants as the creosote bush and several species of cholla cactuses. It may be postulated that such adaptation ensures a more adequate and even supply of moisture than would otherwise be available. Subterranean pasturage of aphids or coccids may also be suspected for these species but I have no first hand evidence of this habit for them at present. *C. depilis* Wheeler is a widespread species in this group and together with related species forms one of the dominant and most abundant segments of the desert ant fauna.

Most of the other species nest under stones or rocks or in old stumps or logs. I found *C. punctulata* Emery nesting directly in the ground near De Ridder, Louisiana and in several other localities. There is a certain plasticity and adaptability in the behavior of all the species, but some appear to be more restricted in habitat than others.

The remarks under each species in the taxonomic sections contain brief discussions of the habits and ecology known specifically for that species.

THE QUESTION OF *Acrocoelia*

The name *Acrocoelia* has been used so many times for the subgenus termed *Crematogaster,* s. str., in the present paper, that I feel some explanation is needed.

The original description of *Crematogaster* is that of Lund in June, 1831, in an article "sur les Habitudes de quelques Fourmis du Bresil" published in the Annales des Sciences Naturelles, Vol 23, p. 123. A German translation of this article appeared the same year in von Froriep's Notizen, Vol. 32, p. 97. Lund's description is brief but leaves no doubt that he had *Crematogaster* in mind. However, he did not assign any species to this

new genus. There the matter rested until Mayr picked up the name *Crematogaster* twenty-four years later. In the meantime Mayr, 1852, (Verh. Zool.-bot. Ver. Wien, Vol. 2, p. 146) had described a new genus *Acrocoelia,* and had assigned two species, *ruficeps* Mayr and *schmidti* Mayr, to it. But in 1855, (Verh. Zool.-bot. Ver. Wien, Vol. 5, p. 468,) Mayr realized that *Acrocoelia* was congeneric with *Crematogaster,* and placed *Formica scutellaris* Olivier and *Myrmica sordidula* Nylander in *Crematogaster* and sank both *ruficeps* Mayr and *schmidti* Mayr as synonyms of *scutellaris* Olivier.

In the remaining years of the 19th century numerous species were described in *Crematogaster* by various authors until it became a very large genus. But no genotype was set until the designation of *C. scutellaris* (Olivier) by Bingham, 1903, in the Fauna of British India, Hym., Vol. 2, p. 124. This designation was an entirely proper one. In fact, *scutellaris* Olivier and *sordidula* Nylander were the only species open for designation, since they were the first species included in *Crematogaster* (see opinion 46 of the International Commission on Zoological Nomenclature). Nevertheless, Emery, 1921, in Wytsman's Genera Insectorum, fasc. 174, attempted to negate Bingham's designation and designated instead *Formica acuta* Fabricius as the type of his "*Crematogaster,* sensu stricto", and *Acrocoelia ruficeps* Mayr = *Formica scutellaris* Olivier as the type of *Crematogaster* subgenus *Acrocoelia* Mayr. This was done on the ground that Lund had only South American species in mind in describing *Crematogaster.* But as Lund never specifically limited his concept of the genus *Crematogaster* to South American specimens and did not specifically mention or indicate any species, and as several of the subgenera of *Crematogaster,* including the *Crematogaster,* s. str. of the present work, occur in South America, Emery's procedure cannot be justified under any rule or opinion of the nomenclatorial code. *Acrocoelia* Mayr must therefore fall as an absolute isogentopyic synonym of *Crematogaster* Lund, while the "*Crematogaster,* sensu stricto," of Emery, 1921, is a synonym of *Crematogaster* subgenus *Eucrema* Santschi, 1918.

It may be noted here also that Sherborn's Index Animalium for 1801–1850 contains two curious errors. In the index to generic names, showing trivial names associated with each, 1801–1850, the specific names "*cephalotes*" and "*histiea*" are listed

for *Crematogaster*. But both of Lund's papers clearly show that he considered *cephalotes* the type of *Atta* Fabr., and "*histiea*" is not mentioned.

Since writing the above, I have examined *Crematogaster acuta* (Fabr.). Judging from its morphology, especially that of the female, I believe there is strong presumptive evidence that it is parasitic. The female is small compared with the worker, with a very smooth and highly polished integument as constrasted with the roughly sculptured integument of the worker, and has a disproportionately long apical mandibular tooth. The thorax is slender and the abdomen small and there are many other striking characters.

But parasitic or not, it is certainly a highly modified form and quite remote from any "basic" or "typical" stock in the genus. The designation of such a species as the type could have had a very unsettling effect on the taxonomy of *Crematogaster*, possibly leading to the splitting of the genus into several genera with most of the species now in *Crematogaster* having to be removed entirely, or other nomenclatorial juggling which I would deem deplorable and foolish.

CREMATOGASTER Lund

Crematogaster Lund, Ann. So. Nat., Vol. 23, p. 132 (1831).
Crematogaster Mayr, Verh. Zool.-bot. Ver. Wien, Vol. 5, p. 468 (1855).
Crematogaster Santschi, Bull. Soc. Ent. France, p. 182 (1918).
Crematogaster Emery, Wytsman's Genera Insectorum, fasc. 174, p. 127, (1921).
Acrocoelia Mayr, Verh. Zool.-bot. Ver. Wein, Vol. 2, p. 146 (1852).
Myrmica (in part) Say, Sykes, Nylander, Fitch, etc.
Formica (in part) Olivier, Latreille, Fabricus, etc.
Atta (in part); *Monomarium* (in part); *Oecodoma* (in part) Buckley (1867).

Type: *Formica scutellaris* Olivier (designation of Bingham, 1903).

WORKERS.—Small to medium sized ants, usually monomorphic. Mandibles with a few strong teeth, often 4 in number. Frontal carinae far apart, the clypeus evenly and convexly produced between them. Antennae ordinarily 11-jointed, rarely 10- or even 9-jointed. Usually the last 2 or 3 joints of the funiculus forming a heavy club; rarely the last 4 joints form

it, or the funiculus filiform. Eyes of moderate size, situated at about the middle of the sides of the head.

Thorax always with distinct meso-spinotal impression. Pro-mesonotal impression variable. Epinotum armed with a pair of spines, rarely unarmed. Metathoracic glands well developed, in certain species enormously so.

Petiole flattened above and thus capable of being raised until flush against the declivity of the epinotum. The bases of the epinotal spines are always far enough apart so as not to hinder this operation. Postpetiole somewhat more nodiform but never strongly so, always attached to the apparent anterio-dorsal surface of the gaster. This odd placement is allowed by a strong overlapping of the first gastric sternite onto the anterior dorsal surface. From above, the gaster is heart-shaped, tapering more or less acutely; in profile, it is quite convex below and flattened above. It may be flexed only dorsally. This whole petiolar-gastral apparatus allows the gaster to be raised up over the head and thorax and the tip of the gaster to be presented forward.

Sting incapable of piercing, very delicate, thin, and broad at apex, spatulate in shape, with the opening for poison just before the flattened portion. The poison appears to be repugnatory toward other insects.

FEMALES.—Usually much larger than the workers and mostly with the structures of the workers as they apply to the petiole, postpetiole, and gaster. Eyes larger; ocelli present. Mandibles often with a few more teeth than in the worker. Thorax and gaster usually large. Mesonotum overlapping the pronotum, seen from above. Epinotal spines usually shorter than in the worker. Mesosternum convex below. Sting as in the worker.

MALES.—Much smaller than the females, in general about the same size as the workers, although in a few species considerably larger.

Mandibles denticulate, with fewer teeth than workers or females. Eyes and ocelli well developed. Antennae 12-jointed, rarely 10 or 11-jointed. Scapes very short. First joints of funiculi very short and then the rest filiform or somewhat nodiform. Thorax similar to the female. No epinotal spines or these much reduced. Mayrian furrows present or absent. Petiole flat above and postpetiolar attachment to gaster similar to that of worker and female but less strongly modified. The genitalia have not been studied, except for a few species examined by the writer and described below.

Subgenus CREMATOGASTER, sensu stricto

Crematogaster, subgenus *Crematogaster* Santschi, Bull. Soc. Ent. France, p. 183 (1918)—M. R. Smith, in Hymenoptera of America north of Mexico, p. 808 (1951).

Crematogaster (in part) Mayr (1855), Bingham (1903), etc.

Acrocoelia Mayr, Verh. Zool.-bot. Ver. Wein, Vol. 2, p. 146 (1852).

Crematogaster subgenus *Acrocoelia* Emery, Wytsman's Genera

Insectorum, fasc. 174, p. 140 (1921). Type designated: *Acrocoelia ruficeps* Mayr = *Formica scutellaris* Olivier).

Crematogaster subgenus *Acrocoelia* M. R. Smith, Amer. Mid. Nat., Vol. 37, no. 3, p. 563 (1947).—Creighton, Bull. Mus. Comp. Zool. Harv., Vol. 104, p. 206 (1950).

Type: *Acrocoelia ruficeps* Mayr = *Formica scutellaris* Olivier.

WORKERS.—With the characters of the genus. Distinguishable from other subgenera by always having a 3-jointed antennal club, antennae 11-jointed, epinotal spines of normal size, metathoracic glands not excessively developed, petiole trapezoidal seen from above, and postpetiole with definite median impression or groove.

In addition a few other characters may be described, which will hold good, at least, for the Nearctic species.

The mandibles have 4 strong teeth. The mandibles, clypeus, and genae always more or less striate. The head robust, often broader than long, with more or less convex sides; the posterior border straight in the middle or slightly concave. Scapes usually surpassing the hind corners of the head a little or at least nearly reaching them. The 3–6th funicular joints usually as broad as long or broader, rarely longer than broad.

Pronotum usually with distinct shoulders, sometimes with only a trace of them; if present, there are nearly always shallow, oblique impressions on the sides of pronotum. Oblique pro-mesonotal impressions usually present on the dorsum but these usually not very strong. Mesoepinotal impression shallow to deep, always distinct. Often the mesonotum showing a somewhat angulate declivous surface down into the mesoepinotal impression when seen in profile. Epinotal spines variable in size and shape. Epinotal spiracles immediately latero-ventrad of the bases of the spines. Postpetiole variable in shape and depth of median impression. I have termed the two lobular sections thus separated the "hemilobes." Mesonotum usually with a median longitudinal carina.

Sculpture varying from smooth and shining to striate or rugose or to densely punctate. Hairs varying from fine and slender to bristle-like, either scattered over most of the surface and thus fairly numerous or arranged in small groups, usually quite constant within the species in either case. In nearly all species there are a pair of constant hairs or setae on the posterio lateral corners of the petiole, and a similar pair or more than one pair on the postpetiole, whose function is discussed in a previous section.

FEMALES.—Mostly with the characters of the workers except for winged thorax and large abdomen. Eyes larger and ocelli present, sometimes large. Mandibles usually with 5 teeth, occasionally with six. Funiculi more evenly incrassate, sometimes without a definite club.

Mesonotum overlapping the pronotum seen from above, the latter rather narrow in front. Mesosternum very convex below. Sides of thorax more or less striate. Epinotum with small spines. Metanotum narrow, beneath the scutellum; it may or may not be produced into a blunt point. Petiole,

postpetiole and gaster similar to worker. Impression on postpetiole much less developed and anterior lateral corners much more developed than in the workers.

Two aberrant forms, known only from females, have been described from North America as workerless parasites. These are very small, very pilose females, but otherwise show little specialization. As I shall show, these "species"—*kennedyi* Wheeler and *creightoni* Wheeler—are probably B-form or mutant females of the so-called "host" species with which they were found, *cerasi* (Fitch) and *pilosa* Emery, respectively.

MALES.—Size variable, often smaller than the worker. Mandibles 3-denticulate with rare exceptions. Scapes short. Funicular joints, at least the basal ones, rather nodiform. Head with convex sides and posterior border. Eyes large, hemispherical. Ocelli small to large. Thorax similar to that of female. Mayrian furrows absent in this subgenus. Sometimes a transverse impression on posterior of mesonotum. Epinotal spines absent or reduced to teeth. Postpetiole without trace of longitudinal impression.

The eastern species of *Crematogaster* all have rather small males with distinct but small ocelli. Several western species, however, notably *californica* Emery, have large males with relatively enormous ocelli, an adaptation, possibly, to nocturnal wedding flights.

Genitalia retractile, usually only the tips of the parameres showing; of simple construction, the aedoeagus consisting of two flattened plates, and when seen from the side, with simple, roundly convex apex and a series of retrorse teeth on ventral border, otherwise unmodified. Volsellae very simple in construction, each consisting only of a rather simple, flattened, oval plate much smaller than the aedoeagal plates, and without development into distinct digitus and cuspis, merely with a deep notch on ventral side. Parameres triangulately lobate, densely clothed with setae apically, hollowed out on inner side and thus forming an enclosing structure for the other parts.

The genitalia of the various species of North American *Crematogaster,* s. str., appear to have such a simple construction and to vary so little between the species, that I consider them useless for species diagnosis. The western species with giant males have very large genitalia, but the construction is nevertheless very similar.

The species groups

Several rather poorly defined species groups may be recognized. These are hard to delimit but may aid somewhat in understanding the various interspecific relationships.

1. The *coarctata* group. This group is the only one having species whose workers regularly have large striae on the lower part of the mesopleura, the thoracic dorsum densely and strongly striate, the mesonotal declivity very strong and angulate, the

antennae long, the sulcus of the postpetiole rather shallow and the hemilobes semiangulate behind, and the hairs fine, elongate and sparse. The females are among the largest of North American Crematogasteri.

2. The *californica-opaca* group. This large and complex group is characterized in the worker by a basically densely punctate head and thorax, although sometimes this sculpture is more or less obscured by rugae on the thorax or lost on the head. The pilosity varies from very pilose species to extremely sparsely haired species like *depilis*. The known females of the species closely related to *californica* are all comparatively large elongate insects measuring about 10 mm. with the head subrectangular and having large eyes and ocelli. The males of some of these species are extremely large and have the scutellum unimpressed laterally and have large eyes and ocelli, possibly for nocturnal use.

3. The *lineolata-laeviuscula* group. As in the preceding group I have tried to emphasize the complex nature of this group by giving it a compound name. The group varies from strongly rugose forms like *lineolata* to smooth and shining forms like *laeviuscula* but nevertheless comprises an inseparable complex. The mesonotal declivity is usually present. The epinotal spines are divergent and straight or nearly so. The petiole is broad and the postpetiole has simple, rounded hemilobes with rather moderate sulcus. The male always has the scutellum laterally impressed.

4. The *sanguinea-ashmeadi* group. This too is a complex group composed of *sanguinea* and its close relatives and *ashmeadi* and its relatives. Nearly all the species have a curious outward thickening or convexity on the bases of the spinotal spines. This involves only the base in long-spined forms like *sanguinea* but the whole spine in very short-spined forms like *ashmeadi*. This group is essentially arboreal.

Besides the four large groups above, two groups are known from a single new species each. These are treated in Part II.

If we postulate that the North American *Crematogaster*, s. str., fauna originated from several immigration waves across the Siberia-Alaskan land bridge, then it seems reasonable that the *coarctata* group may represent the last of such waves, having never spread far from the west coast, whereas the *sanguinea-*

ashmeadi group may represent the oldest wave, being the only group to have representatives in the West Indies, and having the only species with a possible discontinuous distribution—*C. vermiculata.*

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